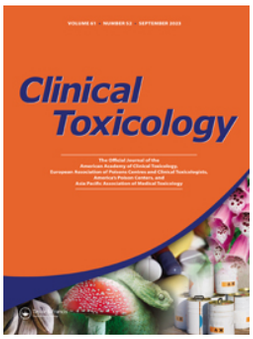

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1. *In vivo* viability of a polyclonal ovine antibody fab fragment as a countermeasure against ricin toxicity

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Background: Ricin is a plant-derived toxin isolated from seeds of the castor oil plant *Ricinus communis* and is rated by the United States Centers for Disease Control and Prevention as a category B bioterrorism agent. Death from ricin poisoning can occur within 36–72 hours of exposure and there is currently no approved therapy for ricin intoxication. A polyclonal ovine antibody Fab (PR022) has been developed by immunising sheep with a *Ricinus communis*-derived protein and purified using a polyclonal ovine antibody platform currently used to manufacture two commercial therapeutics; crotalidae polyvalent immune Fab (ovine) (CroFab®) and digoxin immune Fab (ovine) (DigiFab). This current study was conducted to establish if an antibody fragment generated using a polyclonal ovine antibody platform can demonstrate a strong neutralising effect in an animal model.
Methods: LD_{50} ricin murine models were established at two different contract research organizations using two different ricin batches. Neutralization studies of ricin preincubated for 30 minutes with varying doses of PR022 and administered by the intraperitoneal (IP) route were conducted. In the first study, eight groups of Swiss Webster mice were exposed to either vehicle alone, PR022 alone, ricin alone, or five different doses of PR022 preincubated with ricin via the IP route. Mice were observed for weight change and mortality over a 4-day period. In the second study, two experiments of six groups of BALB/c mice were treated with vehicle alone, or a total of 7 different doses of PR022 across two different experiments preincubated with ricin via the IP route. Body weight, clinical observations, and survival was monitored over a 14-day study period.
Results: Animals challenged with PR022 alone did not display any adverse clinical signs, minimal weight loss and overall weight gain by 96 hours. None of the mice in the first study exposed to all but the lowest dose of PR022 preincubated for 30 minutes with ricin succumbed to the challenge. Some animals displayed weight loss and clinical signs, but these were less severe than in the ricin alone animals and mostly reversed by end of study. In the second study, PR022 preincubated with ricin prior to IP administration appeared efficacious in a dose-dependent manner as evidenced by improved survival rates, decreased incidence and severity of toxic signs and presentation of body weight loss following ricin challenge.
Conclusions: Compared to ricin only controls, PR022 incubated with ricin prior to IP administration appeared efficacious in a dose-dependent manner. Overall, PR022 appeared well tolerated and proved efficacious at neutralizing ricin toxicity in two different IP mouse ricin models. This study shows the potential of the ovine platform as a scalable and viable solution to the lack of medical countermeasures to ricin toxicity.

KEYWORDS Ricin; non-clinical; antidote

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2. Efficacy of sodium tetrathionate when administered intramuscularly for the treatment of acute oral cyanide toxicity in a swine model (*Sus scrofa*)

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Background: Cyanide (CN) has the potential to be weaponized by terrorist groups in deadly chemical attacks, as CN can be easily stored and readily accessible to contaminate food and water supplies. Currently, there are no FDA approved antidotes specific to oral CN. Although there are antidotes available for inhaled CN, these are expensive, resource intensive, and time consuming. For example, hydroxocobalamin requires intravenous (IV) access and administration in high volumes thus limiting its use in a mass casualty, battlefield setting. This gap could be filled by administration of a low volume intramuscularly administered (IM) countermeasure. Such countermeasure would have more practical applicability in mass casualty prehospital, and warfare settings. Sodium tetrathionate has been studied as an IM countermeasure against IV cyanide toxicity in a swine model. In contrast to IV cyanide, oral exposures to cyanide can lead to more severe, prolonged toxicity as the stomach can serve as a reservoir for cyanide after ingestion. In this study, we evaluated the efficacy of IM administration of sodium tetrathionate in a swine model of oral cyanide toxicity to analyze survival compared to untreated swine.
Methods: Anesthetized Yorkshire swine ($n = 10$), weighing 45–55 kg were randomized into a non-treated control group (CTR, $n = 4$) or an IM sodium tetrathionate-treated group ($n = 6$). All animals received 8 mg/kg of oral CN. The treatment group

received 10 mL of sodium tetrathionate (2M stock, with an average dose of 124 mg/kg) intramuscularly 5 minutes post-CN toxicity. All animals were observed until death criteria or study end (120-minutes post-oral CN administration). Continuous hemodynamics, blood chemistries, and ABGs were recorded thorough the study for statistical analyses.
Results: There was 100% survival in the treatment group compared to 0% survival in the CTR group at 120 minutes ($P < 0.0011$). CTR animals had an average time of death of 35 ± 8 minutes and average time to apnea of 10 ± 1.3 minutes. Lactate concentrations were significantly lower in the treatment group (2.1 ± 0.5 mM) compared to CTR (5.0 ± 0.9 mM; $P < 0.02$), at 20 minutes. There was a significant difference in pO_2 levels (mmHg) between CTR (41 ± 5) and sodium tetrathionate (95 ± 4) ($P < 0.0008$). Heart rate, cardiac output, and venous oxygen saturation (SVO_2) were also improved in sodium tetrathionate treated animals compared to CTR.
Conclusions: Treatment with IM sodium tetrathionate improved survival in animals exposed to a lethal dose of oral cyanide when compared to control animals. Sodium tetrathionate may be an effective countermeasure for military and civilian populations who have been exposed to cyanide. Future studies are needed to assess the feasibility of this compound as a potential medical countermeasure for cyanide toxicity.

KEYWORDS Cyanide; dimethyl trisulfide; MASCAL
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Ethical approval

The experiments reported herein were conducted according to the principles set forth in the National Institute of Health Publication No. 80-23, Guide for the Care and Use of Laboratory Animals and the Animal Welfare Act of 1966, as amended.

Disclosure statement

The views expressed are those of the authors and do not reflect the official views or policy of the Department of Defense or its Components. No potential conflict of interest was reported by the author(s).

3. Plasma levels of CXCL14 are an early prognostic biomarker for poor outcome in acetaminophen overdose patients

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Background: Acetaminophen (APAP) overdose is the main cause of acute liver failure (ALF) in Western countries. While early presenting patients can be effectively treated with N-acetylcysteine, late presenting patients are at high risk for ALF and potentially death without a liver transplant. Plasma ALT activities only represent acute liver cell death but cannot differentiate between patients who will recover and those who develop ALF. Therefore, the objective of this investigation was to assess the potential of CXCL14 as a predictive biomarker for negative outcome after APAP-induced liver injury.
Methods: Serial blood samples were collected from consenting APAP overdose patients over several days after admission to the hospital. Plasma levels of CXCL14 were measured by ELISA in three groups of patients: no liver injury (< 100 U/L ALT; $n = 7$), severe liver injury (> 1,000 U/L) and survivors ($n = 29$) and non-survivors ($n = 16$).
Results: Plasma levels of CXCL14 were elevated in survivors on the first day (2,215 ± 303 pg/mL) compared to overdose patients who did not develop liver injury (635 ± 125 pg/ml) but were reduced significantly by Day 3 (1,200 ± 133 pg/ml). In contrast, CXCL14 levels were significantly elevated in the non-survivors (Day 1: 5,900 ± 1,400; Day 3: 8,400 ± 2,500 pg/ml) compared to survivors over time. There was no significant difference in peak plasma ALT activities between survivors and non-survivors. Receiver-Operating Characteristic (ROC) Analysis indicated that CXCL14 levels on all three days had a high capacity to predict death with 100% sensitivity: Day 1 (AUC 0.812, $P = 0.0044$), Day 2 (AUC 0.968, $P < 0.0001$), Day 3 (AUC 1.0, $P < 0.0001$). In contrast, there was no significant correlation between ALT and CXCL14 levels ($r^2 = 0.013$, $P = 0.136$) or bilirubin and CXCL14 levels ($r^2 = 0.0013$, $P = 0.655$). Evaluation of an independent validation cohort of patients is in progress. To assess if CXCL14 is generated in the liver, CXCL14 was measured in an explant from an APAP overdose patient. Compared to control livers, the APAP overdose liver showed increased CXCL14 protein levels by western blotting and by immunohistochemistry in hepatocytes.
Conclusions: Hepatocyte-derived CXCL14 is significantly elevated in plasma of non-surviving APAP overdose patients compared to survivors with similar peak ALT values. Thus, plasma CXCL14 levels 1-2 days after peak of injury are a highly effective early prognostic biomarker to predict negative outcome after severe APAP-induced liver injury.

KEYWORDS Acetaminophen overdose; prognostic biomarker; CXCL-14
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4. Honey and jam neutralize button battery injury in a porcine oesophageal model

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Background: Button battery ingestion in children can cause rapid and extensive alkaline oesophageal injury. Given the potential harm of button battery ingestion, there has been increasing interest to develop effective, accessible, and safe first-aid strategies to minimize tissue injury will awaiting definitive removal. Recent animal studies have shown the potential benefits of administering small doses of honey every 10–15 minutes to reduce injury. The objective of this study is to determine which household substances could potentially be used as early-treatment first aid strategies for reducing battery-induced injury.
Methods: In a cadaveric porcine oesophageal tissue model, a 3VCR2032 button battery was placed on oesophageal mucosal section with the excess tissue folded over the battery. Every 10 minutes, the battery was lifted, and the pH measured. The battery was returned and then the mucosa irrigated with 10 ml of test substance (saline (control), honey and jam [four brands each], orange juice, yoghurt, milk, and Coca-Cola®). For a total of six irrigations. Tissue pH was measured every 10 minutes until 120 minutes, at which time the macroscopic ulceration size was evaluated. Each substance was tested at least six times. In the second experiment, the best performing substances (jam and honey) were tested in an intact oesophagus model (battery not

lifted) against saline, with the button battery inserted into the lumen. The substances were irrigated into the superior end every 10 minutes for six applications. Tissue pH, macroscopic change and histopathology were evaluated at 60, 90 and 120 minutes.
Results: In the first experiment compared to saline, only honey and jam had a lower mean tissue pH at 120 minutes 8.0 (SD: 0.9) and 7.1 (SD: 1.7) respectively, compared to saline 11.9 (SD: 0.6) ($P < 0.0001$). Additionally, honey and jam had a smaller mean area of ulceration 0.24cm^2 (SD: 0.17) and 0.37cm^2 (SD: 0.40) respectively, compared to saline 3.90 cm^2 (SD: 1.03) ($P < 0.0001$). In the intact oesophageal model (experiment 2), compared to saline, honey and jam had significantly lower mean tissue pH and a smaller mean area of ulceration at all time points. Microscopically, both honey and jam appeared to protect oesophageal mucosal tissue at 60 and 90 minutes, with minimal microscopic changes. Compared to saline (control) samples that had changes evident in the mucosal and submucosal layers at the first time point (60 minutes). At 120 minutes (60 minutes after the last irrigation) the honey oesophageal samples had less damage than jam.
Conclusions: Button battery ingestion has the potential to cause severe oesophageal injury. Although definitive removal remains the clinical standard, there is in vitro evidence that the use of first-aid strategies such as honey and jam prior to endoscopic removal may decrease the extent of injury. This cadaveric pig model found that honey and jam were able to neutralize the alkaline injury caused by a button battery resulting in a less micro and macroscopic injury. Honey is already recommended in many treatment guidelines and jam should be considered as an alternative when honey is unavailable.

KEYWORDS Button battery ingestion; oesophageal injury; first-aid
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5. Randomized controlled trial of ANEB-001 as an antidote for acute cannabinoid intoxication in healthy adults

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Background: Emergency department visits due to acute cannabinoid intoxication (ACI) have increased dramatically as US states have liberalized cannabis policy. Serious clinical effects of ACI can include neuropsychiatric symptoms (e.g., panic attacks, psychosis), tachycardia, and hypotension, mediated through cannabinoid type 1 (CB1) receptor, primarily by the CB1 agonist delta-9-tetrahydrocannabinol (THC). The primary objective of this study was to assess the potential of the CB1 antagonist ANEB-001 to reverse THC-induced effects in healthy subjects. The secondary objectives were to assess safety, tolerability, and pharmacodynamics (PD) of ANEB-001.
Methods: This randomized, double-blind, placebo-controlled trial tested single oral doses of ANEB-001 in cannabis-experienced adults challenged with oral THC (NCT05282797). Part A: 10.5 mg THC with coadministration of 50 mg or 100 mg ANEB-001 or matching placebo ($n = 20$/arm). Part B varied timing and dose of THC/ ANEB-001 in 6 cohorts. Study drug was co-administered with THC (cohorts 1 & 2) or delayed by 1 hour post THC (cohorts 3, 4, 5, & 6). ACI was assessed (pre-THC and at 1, 2, 3, 4, 5, and 8 h) via PD outcomes; visual analogue scales (VAS) for feeling high & alertness, body sway, and heart rate. Adverse events (AEs) were assessed over 24 h and at 7 – 14 d. Effects were compared to placebo within cohorts and for pooled THC doses, using a mixed model of covariance for repeated measures (ANCOVA), with treatment, time, treatment by time, and average baseline as covariates.
Results: Part A enrolled 60 subjects; 52 (86.7%) were males and 56 (93.3%) were Caucasian race. The mean (standard deviation) age was 24.2 (5.4) years, and body mass index (BMI) was 23.29 (2.24) kg/m^2. Coadministration of THC + ANEB-001 (50 or 100 mg) produced a significant and sustained decrease in VAS feeling high ($P < 0.0001$) and increase in alertness ($P < 0.01$) vs. placebo at both doses. Part B enrolled 74 subjects; 37 (50%) were males and 65 (87.8%) were Caucasian race. The mean (standard deviation) age was 24.1 (4.1) years and BMI was 22.86 (2.26) kg/m^2. ANEB-001 rapidly reversed THC effects when co-administered or given 1 hour after THC and was safe and well tolerated with no serious or severe AEs. ANEB-001-related AEs were transient and mild, except for moderate nausea/vomiting in one patient each at the 21 and 30 mg THC doses. THC effects on most outcomes were blunted by a high-fat meal. Only five subjects were enrolled in cohort 4 (40 mg THC 1 h before ANEB-001) due to poor THC tolerability.
Conclusions: Single oral doses of ANEB-001 were well tolerated and rapidly reversed THC-induced ACI symptoms in healthy adults when co-administered or after delayed dosing.

KEYWORDS Cannabis; antidote; CB1
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6. Alcohol-related recidivism following emergency department-associated naltrexone

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Background: Alcohol use disorder (AUD) is a pressing public health problem. Over the past two decades, alcohol-related emergency department (ED) visits have risen 47% with an associated 272% increase in cost. Naltrexone is approved for the treatment of AUD and is available in oral and long-acting injectable form, with a number need to treat of 12 for oral naltrexone to prevent return to heavy drinking. Two recent pilot studies demonstrated feasibility of ED-based initiation of both oral and injectable naltrexone. However, data assessing patient outcomes of ED-based naltrexone are lacking. The purpose of this study was to assess the ED visits associated with naltrexone initiation, administered either during ED encounter or shortly thereafter, using rate of ED recidivism with alcohol intoxication as a marker for efficacy.
Methods: This was a retrospective cohort study of all US Veterans Administration ED visits for alcohol intoxication amongst patients age $\geq$18 from 2010 to 2019. All emergency department visits associated with alcohol intoxication, as defined by ICD9/10 code or a serum ethanol concentration $>$ 50 mg/dL, present in the VA Corporate Data Warehouse were included. Patients were considered to have received ED visit associated naltrexone if they had not received naltrexone in the last 90 days and if a naltrexone prescription was administered/filled within 7 days of the encounter. Data collected include demographics, naltrexone route and dose, and time to return visit. The primary outcome was return visits for alcohol intoxication during the study period. Data were described, and a Kaplan–Meier Survival Analysis compared time to recidivist visits between

patients who received ED associated naltrexone and those who did not.

Results: In total, 95,126 patients were eligible for study inclusion. Patients were majority male (94.3%) and white (65.7%), and median age was 54 years (IQR 44–61). 6,677 unique patients accounted for 7,550 total ED encounters associated with naltrexone administration, and 88,449 patients with ED visits for alcohol intoxication did not receive ED-associated naltrexone. Oral administration was associated with 3,936 visits (52%), IM with 544 visits (7%) and the route of administration was uncertain in 3070 visits (40%). Among patients who did not receive ED associated naltrexone, 55,726 (60.7%) would go on to have additional ED visits for alcohol intoxication, as compared to 2,674 (40.0%) patients who received ED associated naltrexone. The median time to recidivist visits for alcohol intoxication was 518 days for patients receiving naltrexone as compared to 134 days for those who did not ($P < 0.0001$).

Conclusions: Our study shows that veterans who were initiated on naltrexone during or shortly after emergency department visits for alcohol intoxication were markedly less likely to have future ED visits for alcohol intoxication. Our study is limited by its retrospective design and possible confounders, e.g. that patients who received naltrexone may be self-selected in terms of motivation to quit drinking and potential overrepresentation of high ED utilizers amongst patients not receiving naltrexone. Future work is needed to prospectively evaluate the effectiveness of ED-based naltrexone.

KEYWORDS Alcohol; naltrexone; harm reduction

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7. Predictors of xylazine positivity in emergency department patients with opioid overdose

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Background: Previous research on opioid overdose (OD) patients in the emergency department (ED) with xylazine suggests decreased severity of some cardiovascular and CNS-related clinical outcomes. We examined predictors of xylazine positivity detected by liquid chromatography quadrupole time-of-flight mass spectroscopy (LC-QTOF-MS) among ED opioid overdose patients.

Methods: The Toxicology Investigators Consortium (ToxIC) Fentalog Study is a multicenter, prospective cohort study enrolled adult (> 18) patients with suspected opioid OD who presented to one of ten participating EDs in the US between September 2020 and December 2022. Waste serum from each patient was analyzed via LC-QTOF-MS to detect all current opioids, fentanyl analogues, and adulterants. Medical record data was abstracted, de-identified, and entered into a REDCap database. The study was approved by a central IRB with waiver of informed consent. Chi-square analysis and t-tests were performed using SAS.

Results: Out of 755 patients who had blood analytes confirmed at the time of data extraction, xylazine was detected in 152 (20.2%). Xylazine positive patients were primarily localized in the Northeast/Mid-Atlantic regions (73.7%), male (76.8%), white (46.7%), and non-Hispanic (81.6%). Bivariate analysis revealed a significant relationship between xylazine positivity and region of the US (73.7% of cases in Northeast/MidAtlantic vs. 26.3% of cases in Midwest/West Coast, $P = 0.0031$). Additionally, males had a significantly higher prevalence of xylazine (76.8%) compared to females (23.2%) ($P = 0.0225$). Midwest/West regions (OR 0.589, 95% CI 0.389–0.892) and female sex (OR 0.635, 95% CI 0.414–0.975) were associated with significantly lower odds of xylazine positivity, after adjusting for age, race, and ethnicity. Goodness of fit testing revealed a chi-square value of 4.35 ($P = 0.8240$) and AUC of 0.6078.

Conclusions: In this prospective, multi-center cohort study, patients from non-Northeast regions of the United States had lower odds of xylazine positivity, which is consistent with current surveillance reports. Female patients also had lower odds of xylazine positivity. Future studies should investigate potential explanations for gender differences in xylazine positivity including substance use patterns, xylazine physiologic effects, and xylazine metabolism.

KEYWORDS Xylazine; opioid; overdose

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8. Clinical and demographic correlates of confirmed xylazine and levamisole exposure among ED patients with acute fentanyl overdose

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Background: Levamisole, a veterinary deworming agent, is an adulterant typically found in cocaine; however, there is a growing prevalence of levamisole adulteration in fentanyl. Xylazine, a veterinary sedative, is another adulterant that is being increasingly found in fentanyl. Interestingly, both have been implicated in skin lesions, with levamisole causing cutaneous vasculitis and xylazine leading to necrotic dermal wounds. However, to our knowledge, no research has examined the acute clinical correlates of both levamisole and xylazine. The objectives of this study are to examine demographic and clinical correlates for levamisole and xylazine in patients presenting with acute opioid overdose.

Methods: This study utilized data from the Toxicology Investigators Consortium (ToxIC) Fentalog Study, a prospective, observational study of patients presenting to a participating emergency department (ED) with suspected opioid overdose (10 sites) from September 2020 to April 2023. Blood waste serum, drawn as part of routine clinical care, was collected, de-identified, and samples were analyzed using liquid chromatography quadrupole time-of-flight mass spectrometry for the presence of over 1,000 novel psychoactive substances (NPS), drugs of abuse, and therapeutic agents. Study enrollment with waiver of informed consent was approved by a central IRB (WCG IRB). This study analyzed both fentanyl-positive patients with and without cocaine. Categories of levamisole and xylazine were mutually exclusive: no levamisole or xylazine, only

levamisole, only xylazine, and both levamisole and xylazine. Bivariate tests were analyzed, utilizing Chi-Square Tests and Fisher's Exact Tests for categorical variables and Kruskal-Wallis Tests for non-parametric continuous variables. All analyses were conducted using R v4.2.1.
Results: Among patients testing positive for fentanyl ($n = 567$), 16.0% had levamisole only, 19.0% had xylazine only, and 6.9% had both levamisole and xylazine. In fentanyl positive patients without cocaine ($n = 379$), 6.6% had levamisole only, 22.7% had xylazine only, and 1.6% had both levamisole and xylazine. Black patients were more likely to be positive for levamisole only ($P < 0.001$). Overall, the total required naloxone dose was statistically significantly lower in the combined levamisole and xylazine category compared to the other categories ($P < 0.001$). These associations were detected for both the cocaine-negative sample and the sample including all fentanyl patients, regardless of cocaine positivity.
Conclusions: In this large multicenter study of ED patients with opioid overdose, we found racial differences in levamisole exposure. Additionally, naloxone dosing was correlated with confirmed levamisole and xylazine exposure. Further study of the clinical impact of adulterants in the recreational opioid supply is warranted to confirm and expand upon these findings.

KEYWORDS Xylazine; levamisole; fentanyl

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9. Ligand and isoform dependent functional responses of the mu opioid receptor with the single nucleotide variant A118G

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Background: Genetic variants have been demonstrated to alter opioid drug pharmacodynamics. The *OPRM1* gene codes for the mu opioid receptor (MOR) and the most well documented single nucleotide polymorphism (SNP, rs1799971) substitutes a G for an A at position 118 (A118G). This SNP has been associated with decreased morphine sensitivity but increased fentanyl sensitivity. Complicating this further, isoforms of the MOR are expressed in anatomically different regions of the body and interact with different second messenger systems. Thus both isoforms and SNPs may yield different clinical effects in patients exposed to different opioids. The objective of this study was to characterize the biology of the *OPRM1* variant rs1799971 in the two isoforms MOR1 and MOR1O when exposed to different opioid agonists.
Methods: We used HEK293 cell lines with the introduced DNA sequences for the *OPRM1* isoforms MOR1 and MOR1O, with and without the A118G SNP. We assessed Gi and Go activity using BRET ratios for β-Arrestin2 bias, production of cAMP, and determined protein folding to understand isoform and SNP biologic responses of the MOR. We utilized fluorescence detectors of *Renilla* Luciferase8 (Rluc8) attached to the C-terminus of our proteins, and a modified YFP, mVenus, attached to the N-terminus of β-Arrestin2 to assess Gi, Go activity. We assessed cAMP production through a Rluc8 and YFP fluorimetry. Morphine, fentanyl, acrylfentanyl, and U47700 were used as MOR agonists. Forskolin was the positive cAMP control and naloxone served as the negative control. The comparison of EC50 values amongst protein variants were assessed by performing a one-way ANOVA. Finally, we developed a complete MOR protein homology model to assess the variant effects of protein-agonist interaction.
Results: The biology of the *OPRM1* A118G SNP was found to be both isoform and agonist specific. On β-arrestin2 assessment, MOR1 displayed a significantly lower EC_{50} value in the presence of morphine (69.2 ± 1.6 nM) compared to MOR1 *A118G* (180.2 ± 27.2 nM) ($P = 0.0047$). While morphine displayed a SNP dependent effect on β-arrestin2 recruitment, acryl-fentanyl displayed an isoform dependent effect, where MOR1 was found to have a lower EC_{50} (171.4 ± 33.6 nM) compared to MOR1O (492.8 ± 116.7 nM) (*P*-value 0.0132). MOR1 *A118G* was observed to have a significantly lower fentanyl EC_{50} value (115.9 ± 17.9 nM) when compared to MOR1O *A118G* (214.1 ± 19.9 nM) ($P = 0.0275$). U47700 displayed no significant changes in EC_{50} across all four constructs. Naloxone demonstrated significant inhibition of morphine binding with all protein constructions. On cAMP assessment, there were large differences in cAMP production between ligands though no significant differences were observed with any of the drugs between the isoform or SNP combinations. Protein modeling demonstrated shifting of the unstructured N-terminus domain in the binding pocket at 3.5Å with all drugs.
Conclusions: Triangulated with 3 biologic assay techniques, we have demonstrated that the A118G allele produces differences in receptor function that are isoform and SNP specific when exposed to different opioid ligands. This may account for differential clinical effects of genetic variants between opioid agonists.

KEYWORDS Opioid; pharmacogenetic; biology

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10. Is HOUR enough after out-of-hospital naloxone for opioid overdose? Prospective preliminary data from real-world implementation of the modified St. Paul's early discharge rule

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Background: The appropriate duration of ED monitoring after out-of-hospital naloxone for opioid overdose remains controversial. Previously, investigators developed St. Paul's Early Discharge Rule and subsequently modified and validated the 6-point rule (Hospital Observation Upon Reversal [HOUR criteria], 1) to attempt to safely discharge patients one hour after out-of-hospital naloxone. Implementation data on HOUR criteria are lacking.
Methods: We report interim outcomes from a quality improvement process at a safety-net hospital after HOUR criteria implementation. All patients receiving out-of-hospital naloxone for suspected opioid overdose were prospectively identified and eligible for inclusion. Data acquisition volunteers, trained in HOUR criteria, prospectively collected data. At one hour post-naloxone, vital signs were obtained and patients were assessed by a clinician for both HOUR criteria and gestalt for safe discharge. We then attempted to contact discharged patients the following day to ensure safety. Adverse events (AEs) were assessed as in the HOUR study. Descriptive statistics were used to analyze data.
Results: From January to April 2023, 221 patients received out-of-hospital naloxone before ED arrival and had a one-hour provider evaluation. Forty-one (18.6%) patients met HOUR criteria. Out-of-hospital naloxone was most commonly administered intravenously ($n = 109$, 49.3%; median dose: 0.5 mg [IQR 0.4–1 mg]).

Fifty-six patients (24.4%) received their first naloxone dose from a bystander. Regarding the primary outcome, one patient (2.4%, 95%CI: 0–33.7%) met HOUR criteria and experienced an AE. This patient intended to snort cocaine but became suddenly unconscious after insufflating the powder. He received three 0.4 mg doses of intramuscular naloxone and 3 minutes of CPR, all from bystanders. On EMS scene-arrival the patient was fully awake with minimal symptoms. 3 displays the patient's vital signs 80 minutes post-ED arrival; at this time the attending emergency physician determined the patient was safe for discharge, however a chest x-ray (ordered due to CPR) had not yet been performed. While awaiting x-ray, the patient became drowsy and bradypnic with abnormal end-tidal capnography; 0.2mg IV naloxone restored normal breathing and mental status. Bradypnea recurred twice more, each time responding to 0.2mg IV naloxone; subsequently a naloxone infusion was administered for 7 hours. The patient was discharged 18 hours after arrival and was well on phone follow-up. Secondary outcomes included urine drug screen (UDS) and follow-up data. Sixteen (7.24%) patients had UDSs with fentanyl (n = 16, 100%), amphetamine (n = 9, 56.2%), and cocaine (n = 8, 50%) being the most common positives; 88% (n = 14) were positive for any stimulant (cocaine/amphetamine). On follow-up, 28/41 (68%) of patients had evidence of life, 4 by phone call and 24 by electronic medical record (EMR) review. No patients were marked deceased in the EMR. Additional follow-up is planned as part of ongoing data collection.

Conclusions: In this preliminary implementation evaluation of the modified St. Paul's Early Discharge Rule, 2.4% (95%CI: 0–33.7%) of patients received additional naloxone for respiratory depression after meeting "safe discharge" HOUR criteria. If this finding persists in a larger dataset, HOUR criteria may not be a sufficiently safe disposition tool after out-of-hospital naloxone.

KEYWORDS Naloxone; fentanyl; addiction

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11. Initiation of methadone for opioid use disorder treatment in the emergency department

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Background: Fentanyl and other synthetic opioids are becoming increasingly prevalent across the United States. These potent and lipophilic agents pose new challenges to providers, including the risk of precipitated withdrawal when starting buprenorphine treatment. While methadone is a proven treatment for opioid use disorder (OUD), and does not risk precipitated withdrawal, the efficacy of methadone for use in emergency department (ED)-based treatment of OUD has not been described. We report on a methadone induction program for OUD for ED patients.

Methods: We describe program evaluation data from a Level 1 Trauma center in an urban safety net hospital. Inductions included were ED visits where the patient was referred to an addiction counseling team and started either buprenorphine or methadone for OUD treatment during the ED visit. Successful linkage to care was defined as a completed follow-up appointment after induction in either an outpatient behavioral health center addiction department or a visit with an addiction counselor in integrated primary care. An induction was considered retained for 90 days if patients were seen continuously in the outpatient setting in the 90 days following linkage to care with no 30-day breaks.

Results: Visit data was examined from Jan 2022 through April 2023 (16 total months). 380 total inductions were included in the analysis. Of these inductions, 225 (59%) took place in the adult ED, 143 (38%) in the psychiatric ED, and 12(3%) in the pediatric ED. Of the 352 unique patients inducted, 239 (68%) of were male and 112 (32%) were female. 51% of these inductions were buprenorphine and 49% methadone. Of buprenorphine inductions (n = 195), 121 (62%) were successfully linked with outpatient follow up. Of methadone inductions (n = 185), 116 (63%) linked with care. Of visits linked with care, 27 (26%) were retained at 90 days in the buprenorphine group and 20 (22%) in the methadone group.

Conclusions: ED-based methadone induction is feasible and correlated with follow-up rates comparable to buprenorphine inductions. Anecdotal evidence from addiction faculty have suggested that methadone might be more effective at suppressing cravings. Additional analyses describing adverse effects associated with methadone is needed in the future, given that it is associated with possible respiratory depression and QTc prolongation. This data set is limited by a small sample size, therefore ongoing collection would help to elucidate each therapy and long-term effects. Methadone appears to be effective and appropriate for ED patients who require treatment of OUD.

KEYWORDS Opioid; methadone; buprenorphine

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12. The relationships of plasma profenofos and ethanol to clinical outcome in acute profenofos self-poisoning

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Background: Organophosphorus (OP) insecticides have been responsible for the majority of deaths from self-poisoning in the developing world. Many patients who have been acutely poisoned with OP insecticides have also co-ingested ethanol. Currently the S-alkyl OP, profenofos EC50, is commonly ingested for self-harm in Sri Lanka. Although clinical experience suggests that ethanol co-ingestion makes management more difficult, the relationship between plasma concentrations of ethanol and of profenofos to clinical outcome is unknown. Therefore, we aimed to determine the relationships between plasma ethanol concentration and plasma profenofos toxicokinetics with clinical outcome in acute profenofos poisoning.

Methods: Demographic and clinical data, including an ethanol history and blood samples were prospectively collected from all cases of acute poisoning with profenofos EC50 presenting to Teaching Hospital Peradeniya, Sri Lanka over four years from 2017 to 2021. Plasma samples were analysed by Gas Chromatography- Mass Spectrometry to quantify the ethanol (n = 99) and profenofos (n = 30 [15 no ethanol, 15 with ethanol]) concentrations. The PKSolver program was used to calculate the

toxicokinetic parameters such as, maximum concentration in plasma (pC_{max}), the time of pC_{max} (pT_{max}), plasma absorption (pt1/2a) and elimination (pt1/2e) half- lives.
Results: Of 99 patients (male 78/99, 78.8%) with acute profenofos self-poisoning, 50 (50.5%) reported history of ethanol co-ingestion. Plasma from 44 of 99 (44.4%) profenofos-poisoned patients had detectable ethanol (median 88.8 $mgdl^{-1}$, interquartile range [IQR] 26.6–122.2). Ethanol co-ingestion (ALC+) group had a non-significant higher risk of death (ALC−) group (5/44 [11.4%] vs. 3/55 [5.5%]; $P = 0.4605$) and of intubation (11/44 [25.0%] vs. 11/55[20.0%]; $P = 0.6298$) than those who had not co-ingested ethanol. The median on admission plasma profenofos concentration was non-significantly higher in ALC + group ($n = 15$) than in ALC- group ($n = 15$) (1493 [IQR 421.4–3030] ngmL-1 vs. 793.6 [IQR 271.6–1367] ngmL-1; $P = 0.1607$) and median butyrylcholinesterase activity was slightly lower [349.9 $mUmL^{-1}$ (IQR 113.2–634.3) vs. 456.7 $mUmL^{-1}$ (IQR 213.4–860.9); $P = 0.1218$; normal range 2300–7000 $mUmL^{-1}$]. The profenofos pCmax and pTmax between the ALC + group and the ALC- group were not statistically different ($P = 0.1607$ and 0.6453, respectively). Similarly, the medians of absorption pt1/2a between the ALC + group and the ALC − group (0.1 and 0.1h, respectively, time 0–24 h) were not statistically different ($P = 0.6594$); however, the medians of elimination pt1/2e value were significantly higher in the ALC + group than ALC − group (23.1 and 9.9 h, time 0–24 h, $P = 0.0002$) indicating that patients in ALC + group had much longer profenofos elimination half-life.
Conclusions: Ethanol co-ingestion leads to alter the toxicokinetic of profenofos insecticide by slowing elimination rate, and possibly increasing risk of death and worsening the hospital outcome. Larger studies are needed to evaluate this further because efforts to reduce ethanol consumption may help with efforts to reduce mortality from profenofos self-poisoning.

KEYWORDS Profenofos; ethanol; self-poisoning

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13. The feasibility of utilization of remote patient monitoring devices in patients with toxicologic exposures: a pilot study

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Background: Poison centers play an important role in medical management of poisoning exposures. In 2021, there were 2,080,917 human exposures reported to US poison centers with 93% occurring in a residence, and 67% managed on site. Home management could be increased and would be safer with knowledge of real time vital signs (VS). Abnormal VS often precede clinical deterioration and their early detection could allow for therapeutic intervention in the home setting to either allow a patient to remain at home or quickly identify the need to seek in person medical care. Patient convenience and healthcare cost savings are potential benefits of remote patient monitoring devices (RPMDs). The purpose of this study was to compare RPMD VS collection to in-hospital nursing VS collection for toxicologic exposures.
Methods: This was a prospective, cohort study in a large, academic, urban hospital from 1 May 2021 to 31 December 2021. Admitted toxicology consultations were reviewed daily for eligibility. Patients > 18 years and able to consent were enrolled from non-intensive care settings. All participating patients had informational study flyers hung at bedside. Informed consent was obtained. This study was approved by the local Institutional Review Board. BioSticker™ is FDA approved for remote patient monitoring. Sensors transmit data via Bluetooth to a bedside hub device which streams participants' heart rate (HR) and respiratory rate (RR) securely to a remotely accessible HIPAA-compliant web portal. Patients wore the device for the duration of their admission while also receiving routine VS checks by nurses. Nurses were blinded to device VS readings. Researchers accessed nurse-collected data from the electronic medical record. Device data was averaged over one hour and compared to corresponding nurse VS timestamps. Data was collected in Excel® and statistical analyses were performed. Device data consistency was assessed using the percentage of manual VS timepoints for which device VS data was retrievable. Device-collected and nurse-collected VS agreement was determined using the mean of the differences between corresponding VS pairs and Bland Altman plot.
Results: Four patients were enrolled in the study. Mean patient age was 36.25 years, two were female, and devices were worn 12–48 hours among the four patients (1). Data collected by BioSticker™ successfully streamed HR and RR for 97.0% of all nurse VS checks. Two patients experienced bradycardia and two patients experienced tachypnea (1). The mean differences between nurse and device values for HR and RR were −4.2 bpm and 2.3 rpm, respectively. There were 18 VS abnormalities (17 HR and 2 RR) detected by nursing VS collection and 26 by BioSticker™ (25 HR and 1 RR). Bland Altman plots display generally consistent agreement across the range of measurement.
Conclusions: BioSticker™ demonstrated overall concordance in VS collection with hospital nursing and reliability. While the sample size was small, the potential for the use of RMPDs is demonstrated in the fidelity of VS collection, relatively low mean differences and Bland Altman concordance. Future, larger studies, including with patient experience surveys, are needed.

KEYWORDS Medical devices; toxicologic exposures

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14. Machine learning for predicting medical outcomes of acute lithium poisoning

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Background: The application of machine learning (ML) algorithms and artificial intelligence in medicine has garnered attention for the ability to help predict medical outcomes. Our objective was to evaluate the performance of a random forest algorithm as an ML model in predicting outcomes secondary to acute lithium poisoning.
Methods: We extracted single-substance human exposure cases reported to the National Poison Data System (NPDS) from 1 January 2014, through 31 December 2018, with documented acute lithium exposures. A random forest model was applied to predict medical outcomes. We calculated metrics such as precision, recall (sensitivity), and F1 score to evaluate the ability of the model to help predict the outcome. Precision measures the percentage of true positive predictions (correctly predicted positive instances) among all positive predictions (true and false positives). Sensitivity is a metric in ML that measures the percentage of true positive predictions (correctly predicted positive instances among all actual positive instances in the dataset). The F1 score is a metric used to evaluate the performance of a classification

model. The harmonic mean of precision and recall ranges from 0 to 1, with a higher value indicating better performance. We defined outcomes as a serious outcome (major effect, moderate effect, or death) and a minor outcome based on NPDS coding criteria. To see what features are most important in making a particular prediction and how those features contribute to the prediction, we used the SHapley Additive exPlanations (SHAP) analysis. The SHAP analysis computes the Shapley values for each feature in a model, representing each feature's contribution to the predicted outcome.
Results: There were 11,525 reported lithium cases during the study; 2,760 cases were classified as acute lithium overdoses. One hundred and thirty-nine patients had serious outcomes and 2,621 had minor outcomes. The random forest model had an overall accuracy and F1 score of 99, 98, and 98% for training, validation, and testing groups, respectively, in predicting serious and minor outcomes. For serious outcomes, we reached a precision of 100% and a sensitivity of 96%. We obtained a precision of 96% and a sensitivity of 100% for minor outcomes. Our results demonstrated that bradycardia and age were the primary contributing features in predicting acute lithium poisoning outcomes. However, SHAP analysis showed that drowsiness/lethargy, age, ataxia, abdominal pain, and electrolyte abnormality contributed to individual predictions.
Conclusions: The accuracy of a random forest algorithm in predicting medical outcomes of acute lithium poisoning was 98%. The model predicted serious and minor outcomes with high sensitivity and precision. Further research is needed to validate these findings.

KEYWORDS Lithium poisoning; machine learning; artificial intelligence

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15. An open-source smartphone application to estimate methemoglobin levels at the bedside from a drop of venous blood

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Background: Acquired methemoglobinemia occurs after exposure to an oxidant toxin. Suicidal ingestions of oxidants are increasing in popularity in the United States but are a global problem, especially in rural communities with access to herbicides such as propanil. A simple bedside test was developed by Shihana and colleagues in 2016 to assist clinicians treating patients with methemoglobinemia who lack timely access to co-oximetry. They demonstrated that the degree of redness in a drop of blood is inversely correlated with the methemoglobin level and developed a color chart for visual estimation of methemoglobinemia. We modernized their approach using a smartphone application, avoiding the need for printed color charts, and utilizing a tool that is ubiquitous even in lower-resourced environments.
Methods: We developed a proof-of-concept application using MIT App Inventor and ran this application on a Pixel 5 smartphone. Initial trials demonstrated a lower degree of redness than reported by Shihana and colleagues, likely due to different lighting conditions (i.e., not using direct light from a flatbed scanner). Four samples with methemoglobin levels between 0 and 79% were created by adding sodium nitrite to fresh blood. A drop of each sample was placed on absorbent gauze and allowed to dry for 120 seconds while the methemoglobin was measured using a GEM5000 (Werfen, Bedford, MA, USA). The smartphone then obtained averaged red values from captured images of the blood drops. A linear regression was performed on this data to obtain an empiric formula for potential use in our hospital environment, was incorporated into the smartphone application, and tested on three new similarly prepared blood samples one week later. The estimated methemoglobin level from the smartphone application was compared to values measured on the GEM5000.
Results: The first sample was estimated to contain 0% methemoglobin by the application, and the GEM5000 reported a value of 0% methemoglobin. The second sample was estimated to contain 36% methemoglobin by the application, while the GEM5000 reported a value of 16.1% methemoglobin. The final sample was estimated to contain 82% methemoglobin by the application, while the GEM5000 reported a value of $>$ 30% methemoglobin. Subtraction of other hemoglobin types resulted in a value of 83.9% methemoglobin reported by the analyzer.
Conclusions: We developed a smartphone application that correlates real-time red values on a drop of blood to measured methemoglobinemia levels. The success of the applications concentrations above 30% is encouraging given that these are patients who would most likely benefit from a rapid bedside test. These findings are preliminary and further research is planned to validate and refine this methodology. We hope that an iteration of this application could be useful for clinicians treating patients with methemoglobinemia who lack rapid access to co-oximetry. Once fine-tuned, we plan on releasing this mobile application under an open-source license, free for use by any clinician, anywhere.

KEYWORDS Methemoglobinemia; application; smartphone

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16. Souring the growth experience: evaluating water bead expansion in different media

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Background: Water-absorbing beads (WABs) are colorful hydrogel-containing toys that expand in water, however, are often mistaken for candy. While previous case reports on WAB ingestion in young children have shown intestinal obstruction, there are limited reports on how large these beads can grow. Conversely, some studies have shown that many WAB ingestions are asymptomatic. Further data on the growth of different WAB types and longer measurement times to account for growth in the small intestines beyond the pylorus are needed to better understand WAB ingestion in children.
Methods: Five different types of WABs (two ® brand WABs, two "small expansion" WABs, and one "jumbo" WAB) and four different stress balls with beads resembling hydrogels were purchased both online and in retail stores. The stress balls were cut open to extract beads from within. Four beads of each product were set aside and measured using digital calipers at baseline. One bead from each product was placed in either 4 oz of water, 4 oz of bottled lemon juice, a mixture of lemon juice and whole milk (2 oz each), and an empty cup in open air. Water served as our growth control and simulated intestinal fluid, lemon juice served as a simulated gastric fluid (slightly weaker pH), and the milk/lemon juice mixture was to simulate a home remedy of giving a child milk, while the empty cup served as a reduction control. Beads were briefly removed from their cups to be measured at

15 minutes, at each hour until 6 hours, and then every 12 hours from hour 12 until hour 120.
Results: Growth of the stress ball and Orbeez® brand beads in water reached a maximum diameter of 12.8 and 13.3 mm at 5 hours, while both of the other liquid media shrank the beads to a final diameter of between 3.5 and 4 mm by the 24-hour mark (with lemon juice alone shrinking faster) with a dried out baseline of 2.3 mm for stress ball and 4 mm for Orbeez® brand. The small WABs peaked at 9.6 mm in water and grew in lemon juice but only to 2.8 mm. The jumbo WAB reached peak growth of 50.3 mm at 72 hours in water before breaking apart but only peaked at 11.4 mm after 36 hours in lemon juice.
Conclusions: Both lemon juice environments profoundly hindered the growth of every single WAB tested. Though the lemon juice simulated a gastric environment, it's possible that providing an acidic beverage versus only water may be a useful home remedy thus reducing clinical significance post-WAB ingestion. In the pure water environment, only the jumbo WAB exceeded 15 mm of growth within 120 hours; all other WABs including the stress ball beads resembling hydrogels could theoretically pass through the pylorus and small intestine of an infant without incident, especially following exposure to an acidic environment. Further studies are warranted; ingestions of WABs by children should still be managed on an individual basis.

KEYWORDS Water beads; pediatric; ingestion
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17. Evaluation of the carbapenem-valproate interaction

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Background: Previous reports consistently show a rapid decrease in valproic acid (VPA) serum concentrations when co-administered with a carbapenem antibiotic; however, the specific consequences and subsequent therapy adjustments are not well described. We aim to report the clinical and therapeutic implications of this drug-drug interaction.
Methods: This retrospective review included adult hospitalized patients who received a carbapenem and VPA for either seizure or mood-related disorders at two large academic medical centers between January 2017 and June 2022. Patients receiving additional agents known to decrease VPA concentrations in the same encounter were excluded. Patients who were not stable on VPA prior to hospitalization, without VPA serum levels, with an admitting diagnosis of seizure, or who had a seizure during the hospitalization prior to carbapenem exposure were also excluded. The primary outcome was incidence of seizures or behavioral events based on VPA indication. Secondary outcomes included change in VPA concentration, duration of subtherapeutic VPA concentration (< 50 mcg/mL), time to seizure or behavioral event, incidence of new-start antiepileptic agents, and incidence of VPA dose increases.
Results: 258 episodes of concomitant use amongst 78 unique patients were included in the final analysis. VPA was used for seizure control in 134/258 (51.9%) and for mood-related disorders in 124/258 (48.1%) encounters, respectively. In those prescribed VPA for its antiepileptic properties, seizures occurred following carbapenem administration in 62/134 (46.3%) encounters with a median percent decrease in VPA concentration of 62% (IQR: 54.9–82.1). VPA concentrations decreased rapidly to subtherapeutic levels within the first 24 hours of carbapenem introduction (median: 46.3%, IQR: 38.4–54.8). Amongst all patients with a seizure indication, new antiepileptic agents were initiated in 23.9% of patients following carbapenem use while the dose of VPA was increased in 30.6%. In those taking VPA for mood-related disorders, 63/124 (50.8%) encounters met the endpoint of behavioral disturbance.
Conclusions: This study demonstrates clinical implications of the carbapenem-VPA drug-drug interaction. Clinicians should be aware of this interaction and consider alternative antimicrobial agents when possible. VPA concentrations decreased rapidly in the first 24 hours indicating that even short-term exposure to a carbapenem may have consequences in patients taking VPA. Adding or increasing doses of antiepileptic agents, increasing the dose of VPA, and/or consultation with a neurologist prior to concomitant use should be considered when this combination is unavoidable.

KEYWORDS Carbapenem; valproate; interaction
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18. Substances asociateds with QRS prolongation reported to US Poison Control Centers

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Background: QRS prolongation on the electrocardiogram (ECG) can lead to an increased risk of ventricular tachycardia and ventricular fibrillation, which can be fatal. Medications that block cardiac sodium channels, like antiarrhythmics and tricyclic antidepressants (TCAs), can cause QRS prolongation. Additionally, medications, like bupropion, can cause QRS prolongation through mechanisms other than sodium channel blockade in overdose. Data collected by US poison control centers can be used for post-marketing surveillance to identify additional substances associated with QRS prolongation and ventricular dysrhythmias in therapeutic use and overdose. This study describes substances with the highest frequency of QRS prolongation and their associated risk of ventricular tachycardia/ventricular fibrillation as reported to US poison control centers.
Methods: A retrospective review of exposures reported to the National Poison Data System (NPDS) from 1 January 2019, to 31 December 2020, with QRS prolongation was performed. Single substance exposures coded with QRS prolongation as related or unknown if related were included. Exposures were excluded if they involved multiple substances or were coded as "confirmed non-exposure" or "substance likely not responsible for the effect." Substance, demographics, medical outcomes, coded clinical effect of ventricular tachycardia/ventricular fibrillation, and treatment with sodium bicarbonate were collected. Descriptive statistics were used to describe means and frequencies. A multiple logistic regression model examined the impact of demographic and clinical characteristics on the development of ventricular tachycardia/ventricular fibrillation. Data were analyzed in IBM SPSS Statistics 27.0 and SAS v9.4 (SAS Institute, Cary, NC).
Results: A total of 4,387 single substance exposures with QRS prolongation were identified, representing 0.1% (n = 4,276,339) of exposures reported to NDPS during the study period. The mean age was 38.2 years (SD 18.6 years). 52.5% of the population was female. Medical outcomes were moderate in 2631 (60%) exposures and major in 1588 (36.2%). 168 deaths (3.8%) were reported. The top 3 categories associated with QRS prolongation included antidepressants (n = 1632, 37.2%), antihistamines (n = 651, 14.8%), and unknown drug (n = 324, 7.4%). TCAs were the most common antidepressant class associated with QRS prolongation (n = 865, 19.7%). Other antidepressants included

miscellaneous antidepressants (n = 452, 10.3%), selective norepinephrine reuptake inhibitors (n = 76, 1.7%), and lithium (n = 75, 1.7%). Diphenhydramine was the most common antihistamine associated with QRS prolongation (n = 542, 12.4%). Ventricular dysrhythmias occurred in 155 (3.5%) exposures with QRS prolongation. Of these exposures, the top 3 substances associated with ventricular dysrhythmias included diphenhydramine (n = 26, 16.8%), antiarrhythmics (n = 20, 12.9%), and amitriptyline (n = 18, 11.6%). Multiple logistic regression showed a significant association between QRS prolongation and ventricular tachycardia/ventricular fibrillation for loperamide (AOR 12.5, 95% CI 6.3–24.5), antiarrhythmics (AOR 5.0, 95% CI 2.4–10.1), treatment with sodium bicarbonate (AOR 4.6; 95% CI 2.9-7.2), unknown intent (AOR 2.5, 95% CI 1.4–4.5), and females (AOR 1.6, 95% CI 1.1–2.3).

Conclusions: The most common substance categories associated with QRS prolongation were antidepressants and antihistamines. Ventricular tachycardia/ventricular fibrillation was rare; however, it was reported with the highest frequency in exposures to diphenhydramine, antiarrhythmics, and amitriptyline with QRS prolongation. Significant predictors of ventricular tachycardia and ventricular fibrillation were loperamide, antiarrhythmics, unknown intent, sex, and treatment with sodium bicarbonate.

KEYWORDS QRS interval widening; QRS prolongation

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19. Survival of severe toxicity from intrathecal TXA administration

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Background: Tranexamic acid (TXA) is a small molecule antifibrinolytic drug used to reduce the risk of major bleeding from trauma or major surgery. Inadvertent intrathecal administration of TXA instead of local anesthetics has been reported in several case reports. At least 20 cases of intrathecal administration have been published to date and 10/20 patients in one review died. The morbidity and mortality associated with this error are variable and may be dependent on early interventions and intensive care access. We report on a case of inadvertent intrathecal TXA administration treated with deep sedation and cerebrospinal fluid (CSF) lavage.

Case report: A healthy 76-year-old male was scheduled for an elective total arthroplasty of his right knee. Three hundred milligrams of TXA was inadvertently injected into the lumbar catheter instead of bupivacaine. The error was immediately identified, and the patient was intubated with 10 mg of midazolam and 30 mg of rocuronium before transfer to the nearest emergency department. In the emergency department, he was hypertensive (213/122 mmHg), tachycardic (148 beats/min), hypoxic to 88% oxygen saturation on 40% FiO2, and experiencing full body myoclonic jerks. Initial EKG showed sinus tachycardia with multiple extra ventricular beats. He experienced one episode of ventricular tachycardia with pulses that was cardioverted with amiodarone. He was also given 4,500 mg of levetiracetam. Approximately 1 hour after arrival, he began to wake and was sedated with intermittent intravenous boluses of midazolam and an infusion of propofol at 100 mcg/kg/min. He was transferred to our tertiary care referral center for CSF lavage within 1 hour of presentation to the emergency department. During transport, he was having more myoclonic jerks and given 1,000 mg of phenobarbital. He developed shock, lactic acidosis (6.8 mmol/L), troponemia (0.5 ng/mL), and had persistent myoclonic jerks requiring norepinephrine and a midazolam infusion. The neurosurgery team placed a lumbar drain three hours after presentation to the outside hospital and performed 10 mL CSF lavage every 30 minutes for a total of 5 exchanges. Over the next several hours, his troponin rose to a peak of 10.85 ng/mL and echocardiogram revealed an ejection fraction of 35%. Continuous electroencephalography did not show seizure activity. On day 2, propofol and norepinephrine were weaned. Myoclonic jerks decreased in frequency to 50% from peak. On day 4, midazolam was decreased to 0.1 mg/kg/hr and then discontinued. He had responsive pupils and a weak cough but was not responding. Over the next several days, his physical exam slowly improved and on day 8 he started following commands. He was extubated on day 10, but re-intubated due to respiratory failure. He was extubated on day 13 and discharged to a sub-acute rehabilitation facility on day 19.

Conclusions: Tranexamic acid is an analogue of both glycine and gamma-amino butyric acid. It may sequester in the CSF, which makes it a potential target for CSF lavage. Early recognition, sedation and control of muscular activity, and drug removal are key interventions to reduce morbidity and mortality.

KEYWORDS CSF lavage; medical error

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20. Increase in poisoning deaths during the COVID-19 pandemic

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Background: After COVID-19 pandemic was declared in March 2020, many states in the United States (US) enacted stay-at-home (lock-down) orders and closed or restricted businesses, schools, and other facilities, which were later modified or lifted. As a result of this disruption to people's lives, the pattern of injuries, including poisonings, experienced by the population changed. The objective of this study was to compare the pattern of poisoning deaths in the US in 2020 to those in 2017–2019.

Methods: Data were obtained from the Centers for Disease Control and Prevention Wide-ranging Online Data for Epidemiologic Research (WONDER) website. Cases were deaths during 2017–2020 with multiple causes of death including an International Classification of Diseases - Tenth Revision (ICD-10) code of T36–T65. The number of deaths during 2020 was compared to the mean for 2017–2019.

Results: There were 85,670 poisoning deaths in 2017, 83,033 in 2018, and 86,638 in 2019 – resulting in a mean of 85,114 – and 108,730 in 2020, an increase of 28% over the 2017–2019 mean. The number of poisoning deaths in 2020 increased by 14% in January-March (2017–2019 mean: 21,293, 2020 number: 24,281), increased by 40% in April–June (2017–2019 mean: 21,128, 2020 number: 29,535), increased by 32% in July–September (2017–2019 mean: 21,481, 2020 number: 28,432), and increased 25% in October–December (2017–2019 mean: 21,212, 2020 number: 26,482). The number of deaths in 2020 among persons aged 0–14 years increased 11% (2017-2019 mean: 471, 2020 number: 523), and aged 15–24 years increased by 37% (2017–2019 mean: 5,882, 2020 number: 8,057), age 25–34 years increased 28% (2017–2019 mean: 18,779, 2020 number: 24,131), age 35–44 years increased 36% (2017–2019 mean: 18,819, 2020 number: 25,684), age 45–54 years increased 20% (2017–2019 mean: 18,669, 2020 number: 22,347), age 55–64 years increased 25% (2017–2019 mean: 15,728, 2020 number: 19,697), and age 65+ years increased 23% (2017–2019 mean: 6,733, 2020 number: 8,271). The number of male deaths increased by 32% (2017–2019 mean: 57,564, 2020 number: 75,762), and the number of female deaths

increased by 20% (2017–2019 mean: 27,550, 2020 number: 32,968). The number of deaths due to poisoning by drugs, medicaments, and biological substances (ICD-10 T36–T50) increased by 31% (2017–2019 mean: 74,807, 2020 number: 98,134), and the number of deaths due to toxic effects of substances chiefly nonmedicinal as to source (ICD-10 T51–T65) increased 20% (2017–2019 mean: 21,030, 2020 number: 25,325). Of the ICD-10 codes with the highest number of deaths, T40 (Poisoning by narcotics and psychodysleptics [hallucinogens]) increased 39% (2017–2019 mean: 54,493, 2020 number: 75,693), T50 (Poisoning by diuretics and other and unspecified drugs, medicaments and biological substances) increased 28% (2017–2019 mean: 30,077, 2020 number: 38,606), T43 (Poisoning by psychotropic drugs, not elsewhere classified) increased 57% (2017–2019 mean: 20,932, 2020 number: 32,764), T51 (Toxic effect of alcohol) increased 29% (2017–2019 mean: 15,306, 2020 number: 19,795), and T42 (Poisoning by antiepileptic, sedative-hypnotic and anti-parkinsonism drugs) increased 22% (2017–2019 mean: 13,621, 2020 number: 16,624).

Conclusions: The number of poisoning deaths in the US increased in 2020 when compared to 2017–2019. The greatest increase was observed during April–June.

KEYWORDS Poisoning deaths; COVID

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21. A 21-year review of pediatric cetirizine exposures as reported to a single regional poison center

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Background: Cetirizine, commonly known by the brand name Zyrtec®, is a second-generation antihistamine that is FDA-approved for the treatment of acute and chronic urticaria and allergic rhinitis. The drug is widely used in the pediatric population and is generally considered safe. However, in recent years, pediatric ingestions of cetirizine have become increasingly reported to regional poison centers (RPC). Despite the widespread use of cetirizine, there is limited data on the incidence and outcomes of pediatric cetirizine ingestions. In this study, we aimed to report the incidence and outcomes of exposures involving cetirizine in pediatrics as reported by our RPC.

Methods: This was a retrospective chart review from 1 January 2000 to 31 December 2021, analyzing children 6 years or less with a single acute ingestion of cetirizine. Other inclusion criteria required a historical amount of cetirizine ingested and a documented outcome. The data collected included age, sex, amount of cetirizine ingested, reported symptoms, treatment received, and outcomes.

Results: Over a 21-year period, 5786 cases of pediatric cetirizine ingestions were reported to our RPC. Of these cases, 365 (6.3%) met all inclusion criteria. The mean age of the patients was three years, and 56.2% were male. There were 63 (17.3%) cases describing exact known amounts ingested, 119 (32.6%) estimated amounts, and 183 (50.1%) described as maximum possible. The known exact amounts ingested ranged from 1 mg to 270 mg, with a possible maximum amount of 930 mg. No effects were reported in 275 (75.3%) of the cases, 90 (24.6%) cases experienced minor effects, and 2 (0.1%) cases exhibited moderate effects. The most common symptoms reported were drowsiness (14%), agitation (2.1%), and tachycardia (2.1%). Out of the 365 cases, 204 (55.9%) were treated at home, and 154 (42.2%) were evaluated in a hospital/clinic, 7 (1.9%) other. The mean dose ingested that was recommended by the RPC to be managed onsite was 40.7 mg (2.8 mg/kg), compared to the mean dose ingested in which hospital triage was recommended, which was 118.5 mg (9.2 mg/kg). Of those treated in a hospital, 15 (4.1%) were admitted, and 134 (87%) were released from the emergency department. One patient received bronchodilators unrelated to the exposure. All other patients received either no therapy (73.0%), gastrointestinal decontamination (26.9%), or intravenous fluids (0.1%).

Conclusions: Our study provides valuable information on the incidence and outcomes of pediatric cetirizine ingestions as reported to our RPC. Most children experienced no effects when the reported ingestion was below 6 mg/kg. Only two cases total resulted in moderate effects, which resolved without intervention. Children who are referred to a healthcare facility mostly require no intervention and are discharged home after an observation period. Until further studies are concluded, any cases with more than minor symptoms should continue to warrant healthcare facility referral and evaluation. It is important to note that the inconsistency of coding and follow-up practices of the reporting poison center should be taken into consideration when interpreting these data.

KEYWORDS Cetirizine; pediatrics; triage

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22. Predictors of prolonged supratherapeutic serum lithium concentrations: a retrospective chart review

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Background: The EXTRIP (Extracorporeal Treatments in Poisoning) workgroup has recommended the extracorporeal removal of lithium in severe poisoning if specific criteria are met. These criteria include "If the expected time to obtain a [Li+] < 1.0 mEq/L with optimal management is > 36 h." There is a lack of data regarding which patient characteristics are associated with the rate at which patients achieve a [Li+] < 1.0 mEq/L.

Methods: We conducted an IRB-approved chart review study analyzing electronic medical records from five hospitals. Inclusion criteria included: serum [Li+] > 1.2 mEq/L during hospitalization and poison center consultation. We excluded patients who received an extracorporeal removal treatment before 36 hours had elapsed from the time of initial serum [Li+] > 1.2 mEq/L. Patient characteristics were described using frequencies and percentages for categorical variables, and medians and interquartile ranges for continuous variables. Mean and median times-to-event were computed using Kaplan-Meier estimates. The primary analysis consisted of a Cox regression and the resulting hazard ratios (HR) and 95% confidence intervals (95% CI). Analyses were conducted using R (v4.2; R Core Team).

Results: One hundred and two patients were included in the study. The median age was 37 years, and the majority of the patients were female (69%). The median initial [Li+] was 2.1 mEq/L. The mean and median time to reach a [Li+] < 1.0 mEq/L were 47.1 (40.5–53.8) and 42.5 (33.9–51.0) hours, respectively. Age, concurrent use of a thiazide, NSAID, or ACE/ARB, higher initial serum [Na+] and higher initial serum [Li+] were identified as predictors of prolonged time to [Li+] < 1 mEq/L.

Conclusions: In this retrospective chart review of patients with supratherapeutic [Li+], several risk factors for prolonged supratherapeutic [Li+] were identified. Additionally, the estimated

mean and median times to achieving serum [Li+] goals exceeded 36 hours, indicating that extracorporeal treatments might be underutilized in this population.

KEYWORDS Lithium; extracorporeal removal; hemodialysis

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23. Methotrexate bomb: gestational SAC toxicokinetics, pancytopenia, anuria after methotrexate termination of pregnancy

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Background: Methotrexate (MTX) toxicity is well-described, and consensus management recommendations exist. We present a case of severe methotrexate toxicity with unique depot toxicokinetics, anuria requiring dialysis, and pancytopenia with absolute neutropenia after gestational sac injection of MTX for pregnancy termination.

Case report: A 37 (G5,P2,L1,A2) at pregnancy week 7 received MTX 50 mg in 50mL of normal saline injected into the gestational sac under ultrasound guidance for pregnancy termination. That evening she reported anuria but was reassured, instructed to drink more, and discharged. The following day she sought treatment for anuria, nausea, and vomiting. No urine return was noted after placement of a foley catheter, and laboratory investigations demonstrated acute kidney injury (AKI) and hepatic injury. She received furosemide 50 mg IV and normal saline 1000 mL. Only 30 mL of urine output resulted, so she was admitted for further treatment, including broad spectrum antibiotics for possible pyelonephritis, and daily hemodialysis for anuria. The treating physicians considered possible MTX toxicity and ordered a serum MTX concentration, with a result reported 5 days later. The serum MTX level was 9.6 mmol/L, and a toxicology consultation was requested. The toxicology team recommended leucovorin (150 mg/m^2 q6H). The patient developed jaundice, thrombocytopenia with severe petechiae, facial hyperpigmentation, mucositis, and fever. Receiving leucovorin and dialysis, her serial MTX levels decreased until post-procedure day 8. Ultrasonography that day demonstrated an intact germinal sac. She subsequently developed abdominal discomfort, vaginal discharge and passed products of conception. The following day, the MTX level precipitously rose from 0.08 to 2.7 Umol/L. She developed leukopenia progressing to absolute neutropenia and was treated with GCSF 300 mcg/day for 6 days. Thrombocytopenia was treated by platelet administration six times, and anemia was treated by PRBC infusion three times. Her multiple issues- acute kidney injury, hepatic injury, pancytopenia, and mucositis- resolved over 18 days, and she was discharged on day 24.

Discussion: This case involved unusual toxicokinetics, with MTX in the gestational sac acting as a depot. Gestational sac rupture on day 9 resulted in precipitous elevation of the MTX level. Based on the MTX level, body mass, and information from the treating hospital, it is believed that a 50–100-fold dosing error possibly occurred. Hemodialysis was required to treat anuria for 9 days, and during the initial 6 days before leucovorin was initiated, hemodialysis was the only therapy increasing MTX elimination. Repeated treatment with GCSF, and platelet and red blood cell transfusions were required.

Conclusions: MTX within the gestational sac exhibited toxicokinetics with depot properties, with elevation in serum level after gestational sac rupture. It is possible that sequestration of MTX in the gestational sac, with delayed release, was protective in this case. The gestational sac toxicokinetics are understandable but interesting. Consensus guidelines for MTX toxicity don't recommend routine hemodialysis, but it may be required to treat AKI, and if leucovorin cannot be administered or in cases of anuria, hemodialysis may be the option to ameliorate MTX toxicity. If available, glucarpidase would have been a potentially useful therapy.

KEYWORDS Methotrexate; pregnancy; pancytopenia

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24. Bismuth neurotoxicity successfully treated with dimeraptosuccinic acid

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Background: Chronic bismuth toxicity causes progressive myoclonic encephalopathy. Findings include neuropsychiatric changes (inattention, memory impairment, and hallucinations) and motor findings (tremors, spasticity, myoclonus, and ataxia). Chelation with dimercaptosuccinic acid (DMSA) has been used, although evidence is limited to case reports and animal studies. Given the risks of chelation, it should only be considered in severe or unimproving cases. We describe a case of severe bismuth neurotoxicity treated with DMSA with neurocognitive recovery as evidenced by subjective self-report and quantitative Montreal Cognitive Assessment (MoCA).

Case report: A 63-year-old male with a history of metastatic melanoma (MM) in remission presents to the emergency department (ED) after witnessed seizure-like activity. In the ED, the patient was confused with episodes of generalized spasticity lasting 15–30 seconds. Over the preceding 9 months, the patient experienced progressive decline in neurologic status, leading to loss of professional employment. His decline hastened in the two months preceding presentation, with worsening memory, attention, and executive functioning. He also developed spastic movements, tremors, and imbalance. He was admitted and underwent an extensive multidisciplinary work-up including MRI neuroimaging and lumbar puncture to exclude infectious, autoimmune, and paraneoplastic encephalopathies. Prion disease was considered the likely diagnosis; however, testing results proved negative. Neurologic toxicity from immunotherapy was less likely, since treatment with nivolumab/ipilimunab for MM was stopped over one year prior. During admission, he received intravenous steroids and immunoglobulin. He experienced a subtle improvement in myoclonus after starting levetiracetam, but failed participation in MoCA due to severity of cognitive impairment. The patient remained severely impaired, and on hospital day (HD) #19, medical toxicology was consulted. Additional history revealed the patient developed gastrointestinal symptoms after his MM immunotherapy 2 years prior, and began consuming bismuth subsalicylate to treat his vomiting and diarrhea. He ingested liquid bismuth subsalicylate 525 mg twice daily with multiple additional 262 mg ts as needed. Serum bismuth concentrations were ordered on blood from HD-16, as well as day of consultation. Confirmatory results returned on HD-22 and chelation with DMSA began. After one week the patient continued to improve and was discharged to inpatient rehabilitation. He spent

one week in rehabilitation and was stable for home care. Throughout his 21-day chelation course he had serial MoCAs in addition to bismuth surveillance . At day #120, since hospital admission the patient has had substantial improvement in cognitive function and has returned to previous activities, but has not yet returned to his high level profession.
Discussion: While DMSA enhances bismuth elimination, there is little data surrounding clinical outcomes. Neurocognitive improvement after initiation of chelation was substantial in this case. MoCA scoring began from "untes" cognitive functioning to > 27/30 over the course of chelation.
Conclusions: Serial bismuth concentrations and MoCA assessments aid in the management of bismuth neurotoxicity. In cases of severe toxicity, bismuth is detected in the CSF. DMSA chelation should be considered if severe neurotoxicity continues despite removal from exposure.

KEYWORDS Bismuth; chelation; DMSA

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25. Amlodipine therapeutic misadventures reported to a statewide poison control system

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Background: The current Poisindex hospital referral threshold for amlodipine in adults is > 10 mg. Anecdotally, patients chronically on amlodipine often tolerate a one-time double-dose without clinically significant hypotension. The purpose of this study was to determine if accidental adult ingestions of < 21 mg amlodipine might be safely observed at home.
Methods: This is a retrospective chart review of single-substance cases reported to a statewide Poison Control System from 1/1/2002 to 12/31/2021 involving unintentional acute-on-chronic amlodipine ingestions > 9 mg in adults observed at least 6 hours post ingestion. Exclusion criteria: acute ingestions, cases observed < 6 hours, cases with any reason for exposure other than "unintentional– therapeutic error" and cases with dosing certainty other than "exact" as defined by author interpretation of the documented case history.
Results: A total of 581 cases were identified and 103 cases (18%) met study criteria. Hospital management occurred in 65 cases (63.1%) with 38 managed on-site. Of included cases, the average age was 66.3 years with 64.1% females. The amounts ingested ranged from 10 to 70 mg (mean 22.4 mg). Reported clinical effects included dizziness/lightheadedness in 18 cases (17.5%), bradycardia in 8 cases (7.8%), hypotension in 2 cases (1.9%) and hypotension with bradycardia in one patient (1.0%). No effects developed in 76 (73.7%) cases and no deaths occurred. In 19 (18.4%) cases the patient was also taking cardiac or antihypertensive medications at prescribed doses; none of which developed hypotension. Of 68 cases ingesting < 21 mg (mean 16.5 mg; range 10–20 mg), 10 (14.7%) experienced dizziness/lightheadedness only and 5 (7.4%) developed asymptomatic bradycardia not requiring intervention. No patients developed hypotension alone, but transient hypotension (80 SBP) with bradycardia (HR 30's bpm), pallor, and syncope developed in one (1.5%) male aged 50 who took 10 mg amlodipine daily as his only antihypertensive medication and took another 10 mg 4 hours after the first dose. Symptoms developed 5 hours after the initial 10 mg dose and 1 hour after the second 10 mg dose. He received IVF, calcium gluconate 1 gm, and glucagon 1 mg. No further interventions were needed and he was discharged the next day. No effects developed in 52 (76.5%) of cases ingesting < 21 mg. Of 35 cases ingesting > 20 mg (mean 33.7 mg; range 25–70 mg), 6 (17.1%) experienced dizziness/lightheadedness only, 3 (8.6%) developed asymptomatic bradycardia not requiring intervention, and 2 (5.7%) developed isolated hypotension requiring IVF after ingestion of 40 mg and 35 mg respectively. No effects developed in 24 (68.6%) cases.
Conclusions: This study confirms prior research that home management is reasonable in adult accidental acute-on-chronic ingestions of < 21 mg amlodipine if the patient is not alone and poison center follow up can be performed over an 8-hour period post-ingestion to assess for symptoms requiring hospital referral. This approach will save significant resources for both patients and the healthcare system by avoiding unnecessary emergency department visits in asymptomatic patients.

KEYWORDS Amlodipine; therapeutic error

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26. A 21-year review of supratherapeutic bupropion ingestions as reported to a single regional poison center

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Background: Bupropion is an aminoketone antidepressant FDA-approved for adult depression, seasonal affective disorder, and smoking cessation. It acts by selectively inhibiting neuronal reuptake of dopamine, norepinephrine, and serotonin. Unintentional supratherapeutic doses of bupropion are frequently reported to regional poison centers (RPC). Literature describes any therapeutic misadventure of > 600 mg as increasing the risk of seizures. Our aim is to report the incidence and outcomes of exposures involving supratherapeutic doses of bupropion reported by a single RPC.
Methods: This is a single poison center retrospective chart review of data reported from 1 January 2000 to 31 December 2021, and included patients of all ages with a history of unintentional acute-on-chronic ingestions of bupropion. Other inclusion criteria were a history of the amount of bupropion ingested and a documented outcome. Data were analyzed for patients' demographics, the amount and duration of bupropion use, and clinical effects reported.
Results: Over a 21-year period, 1793 cases of supratherapeutic bupropion ingestions were reported of which 156 (8.6%) met all inclusion criteria. For all included exposures, the average age was 43.5 years with 68.6% females. There were 106 (67.9%) cases describing exact known amounts ingested, 35 (22.4%) with estimated amounts, and 15 (9.6%) described as maximum possible. The amounts ingested ranged from 225 mg to 4350 mg. For cases meeting inclusion criteria, 52 (33.3%) had been on bupropion for > 3 months, 48 (30.8%) were < 3 months, and 56 (35.9%) of unknown duration. The most reported symptoms were dizziness (10.3%), nausea (10.3%), tachycardia (10.3%), and tremor (10.3%). No effects were reported in 52 (33.3%) of cases. Out of 156 cases, 36 (23.1%) were managed at home, 111 (71.2%) were treated in a healthcare facility, and 9 (5.7%) other. Ninety-eight (62.8%) patients ingested no more than a double-dose, 56 (35.8%) more than double their daily dose, and the therapeutic dose was unknown for 2 patients. Of those who ingested no more than double their daily dose, 35 (35.7%) experienced no effects, 40 (40.8%) minor effects, 21 (21.4%) moderate

effects, and 2 (2%) major effects. There were 6 (6.1%) who had a documented seizure at no more than double their daily dose. Only 16 (10.3%) with moderate and 2 (1.3%) with major effects were single agent ingestions. The two cases with major effects experienced multiple seizures after doses of 300 mg (double their daily dose) and 900 mg (600 mg normal daily dose).
Conclusions: Based on review of 21 years of data for unintentional supratherapeutic bupropion ingestions reported to the RPC, it is suggested that patients who ingest double their therapeutic dose of bupropion or above be observed at a healthcare facility due to the risk of seizures. Clinical effects are highly variable, but patients are likely to experience more than minor effects, including seizures, at double their therapeutic dose. Further studies are needed to identify a clinically safe weight-based triage number for bupropion. This study is limited by its retrospective nature, inconsistencies in coding and follow-up practices, and incomplete data reported to the RPC.

KEYWORDS bupropion; double dose; seizure
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27. Compounded semaglutide products may "compound" the risk of therapeutic errors

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Background: The popularity of the once weekly injectable product semaglutide, a glucagon-like peptide-1 receptor agonist, as therapy for weight loss has led to drug shortages across the United States. As a result, compounding pharmacies offer compounded semaglutide combination products in multidose vials, differing from the single dose pen version of the commercial product. Patients must draw up the appropriate dose from the vial. We report a series of dosing errors with compounded semaglutide that resulted in prolonged adverse effects and visits to emergency departments (EDs) for symptomatic management.
Case series: Five female patients ages 35, 47, 49, 53 and 58 were prescribed compounded semaglutide combinations for weight loss. Dosing instructions were misinterpreted in each case. Case 1 injected daily instead of weekly with increasing doses over 3 days. The recommended regimen was in units starting at 5 units and increasing by 5 units each week, which the patient titrated over the 3 days. Cases 2-4 injected 10 times the intended starting dose. Case 5 administered 20 times the intended dose. The vial sizes and concentrations included 5 mg/2 mL, 5 mg/2.5 mL, and 12.5 mg/2.5 mL. The three patients with the 10-fold dosing error drew up 0.5 mL of solution rather than 0.05 mL. The fifth patient inadvertently pulled up a full 1 mL syringe instead of 0.05 mL, giving herself a 5 mg dose. Case 1 complained of satiety, continual heartburn, and food intolerance. Cases 2-5 had persistent nausea and vomiting, especially over the first several days, mostly improving by day 3 or 4, which corresponds with the time to peak of 1-3 days after subcutaneous administration. These patients required treatment with intravenous fluids and antiemetics to manage their symptoms and fluid losses. On follow up, cases 2, 4, and 5 had to slowly reintroduce solid foods back into their diet.
Discussion: Patients provided with compounded semaglutide vials for weight loss may be new to self-injections. Unfamiliarity with drawing up medication via syringe, misunderstandings between milliliters, milligrams or unit-based syringes and limited patient teaching may contribute to these types of therapeutic mistakes. Since these products are multidose vials, the degree of dosing error can be significantly larger compared to dosing mistakes with the pens. The duration of adverse effects also lingers for days and increases the risk of returning to the ED. The titrating doses some of the patients reported were faster than the recommended titrations on commercially available products, further augmenting the possibility of an error and negative clinical effects. Information about this exposure is limited and the Food and Drug Administration Adverse Events Reporting System (FAERS) has recorded 8 cases of similar reactions to compounded semaglutide.
Conclusions: This series demonstrates dosing errors with compounded semaglutide. Poison centers and health care providers should be aware of the possible risks and the duration of effects of potential therapeutic errors in this patient population who are often new to self-inject therapies.

KEYWORDS Semaglutide; therapeutic error
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28. Tirzepatide-induced starvation ketoacidosis: a case report

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Background: Tirzepatide is a novel glucagon-like peptide-1 receptor agonist (GLP-1 RA) and glucose-dependent insulinotropic polypeptide (GIP) agonist indicated as an adjunct therapy to diet and exercise in adults with type 2 diabetes mellitus (T2DM). By activating both GIP and GLP-1, it synergistically stimulates glucose-dependent insulin release. This mechanism also potentiates extra-pancreatic effects such as increased satiety and reduced appetite, making it an effective therapy for weight loss. However, during clinical trials, tirzepatide was associated with a 16-fold higher dropout rate than placebo due to treatment-limiting gastrointestinal (GI) side effects such as nausea and vomiting.
Case report: This case report describes the development of severe GI-related adverse effects leading to starvation ketoacidosis in a 29-year-old female, with a body mass index of 26.5 kg/m^2, following the administration of tirzepatide. The patient reported that she was prescribed tirzepatide 2.5 mg subcutaneous injection once weekly for weight loss. She did not report having a history of T2DM. After suffering from nausea and vomiting for five days after administering the third weekly dose, she presented to the emergency department. Laboratory findings showed metabolic acidosis (pH 7.24, bicarbonate 13 mEq/L) with an increased anion gap (anion gap 17), an elevated beta-hydroxybutyrate level (beta-hydroxybutyrate 61.7), euglycemia (blood glucose 86 mg/dL), hypokalemia (potassium 3.2 mEq/L), and hypophosphatemia (phosphorous 1.6 mg/dL). Based on the patient's five days of vomiting, oral intolerance, and the absence of other causes of anion gap metabolic acidosis, starvation ketoacidosis was diagnosed. The patient received balanced crystalloid fluids, 0.9% sodium chloride – 5% dextrose, and 5% dextrose – 0.45% sodium chloride with potassium chloride 20 mEq. With the administration of anti-emetics, dextrose, and adequate electrolyte replacement, the patient's anion gap closed.
Discussion: During starvation, a low insulin/glucagon ratio stimulates lipolysis and the generation of ketone bodies which progressively depletes the alkali reserve causing ketoacidosis. Combined insulin and GLP-1 RA regimens in patients with T2DM have been associated with diabetic ketoacidosis. This case is unique in that the patient was an otherwise healthy non-diabetic, but experienced intractable nausea and vomiting, resulting in electrolyte abnormalities and starvation ketoacidosis following tirzepatide administration. Of note, the greatest risk of GI adverse

effects is typically seen with the initiation or dose titration of tirzepatide. Although this patient was susceptible to the common GI effects of tirzepatide, she presented with a rare and exacerbated case that rendered her unable to continue treatment due to the development of life-threatening starvation ketoacidosis.
Conclusions: To our knowledge, no case reports or case series describing starvation ketoacidosis secondary to intractable nausea and vomiting following tirzepatide administration have been reported. Patient and provider awareness of the potential severity of GI effects following tirzepatide administration may facilitate prompt recognition of life-threatening ketoacidosis in the future.

KEYWORDS Tirzepatide; ketoacidosis

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29. Succimer treatment for bismuth toxicity

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Background: Bismuth encephalopathy is a rare yet serious medical condition caused by the excessive chronic intake of bismuth-containing compounds. Bismuth is a heavy metal element found in over-the-counter medications for treating gastrointestinal symptoms, such as flatulence, dyspepsia, and odor. Bismuth compounds are safe when used as directed. Chronic or excessive use can result in toxic accumulation in the body, and can present with neurological symptoms, classically myoclonic encephalopathy. This case report highlights the treatment of a patient with bismuth encephalopathy using succimer as a chelating agent.
Case report: A 39-year-old male with a past history of attention deficit hyperactivity disorder, bipolar disorder, and chronic flatulence presented to the emergency department with confusion, myoclonic jerks, and tachycardia. The patient had been using large amounts of Devrom (bismuth subgallate) for his long-standing flatulence. He had been hospitalized previously for seizure-like activity and encephalitis, six months earlier and was diagnosed with serotonin syndrome. His SSRI was discontinued at that time. On initial assessment, the patient was found to be disoriented and exhibited signs of myoclonus. His vital signs were afebrile with a heart rate of 120 beats per minute and a BP 154/96. The patient's history of chronic bismuth-containing medication ingestion raised suspicion of chronic bismuth toxicity. Initial laboratory revealed elevated serum bismuth concentration (> 500 ng/mL). The patient was admitted to the hospital for further management and monitoring. Bismuth subgallate was discontinued. His symptoms gradually improved during his hospital stay of thirteen days. At discharge the patient still felt slightly confused and "not back to baseline." He was started on oral Succimer treatment (10 mg/kg TID ×5d, then 10 mg/kg BID ×14d). Repeat bismuth concentration one week after starting treatment showed a 24hr urine bismuth of 171.7 mcg/L and a serum bismuth of 245.8 mcg/L. Two weeks after completing 19 day treatment, the patient remained asymptomatic, with a 24hr urine bismuth of 11.5 mcg/L and a serum bismuth of 3.2 mcg/L.
Conclusions: This case emphasizes bismuth toxicity as a potential consequence of chronic ingestion of bismuth-containing stool deodorizers. Previous case reports cite using dimercaprol as a chelating agent, but succimer was chosen in this case due to structural similarity and lack of availability of dimercaprol. Although bismuth compounds are widely used, and generally well-tolerated, excessive use can lead to toxic accumulation and progressive encephalopathy. Clinicians should be aware of the potential for bismuth toxicity in patients with neurological and cardiovascular symptoms, especially if there is a history of excessive use of bismuth-containing compounds.

KEYWORDS Bismuth; myoclonic; encephalopathy

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30. Paxlovid induced serotonin syndrome

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Background: Covid-19 (SARS-CoV-2) is a highly contagious infectious disease responsible for the current coronavirus pandemic that has caused over 6 million deaths worldwide. In clinical trials, Paxlovid™ (nirmatrelvir/ritonavir) has been shown to reduce the risk of hospitalization and death in people with mild to moderate COVID-19 at high risk of developing severe disease. While promising, clinically significant drug-drug interactions may occur, mostly due to ritonavir's potent inhibition of cytochrome CYP3A4. We present a case of serotonin syndrome, likely due to drug-drug interactions in a patient newly prescribed Paxlovid™ to treat Covid-19.
Case report: A 43-year-old woman presented to a tertiary care facility after starting Paxlovid™ 4 days earlier for confirmed Covid-19 illness. She took the medication as prescribed along with her other daily medications, which included venlafaxine, buspirone, and trazodone (unknown daily doses). The day prior to her ED visit, family noticed she was withdrawn, confused, and unable to keep up with normal activities of daily living. On physical exam, she had bilateral nystagmus, inducible clonus in her extremities, and hyperreflexia. She was noted to be tachycardic (110–120 beats/minute) and hypertensive (systolic BP 150 mmHg). EKG revealed a QTc interval of 482 msec and QT interval of 350 msec. Lab-work was no for a serum sodium of 110 mEq/L. Acetaminophen, salicylate, and alcohol concentrations were negative. With concerns for possible serotonin syndrome (Hunter Criteria were met), she was given lorazepam 2 mg and intravenous fluids and admitted to the hospital. An emphasis was placed on avoiding serotonergic medications such as fentanyl, and body temperature was monitored closely. Over 48 hours the patient clinically improved, and sodium level returned to normal.
Discussion: Ritonavir is a CYP3A4 inhibitor, while buspirone and trazodone are both CYP3A4 substrates. Coadministration over four days resulted in decreased elimination of the serotonergic agents and thus symptoms consistent with serotonin syndrome. Venlafaxine is a CYP2D6 substrate and was not subject to this drug interaction but had the potential to exacerbate symptoms given its own serotonergic activity. Hyponatremia is a rare complication of serotonin syndrome and more common amongst elderly patients, but was demonstrated here without any other no medical cause or explanation, and onset of symptoms seemed to align with the time she started Paxlovid™. Nonetheless, altered mental status and confusion could have been solely related to the hyponatremia as well. Information that would have aided in a more thorough assessment of this case would have been retail pharmacy records showing whether or not her medications were filled at the same location and if perhaps a drug-drug interaction alert was bypassed.
Conclusions: Paxlovid™, while an important treatment for COVID-19, carries a high risk for potential drug-drug interactions, some of which can be severe. With the anticipated permanent presence of COVID-19, it is imperative that healthcare providers ensure thorough medication review and consultation prior to dispensing Paxlovid™ to minimize these drug-drug interactions whenever possible, and that providers collaborate when able to ensure continuity of care.

KEYWORDS COVID; serotonin syndrome; paxlovid

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31. Overdose of a novel combination antidepressant, dextromethorphan-bupropion extended release

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Background: In August 2022, the FDA approved a new dextromethorphan/bupropion (DXM-BUP) extended-release t (Auvelity®, Axsome Therapeutics, New York, NY) for the treatment of major depression. The putative mechanisms include N-methyl-D-aspartate (NMDA) antagonism by DXM and CYP 2D6 inhibition by BUP to increase DXM concentrations. While BUP may increase dopamine and norepinephrine concentrations in the postsynaptic cleft, the manufacturer asserts that this is not the primary effect. DXM is thought to increase Brain Derived Neurotrophic Factor (BDNF) concentrations, amongst other antidepressant mechanisms. To our knowledge, there are no prior documented cases of DXM-BUP overdose.
Case report: A 22-year-old man with a history of depression, Reynaud's phenomena, and ADHD presented to a community emergency department with hallucinations. He was prescribed DXM-BUP 45–105 mg extended release ts for depression. Throughout the week, the patient had been taking up to three ts daily, totaling 135 mg of DXM and 315 mg BUP, to abuse the drug recreationally. The day of his ED presentation, he ingested a fourth t, totaling 180 mg DXM and 420 mg of BUP with intent to "get high". His parents noticed erratic behavior and brief seizure-like activity. He also had visual hallucinations, saying the "glass was moving in the ambulance." He also described auditory hallucinations, stating he perceived a "whistling sound." His EKG on ED presentation showed a heart rate of 155 beats/min, QRS duration of 105 ms, and a QT interval of 290 ms. He received supplemental oxygen up to 6 L/min due to desaturation. He had a slightly elevated anion gap of 17 and creatinine of 121 mmol/L (1.37 mg/dL). The remainder of his chemistries, including lactate and troponin, were normal. Immunoassay urine drug screen was negative. Ethanol, acetaminophen, and salicylates were undetectable. He received 1 mg of lorazepam, 1000 mL normal saline, and 2 g of magnesium sulfate in the ED. He was admitted to the intensive care unit with seizure precautions for overnight observation. His hallucinations subsided over the 12 h with gradual return to normal heart rate over 30 h. DXM-BUP was discontinued, and the patient received a prescription for escitalopram for his depression.
Discussion: The combination of dextromethorphan and bupropion presents a complex problem in overdose. Bupropion, a synthetic cathinone, lowers the seizure threshold and has sympathomimetic effects such as tachycardia, hypertension, and diaphoresis. It also inhibits gap junctions in cardiomyocytes, preventing propagation of depolarization of excitatory cells. This in turn can cause QRS prolongation and dysrhythmias. Dextromethorphan, a weak opioid agonist, inhibits serotonin reuptake and may cause serotonin syndrome. The NMDA antagonism can also lead to dissociation and hallucinations. In this case, seizures, hallucinations, and sympathomimetic toxicity gradually resolved with benzodiazepines and IV fluids. Tachycardia is usually a worrisome sign in acute BUP overdose but may result from either DXM, BUP, or both.
Conclusions: Overdose of this novel combination of two familiar drugs produced tachycardia, seizure-like activity, and both auditory and visual hallucinations.

KEYWORDS Dextromethorphan; bupropion; overdose

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32. Intentional ingestion of novel combination antidepressant dextromethorphan/bupropion

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Background: The understanding of the basis of depression is evolving and new treatments may involve antagonizing N-methyl-D-aspartate (NMDA). To harness this mechanism a new combination antidepressant has entered the market that contains dextromethorphan 45 mg and bupropion 105 mg extended release (ER). In addition to the NMDA antagonism, dextromethorphan also blocks the reuptake of presynaptic serotonin reuptake and alters dopaminergic neurotransmission. Bupropion's therapeutic mechanism is through norepinephrine and dopamine reuptake inhibition, however its role in serotonin toxicity is controversial. This formulation additionally takes advantage of CYP2D6 inhibition via bupropion to increase plasma concentrations of dextromethorphan. While the neurotoxicity and cardiotoxicity of bupropion and dextromethorphan are known, the combination of the two in overdose via this new formulation has not been reported. We present a case of overdose involving this co-formulation resulting in seizures and prolonged clinical signs of serotonin toxicity.
Case report: Twenty-year-old male with history of depression presented to the ED after intentional ingestion of "one bottle" of dextromethorphan/bupropion ER 45/105 mg. Upon arrival, he was alert and vital signs were: BP 131/60 mmHg, HR 113 bpm, RR 16 bpm, T 36.8 Celsius, SpO_2 95% on room air. Shortly after arrival, he had a self-terminating generalized tonic-clonic (GTC) seizure lasting 2 minutes. Intravenous (IV) lorazepam 2 mg was administered without return to baseline. One hour later, he experienced another self-terminating GTC seizure lasting 1 minute and received IV lorazepam 2 mg. His examination was significant for tachycardia, diaphoresis, patella hyperreflexia, tremor, and clonus in the lower extremities. Cyproheptadine 12 mg via nasogastric tube and levetiracetam were administered. He was intubated eight hours later for airway protection and sedated with dexmedetomidine. Medical toxicology was consulted and recommended sedation with a midazolam infusion. A gas chromatography/mass spectrometry analysis (GCMS) of the patient's urine was positive for bupropion and metabolites, levetiracetam, dextromethorphan and metabolites, levorphanol, and citalopram. Intervals were normal on ECG. He was admitted to the intensive care unit and continued to exhibit neuromuscular hyperexcitability requiring sedation with midazolam and dexmedetomidine. He was extubated on hospital day (HD) 5 with return to baseline mental status and transferred to inpatient psychiatric facility on HD 9.
Discussion: This, to our knowledge, is the first documented case of intentional overdose with the combination therapy of dextromethorphan/bupropion. Dextromethorphan's NMDA antagonism theoretically provides neuroprotective effects and antiepileptic properties. Despite this, he experienced repeat seizure activity consistent with presumed bupropion and/or serotonin toxicity. He exhibited signs and symptoms consistent with serotonin toxicity. No further seizures were observed after initiation of midazolam. Limitations include no quantitative analysis and GCMS revealed presence of citalopram, another serotonergic agent that may have contributed to toxicity.
Conclusions: Dextromethorphan/bupropion is a new combination therapy for major depressive disorder. Toxicity presents

with seizures and serotonin toxicity. Dextromethorphan did not appear to be protective of bupropion's epileptogenic properties. Healthcare providers' awareness of this coformulation is prudent with overdose management prioritizing aggressive sedation.

KEYWORDS Antidepressants; bupropion; dextromethorphan

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33. Association of metformin associated lactic acidosis (MALA) following acute illness in patients on chronic metformin therapy

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Background: MALA is defined as a serum lactate of $\geq$5 mmol/L and a serum pH of $\leq$7.35. The literature related to MALA, and metformin's Black Box Warning, is heavily focused on which patients, if any, to exclude from metformin therapy initiation. However, with the focus being the rare incidence of MALA with appropriate, chronic administration of metformin, attention to preventing MALA in patients on chronic therapy who develop an acute illness is lacking.
Case series: A Poison Center's database from January 2018 to February 2023, for metformin exposures ages 18–100 years was searched. Of these 288 cases, 52 had clinical effect of acidosis coded. Narratives from the 41 of 52 cases in which National Poison Data System (NPDS) reason code equaled adverse reaction-drug (ADR) ($n = 6$) or intentional-suspected suicidal ($n = 35$) were reviewed. All six ADR cases (100%) met the MALA definition, none had a co-ingestant or medical cause (e.g., sepsis) explaining the elevated lactate. All 6 presented following an acute illness involving decreased oral intake and subsequent acute kidney injury (AKI). Four of 6 received vasopressors, 4 received hemodialysis (HD), 1 continuous renal replacement therapy (CRRT). Two of the 6 died, 3 had a major effect outcome (average length of stay 14 days) and one moderate effect outcome. For comparison, only 3 of the 35 (9%) intentional self-harm cases met criteria for MALA without an identified cause for lactate elevation. All 3 received vasopressors and extracorporeal elimination; two died.
Discussion: The literature debate and discussion over whether MALA risk consideration has a place in initiation of metformin therapy has led many practitioners to believe that MALA is not of concern. In this series, MALA developed in patients taking metformin following acute illness with decreased oral intake leading to AKI. The result was prolonged hospitalization, invasive interventions, intensive vasopressor therapy and outcomes from moderate to death. Metformin levels have not been found to correlate with severity and this center's experience is consistent with real world conditions in which metformin levels are not readily available in the clinical setting yet patients need to be managed. In all 6 cases, other medical causes of MALA were excluded by laboratory/medical findings; the common feature was an acute illness with MALA as a complication. This is in keeping with a study that evaluated hemodialysis for MALA in which all 4 of the 7 patients with MALA and confirmed metformin levels were noted to have developed MALA after an acute illness (the other three were acute overdose cases).
Conclusions: Increased awareness of preventable, clinically significant MALA in patients chronically taking metformin should be used by prescribers and pharmacists as a reminder to counsel patients to hold doses should they develop and illness that prevents normal eating and drinking and contact their prescriber. The debate about rare cases of MALA in patients with daily metformin use should not detract from counseling best-practices.

KEYWORDS Metformin; acidosis; adverse effects

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34. The baclofen blues: hemodialysis for baclofen toxicity

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Background: Baclofen is a GABA-B agonist that is often used to treat muscle spasticity and rigidity. It is renally cleared at a high rate in patients with normal renal function. Protein binding is 30-35%, with an endogenous half-life of 3-6 hours in patients with normal renal function. When renal dysfunction is present, patients are at high risk for baclofen accumulation and subsequent toxicity. Hemodialysis has been reported to be beneficial in patients with toxicity from therapeutic baclofen with kidney impairment, however few reports quantitatively describe baclofen clearance with intermittent hemodialysis.
Case report: An 84-year-old female patient with history chronic kidney disease presented to the emergency department (ED) after being found encephalopathic by a family member. Three days prior to her presentation, her primary care physician added baclofen 20 milligrams twice daily for chronic neck pain. In the ED, she was found to be obtunded, with shallow respirations, and responsive only to painful stimuli. A venous blood gas showed respiratory acidosis with a pH of 7.28 and PCO2 of 62. Her creatinine was at her baseline of 2.0 mg/dL with glomerular filtration rate of 24 mL/min. The remainder of her laboratory work-up and a CT of her head was unremarkable and baclofen toxicity was presumed. It was discovered that the patient had orders for "do not intubate" and "do not resuscitate" confirmed by her family and therefore the patient was placed on bilevel positive airway pressure ventilation and admitted to the medical intensive care unit. Given the inability to provide definitive airway management with endotracheal intubation, the decision was made to clear baclofen using intermittent hemodialysis. Her pre-dialysis baclofen level was 0.47 mcg/mL. Therapeutic reference range of baclofen is 0.2–0.4 mcg/mL. After a four-hour session of intermittent hemodialysis, her mental status improved and her respiratory acidosis improved to pH of 7.35 and PCO2 of 52. Her post-dialysis baclofen level was 0.17 mcg/mL. She underwent one additional four-hour session of intermittent hemodialysis with further improvement of her mentation and normalization of her respiratory acidosis. Repeat baclofen level was found to be 0.071 mcg/mL. A repeat baclofen level was obtained the following day to assess for rebound effect and was found to be 0.055 mcg/mL. Calculated clearance while on dialysis was 33 L/h compared to 3.8 L/h endogenously. Unfortunately, on hospital day seven, the patient succumbed to aspiration pneumonia.
Discussion: Baclofen accumulation and toxicity is common in patients with impaired renal function. In this case, a patient with chronic kidney disease was placed on baclofen and showed evidence of baclofen toxicity. Intermittent hemodialysis was shown to effectively clear baclofen, with subsequent improvement of the patient's respiratory acidosis and obtundation. In this instance, the patient suffered no baclofen withdrawal because it was a recently started medication.
Conclusions: Intermittent hemodialysis may be used to effectively clear baclofen in patients with impaired renal function.

KEYWORDS Baclofen; hemodialysis; chronic kidney disease

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35. Toxicologic mimic: hearing loss secondary to stroke in a patient on cisplatin chemotherapy - an ear-replaceable collaboration between toxicology and neurology

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Background: Cisplatin is a chemotherapeutic agent highly associated with ototoxicity in over 50% of cases. Cisplatin and the toxic metabolite *cis*-diamine(aqua)chloroplatinum are transported into cochlear sensory hair cells. These agents increase oxidative stress and trigger apoptosis. We report a rare toxicological mimic – a patient undergoing treatment with cisplatin who experienced hearing loss, ultimately determined to be due to infarct, rather than cisplatin-induced ototoxicity.
Case report: A 52-year-old female with a past medical history of right temporoparietal infarction, coronary artery disease, and stage III cervical cancer on cisplatin presented to the emergency department after waking up with deafness. The patient recently underwent cycle 4 of cisplatin and radiation therapy. She denied previous hearing dysfunction. Her initial work up included a CT Head which revealed a prior right temporoparietal infarction, and no new intracranial pathology. A CT angiogram showed no significant occlusions. She was not eligible for acute stroke interventions. She was admitted to the stroke service for further evaluation and toxicology was consulted for possibility of cisplatin-induced ototoxicity. MRI Brain with and without contrast revealed left temporoparietal infarction as well as prior right temporoparietal encephalomalacia indicative of prior infarction. Audiometry was performed which confirmed bilateral sensorineural hearing loss. To further delineate the etiology, a Brainstem Auditory Evoked Response (BAER) test was performed. The results were normal, indicating an intact auditory pathway up to the level of the inferior colliculus in the midbrain. This result pointed towards a cortical etiology, making cisplatin ototoxicity very unlikely. The likely etiology was bilateral sensorineural hearing loss in the setting of acute ischemic stroke. Her hearing loss improved (but did not resolve) during her hospital stay. The patient was discharged to home. The case was discussed with her outpatient gynecologic oncologists. Given the diagnostic certainty that the cisplatin chemotherapy did not cause her sensorineural hearing loss, she remained on Platinum-based chemotherapeutic agents.
Discussion: Sudden onset sensorineural hearing loss has a wide differential including infection, ototoxic drugs, trauma, autoimmune disease, and acute ischemic stroke. However, acute bilateral sensorineural hearing loss secondary to stroke is a rare entity, requiring bilateral cortical infarction. Given the frequency of ototoxicity in patients treated with cisplatin, this creates diagnostic challenge. In a patient with prior stroke and stroke risk factors, this case highlights the need for caution in attributing hearing loss to cisplatin. To differentiate, the history needs to be considered. Cisplatin ototoxicity has an insidious onset. Hearing loss often begins shortly after cisplatin initiation and is irreversible. This patient had already been receiving cisplatin for weeks. Additionally, her hearing loss began to improve, which would not be expected with cisplatin toxicity. Finally, the BAER findings did not support the suspected pattern of cisplatin-induced hearing loss.
Conclusions: While ototoxicity is common during cisplatin use, other etiologies of hearing loss should be investigated, especially given the risk of hypercoagulability with malignancy. This case represents the importance of maintaining multiple differential diagnoses and the benefit of collaboration between neurology and toxicology to achieve the best outcome for our patients.

KEYWORDS Cisplatin; stroke; hearing loss

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36. Acute toxic conjunctivitis and dermatitis after a single benzalkonium chloride exposure

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Background: Benzalkonium chloride, a known preservative, has been established as a mucosal irritant. The most common causes of chronic toxicity are recurrent use of nasal and ophthalmic formulations and unintentional ingestion. Acute toxicity causes mucosal irritation and erosion of the gastrointestinal and respiratory tracts. Several studies have assessed whether this substance is an irritant or an allergen. Although a mechanism has not been established, these studies report that benzalkonium chloride is an irritant and a weak allergen with sensitizing properties, however, allergies to benzalkonium chloride are thought to be rare.
Case report: A 68-year-old female with a history of bilateral cataract surgery, Lasik with monovision, dry eye syndrome, and meibomian gland dysfunction was evaluated in the emergency department with concern for bilateral ocular chemical injury five hours after using a benzalkonium chloride containing moist towelette for make-up removal. She endorsed bilateral eye pain, redness, periorbital edema, and discharge. She received two liters of saline irrigation with no significant improvement. This was the first time she had used these wipes for makeup removal. On examination, her corrected visual acuity was 20/25 in the right eye and 20/30 in the left eye. Visual fields, color vision, pupils and intraocular pressures were all unremarkable. Extraocular motility mildly limited by chemosis. Anterior segment examination demonstrated significant bilateral upper and lower eyelid edema, erythema, mucopurulent discharge, 3 + 360 degree prolapsing hemorrhagic chemosis with associated lagophthalmos. The eyelids were everted and irrigated. The pH was physiologic at 7.5 after irrigation. Her corneas were normal. The rest of her anterior segment exam and the posterior segment exam were unremarkable. The patient received additional irrigation and was evaluated by an ophthalmologist with the above findings. She was started on erythromycin ointment and preservative free artificial tears. Ophthalmology follow-up was scheduled. At her follow-up appointment four days later, she was significantly improved. The periorbital edema and discharge were resolved and her chemosis was decreased. There were still conjunctival follicles in her deep fornix, however, no other abnormalities were seen. The erythromycin ointment was discontinued and she was started on an oral prednisone taper for residual inflammation. At her one-month follow-up appointment, she was asymptomatic and had a normal examination without any permanent damage.
Discussion: Although the allergic and inflammatory characteristics of benzalkonium chloride have been shown in chronic use, this

patient denies any previous dermal, ophthalmic, or occupational exposure to this substance. Additionally, she denied any history of allergies. This case provides an example of bilateral acute toxic conjunctivitis and dermatitis secondary to benzalkonium chloride exposure. Given the widespread use of this substance as a preservative, it is imperative to be cognizant of the risk of acute toxicity. Although permanent damage was not seen in this case, the risk remains if there is delayed presentation or treatment.
Conclusions: We present a case of acute toxic conjunctivitis and dermatitis after a single benzalkonium chloride exposure. This highlights the risk of acute toxicity in addition to the known risks with chronic exposure.

KEYWORDS Benzalkonium chloride; conjunctivitis; toxicity

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37. Units (mL vs. mg) matter: iatrogenic cardiac arrest following a five-fold intravenous diltiazem dosing error

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Background: Iatrogenic medication administration errors are common despite continued work to eliminate their occurrence. In intravenous formulation, the calcium channel blocker (CCB) diltiazem is a preferred agent for purposes of rapid control of supraventricular tachydysrhythmias in hemodynamically stable patients due to AV-nodal blocking activity. This medication has potential for administration errors due to differences in dosing strengths in intravenous versus oral formulations, and variation and complexity of bolus, re-bolus, and infusion protocols. We report a case of iatrogenic diltiazem overdose resulting in cardiac arrest successfully treated with intravenous calcium chloride and epinephrine.
Case report: A 49-year-old man presented to a low-volume, rural ED with abdominal pain and tachycardia. He was found to have supraventricular tachycardia resistant to rate controlling measures with adenosine and IV metoprolol. Diltiazem was chosen as the next therapy, however, instead of the intended 20 mg IV bolus, the patient received 20 mL of diltiazem. At 5 mg/mL concentration, he errantly received 100 mg of IV diltiazem. He then briefly suffered a brady-asystolic cardiac arrest, with return of spontaneous circulation achieved after administration of 2 g of calcium chloride and 3 mg of epinephrine. Post-arrest, the patient regained consciousness with initial vitals of heart rate 122 beats/min, blood pressure 118/93 mmHg, oxygen saturation 99% on room air. He was stabilized on a norepinephrine infusion to maintain adequate blood pressure, which he required for approximately 3-4 hours before it was successfully weaned without further hemodynamic instability.
Discussion: Iatrogenic diltiazem overdose is a rare, however serious error that may result in hypotension, heart block and cardiac arrest. Occurrences are likely underreported in the literature. Following this overdose, the patient responded well to IV calcium and usual advanced cardiac life support treatments, including epinephrine. Metoprolol, a beta-adrenergic antagonist with AV nodal blocking activity, may have enhanced the toxicity of diltiazem. However, the five-fold iatrogenic diltiazem overdose and proximal temporal relationship to cardiac arrest suggest diltiazem was the culprit. Avoidance strategies for this type of medication error should include measures such as limiting vial size of diltiazem stored directly on hospital floors or in dispensing cabinets to small vials (25 mg/5mL). Large volume vials (e.g., 125 and 50 mg/10 mL) should be stored in central pharmacy and be clearly labeled for IV continuous infusion with dilution required. Medication orders, both verbal and electronically written, should be ordered in appropriate medication based units (mg, mcg, units) and not in volumes. Providers should always use units when verbally communicating medication doses; e.g. in this instance an order to "give 20" could have contributed to the error if the provider neglected to clarify ml or mg. Last, for high-risk medications that are infrequently used, routine education for providers and nurses to prevent such iatrogenic errors is warranted.
Conclusions: Medication administration errors continue to pose risk for severe iatrogenic harm to patients. In this case of intravenous diltiazem overdose, cardiac arrest ensued, however the patient was successfully resuscitated with usual advanced life-support measures, including epinephrine.

KEYWORDS Calcium channel blocker; iatrogenic error; cardiac arrest

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38. Accidental intraventricular injection of bupivacaine and epinephrine treated with intravenous lipid emulsion

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Background: Bupivacaine is a long-acting amide anesthetic, often utilized for regional, local, or epidural anesthesia via blockade of nerve sodium channels. Bupivacaine is used therapeutically in the intrathecal space, and is sometimes co-administered with epinephrine to prolong anesthesia via local vasoconstriction. While there are many case reports of severe local anesthetic systemic toxicity (LAST), including cardiovascular and neurologic complications requiring intravenous lipid emulsion (ILE) therapy, there is scant literature on LAST from co-administration of bupivacaine and epinephrine into the intrathecal space. Here we present a case of an accidental intrathecal administration of bupivacaine and epinephrine resulting in signs of LAST treated with ILE.
Case report: A patient with a brain tumor was intubated and sedated with propofol for a procedure to insert an intraventricular device into his brain. While the ventricle was meant to be instilled with 5 mg gentamicin for infection prophylaxis, 10 mL of bupivacaine 0.25% (25 mg) with 1:200,000 epinephrine (50 mcg) was accidentally administered. Blood pressure decreased with normal heart rate, so 250 mL of 20% ILE was given over 20 minutes, followed by an additional 118 mL given 12 minutes apart. The patient was immediately placed on continuous electroencephalogram (EEG) to monitor for seizure activity, however no seizures occurred on hospital day (HD) one. The following day, systolic blood pressure ranged from 106-114 mmHg with pulse rates in the 50s, and the patient was extubated without neurological sequelae.
Discussion: Cerebral ventricular administration of bupivacaine is rare, so data is limited on toxicity from this route. Seizures are reported from intrathecal injection of bupivacaine ranging as low as 8-15 mg, as compared to the larger 50-100 mg doses causing LAST due to presumed intravenous injection during regional nerve blocks or epidurals. While the use of intrathecal epinephrine with local anesthetics is generally considered safe in correct doses, and peripheral use of epinephrine may be protective against LAST due to restriction of anesthetics into the circulation, there is animal evidence that suggests epinephrine can worsen anesthetic neurotoxicity due to reduction of dural blood flow, reducing the clearance time from the subarachnoid space. ILE therapy is proposed to work by acting as a "lipid sink" to pull lipophilic drugs away from the brain and heart and redistribute

them to other organs. ILE and 10% lipid-containing propofol were both given to this patient after the exposure and would logically abate symptoms of LAST, but it is unclear how much of the bupivacaine could have escaped the CSF and affect the heart to cause hypotension. While this patient recovered without any major adverse effects, lack of knowledge of the kinetics of drugs given intraventricularly prevents adequate assessment of whether this outcome was affected by ILE.
Conclusions: In this case of an inadvertent intraventricular administration of bupivacaine and epinephrine in which ILE was given, it is unclear to what extent ILE had in preventing or treating LAST. Further studies are needed to evaluate the pharmacokinetics of lipophilic drugs given intraventricularly.

KEYWORDS Lipid emulsion; bupivacaine; epinephrine

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39. Tumescent lidocaine administration with subsequent systemic toxicity

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Background: Liposuction is an increasingly common procedure in the United States. One anesthetic technique commonly used in this procedure is the administration of tumescent lidocaine. Tumescent lidocaine solutions also frequently contain epinephrine and sodium bicarbonate to raise its toxic threshold and decrease patient discomfort. We present a case of a 55-year-old female with seizures and obtundation after tumescent lidocaine administration.
Case report: A 55-year-old female with no significant medical history presented to the Emergency Department (ED) with severe obtundation after possible seizure-like activity. Prior to ED arrival, the patient was at baseline and received tumescent lidocaine for a liposuction procedure. She received 1L of the tumescent solution containing normal saline infused with 100 mL of 1% lidocaine, 1.5 mL epinephrine (1 mg/mL), and 15 mL of sodium bicarbonate (8.4% sodium bicarbonate). She also was given 0.5mg of alprazolam and one breath of nitrous oxide for anxiolysis. Twenty minutes later, the patient had possible seizure-like activity and severe obtundation. EMS administered midazolam and seizures abated. The patient did not require cardiopulmonary resuscitation. The patient was brought to the ED where she was unresponsive and intubated for airway protection. She was noted to have a heart rate of 118 beats per minute and respiratory rate of 24 breaths per minute; she was otherwise hemodynamically s. ECG revealed sinus tachycardia with an incomplete right bundle branch block, a QRS of 116 ms, and QTc of 453 ms. Laboratory testing showed a pH of < 7.0, pCO2 of $>$ 130, and lactate of 14.2 mmol/L. Her basic metabolic panel was nonactionable. The patient's laboratory abnormalities improved with supportive measures, and she was extubated the following day. No epileptic activity was noted on EEG, and no other medical causes were identified for her symptoms. She returned to baseline and was discharged on hospital day two. Her lidocaine level was 5.2 mcg/mL (reference 2–5 mcg/mL) and monoethylglycinexylidide level was 1.3 mcg/mL (reference 0.2–5.2 mcg/mL); these levels were obtained about 2 hours post ED arrival. She has had no reported seizures or altered mentation since that time.
Discussion: This case represents a rarely encountered scenario of systemic lidocaine toxicity secondary to tumescent lidocaine administration. The commonly reported maximum tolerated dose for lidocaine injections without epinephrine is between 4 and 5 mg/kg whereas that of tumescent lidocaine is 35 mg/kg; based on history, the maximum dose this patient received was 17.8 mg/kg. However, the patient's lidocaine and monoethylglycinexylidide levels were detectable and given her history and workup, systemic lidocaine toxicity remains the most likely cause of her symptoms. Possible reasons for her presentation include a higher than intended concentration of lidocaine in tumescent lidocaine solution as it was compounded in the office as well as inadvertent installation into a blood vessel during administration. She was hemodynamically stable and did not require fat emulsion therapy and responded well to supportive measures.
Conclusions: Though the maximum tolerated mg/kg dose of lidocaine is relatively high with tumescent lidocaine, systemic toxicity can still occur. Providers should maximize supportive measures while pursuing other causes for symptoms to optimize patient outcomes.

KEYWORDS Lidocaine; seizure; systemic toxicity

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40. Management of neuroleptic malignant syndrome due to a long-acting injectable antipsychotic

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Background: Neuroleptic Malignant Syndrome (NMS) is a rare, life-threatening syndrome associated with anti-dopaminergic medications such as antipsychotics. The mainstay of treatment of NMS is to remove the offending agent in addition to supportive care; however, long-acting injectable antipsychotics pose a unique challenge should a patient develop NMS as the offending agent may persist for many weeks. Treatment strategies are poorly described in such cases. We present a case of NMS due to paliperidone palmitate, an injectable antipsychotic, that was treated successfully with a course of bromocriptine, a dopamine receptor agonist.
Case report: A 41-year-old male with a history of schizoaffective disorder presented to the ED from his behavioral health rehabilitation facility with nausea, vomiting, and abdominal distension. He was found to have a small bowel obstruction and was admitted for medical management. He was treated with IV chlorpromazine and IM olanzapine for agitation after admission. He subsequently developed a sudden onset of altered mental status, tachycardia to 130 bpm, and hyperthermia to 38.1 °C within 12 hours of receiving the antipsychotics. Repeat CT demonstrated numerous pill-shaped radio-opaque objects in the colon. Review of home medications revealed chlorpromazine, lithium, and long-acting paliperidone in addition to clonazepam. His last injection of paliperidone was 1 week prior to admission. Over the next 24 hours, he began to develop rigidity of his extremities with labs no for a Creatine Kinase (CK) level of $>$ 5000 U/L, consistent with rhabdomyolysis due to Neuroleptic Malignant Syndrome (NMS). The patient was treated with benzodiazepines, intravenous hydration, and external cooling measures with gradual improvement in his symptoms overnight. The patient's symptoms returned over the next 48 hours despite cessation of antipsychotics, initiation of a regular benzodiazepine regimen, and an enema to remove the suspected chlorpromazine retained in his colon. Due to concern for recrudescence of NMS in the setting of a long-acting injectable antipsychotic, the patient was started on a bromocriptine regimen with marked improvement in his symptoms.
Discussion: Paliperidone palmitate is a long-acting injectable atypical antipsychotic with a mean time-to-peak of 13 days and a mean half-life of 25–49 days. This extended duration of action makes management of acute toxicity challenging. Previous case reports of other injectable medications suggest that surgical excision or other means of extraction have little to no benefit. In this

case of NMS due to prolonged dopamine receptor antagonism, dopamine receptor stimulation via bromocriptine was very effective in mitigating the symptoms of NMS. The treatment dose was titrated to effect, and the treatment duration was based on paliperidone's estimated duration of action as well as the patient's clinical status; down-titration of the drug was trialed when the patient began to exhibit psychotic symptoms suggestive of dopaminergic excess.
Conclusions: Bromocriptine, titrated to effect and tapered off according to the anticipated duration of action, was an effective means of treating NMS due to a long-acting injectable antipsychotic.

KEYWORDS Neuroleptic malignant syndrome; NMS; long-acting injectable antipsychotic

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41. How long should we watch? Recurrent antimuscarinic delirium from scopolamine patch placed for post-operative nausea and vomiting, reversed (twice) with physostigmine

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Background: Scopolamine is an antimuscarinic medication often utilized for post-operative nausea and vomiting (PONV); it is commonly administered via a long-acting topical patch. Patches are placed behind the ear for antiemetic effect, and replaced every 3 days. Scopolamine blocks the action of acetylcholine at parasympathetic sites in smooth muscle, secretory glands and the CNS, however side effects consistent with the antimuscarinic toxidrome may occur, including delirium. Reversal of such delirium with physostigmine is rarely reported; furthermore, the required monitoring period post-reversal is not well-described. Here we present a case where the patient had recurrent delirium necessitating a second dose of physostigmine.
Case report: A 63-year-old man had a scopolamine patch placed to control PONV following knee arthroplasty. Hours after patch application, the patient developed confusion and difficulty swallowing. There was concern at first for stroke, however symptoms were believed to be more likely related to antimuscarinic excess following patch placement. The patch was removed, and the patient was given 1 mg of intravenous physostigmine; subsequently all symptoms resolved. His physician contacted the Poison Center (PC) to inquire about an appropriate post-physostigmine observation period, and the likelihood the patient would need subsequent physostigmine doses. The PC, per its physostigmine guideline, recommended observation $\geq$4 hours following physostigmine administration. Four hours after the initial physostigmine dose, the patient became aphasic and confused. Another 1 mg IV physostigmine resolved his symptoms. He was admitted to the hospital observation unit for continued monitoring. Approximately 5.5 hours later, the patient remained markedly improved and required no further physostigmine doses. He was subsequently discharged.
Discussion: Scopolamine is commonly well-tolerated and effective when used for PONV, however on occasion antimuscarinic delirium may occur which can be reversed with physostigmine. Age, current medications, and past medical history may contribute to individual sensitivity. Once toxicity from a patch occurs, it should be removed, however due to drug deposition in the skin, predicting the duration of toxicity may be difficult. If delirium is reversed with physostigmine, monitoring should continue based on the expected duration of effectiveness of physostigmine, rather than a guess on the duration of symptoms based on the kinetics of scopolamine. Previous data suggest most cases of recurrent antimuscarinic delirium occur within four hours of physostigmine reversal. Given the possibility for deport formation from a scopolamine patch, a minimum of four hours of observation seems prudent in these patients. The US is currently experiencing a prolonged physostigmine shortage making this clinical question less timely to American clinicians, however some facilities may have remaining stockpiles of physostigmine. Furthermore, drug shortages frequently resolve with little warning.
Conclusions: Antimuscarinic delirium may occur from topical scopolamine patches placed for PONV and may result in prolonged toxicity requiring multiple doses of physostigmine. In this case, delirium recurred four hours after physostigmine reversal, suggesting the patient experienced recurrent toxicity from a depot of scopolamine remaining within the dermis after patch removal. Observation of at least 4 hours after physostigmine reversal for recurrent delirium is recommended in cases of antimuscarinic delirium from scopolamine patches.

KEYWORDS Scopolamine; physostigmine

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42. Use of rivastigmine for reversal of antimuscarinic agitation and encephalopathy in pediatric patients

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Background: The treatment of antimuscarinic encephalopathy and agitation can involve centrally acting acetylcholinesterase inhibitors. Physostigmine shortages have led to the increased utilization of rivastigmine however no cases describe use in the pediatric population. We reviewed 8 cases of pediatric drug overdose causing antimuscarinic toxicity treated with rivastigmine.
Case series: This is a retrospective review of a series of patients who presented to an academic children's adult hospital and were admitted to the medical toxicology service. Rivastigmine for the treatment of agitation and encephalopathy associated with antimuscarinic toxicity for use under the restriction of the medical toxicology service was approved by the institution's pharmacy and therapeutics committee. Charts were reviewed and information collected on patient's presenting characteristics, adverse outcomes, total benzodiazepine requirement, urine liquid chromatography/mass spectroscopy (LC/MS) drug testing, and hospital day of clearance. Patient 1 suffered aspiration pneumonia and urinary tract infection and Patient 7 suffered bradycardia as low as 38 beats per minute but was asymptomatic and returned to a normal heart rate after removal of the rivastigmine patch. No patients experienced diarrhea or vomiting and no other adverse events were noted. Patient 1 experienced recrudescence of encephalopathy after the rivastigmine patch was removed necessitating replacement of the patch after which encephalopathy again remitted.
Discussion: In this retrospective case series, we explored the previously undescribed use of rivastigmine in the pediatric population for the treatment encephalopathy and agitation from antimuscarinic toxicity. In general, patients tolerated rivastigmine well, and adverse events were limited to asymptomatic bradycardia that improved after removal of the rivastigmine patch.
Conclusions: This case series demonstrates the feasibility and safety of utilization of rivastigmine in the pediatric population for

the treatment of encephalopathy and agitation from antimuscarinic toxicity with appropriate patient selection and monitoring.

KEYWORDS Rivastigmine; antimuscarinic toxicity

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43. Treatment of an antimuscarinic toxidrome with rivastigmine

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Background: Ingestions such as atropine or diphenhydramine can cause a severe central antimuscarinic toxidrome with hallucinations and delusions. Antidotal therapy with intravenous physostigmine, the standard of care, is no longer available in the United States. Sedation with benzodiazepines is an alternative therapeutic pathway, but is not always effective and does not decrease the duration of delirium and the need for ancillary testing. Carbamates like rivastigmine are available to treat Alzheimer's dementia and can be considered to treat antimuscarinic toxidromes.
Case report: This is a single patient chart review. A 16-year-old girl with a prior psychiatric admission for suicidal depression and a recent visit for alcohol intoxication was brought to an emergency department by her mother who had concerns that her daughter was "acting psychotic" and hallucinating. The patient was confused, anxious, jittery, and reporting seeing hamsters and bugs that were not there. Vital signs on arrival were: pulse, 138/minute; temperature, 36.8°Celsius; and blood pressure, 121/92 mm Hg. Pupils were 7 mm and reactive. Mucus membranes were dry. She reported taking twenty-four 50 mg diphenhydramine ts because her sister told her that she would get high. The exact time of ingestion was unknown. Laboratory profile was unremarkable except for a urine drug screen that was positive for THC. ECG showed sinus tachycardia with narrow QRS and normal intervals. No GI decontamination was given. She received 1 mg lorazepam 3 hours after arrival followed by worsening of agitation. Rivastigmine 1.5 mg by mouth was given about 4 hours after arrival with minimal improvement. A second 1.5 mg dose of rivastigmine was given one hour later with prompt and sustained resolution of hallucinations and delusions.
Conclusions: Oral rivastigmine was associated with prompt resolution of the severe central antimuscarinic toxidrome in this patient and may be an effective antidote when physostigmine is unavailable.

KEYWORDS Diphenhydramine; rivastigmine; anti-muscarinic toxidrome

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44. Anticholinergic delirium in a pediatric patient reversed with transdermal rivastigmine: a case report

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Background: Antidotal treatment of anticholinergic delirium (ACD) standardly involves administration of the parenteral acetylcholinesterase inhibitor, physostigmine. However, due to cessation of physostigmine production, administration of oral or transdermal rivastigmine may serve as a sui alternative. Although approved for treatment of Alzheimer's or Parkinson's disease-related dementia, the drug may be a safe and effective treatment for both adult and pediatric ACD. A case of a pediatric patient with diphenhydramine induced ACD who was successfully treated with transdermal rivastigmine is presented.
Case report: A 15-year-old, 47 kg, female patient without medical history presented to the emergency department after intentionally ingesting 2.5 grams of diphenhydramine the evening prior. The patient was delirious and quickly transferred to a tertiary care center pediatric intensive care unit (PICU). On PICU admission, the patient was exhibiting florid and typical ACD. An electrocardiogram demonstrated sinus tachycardia, QRS 78 msec and QTc 476 msec. Serum acetaminophen, salicylate, ethanol and routine chemistries were unremarkable. In the first 5 hours after PICU admission on hospital day (HD) 1, she received a total of 10 mg IV lorazepam for agitation. Transdermal rivastigmine 0.2 mg/kg/24 hours was administered 3 hours after arrival in the nearest available patch dose, 9.5 mg/24 hours. Two hours after patch application, the patient required no further lorazepam for the remainder of her hospitalization. Six hours after rivastigmine initiation, she was fully oriented with resolution of her ACD. She did develop urinary retention on HD 2 requiring intermittent bladder catheterization, which subsequently fully resolved. The rivastigmine patch was removed after 24 hours on HD 2 without delirium recrudescence. No additional rivastigmine was administered. The patient did not experience any adverse effects from the rivastigmine patch. She was transferred in normal condition on HD 4 for psychiatric hospitalization. Serum diphenhydramine concentration drawn on HD 1 measured 1196 ng/ml. Comprehensive urine drug testing (LC/MS) detected only caffeine, lorazepam and diphenhydramine.
Discussion: This is a unique case because while there is published literature investigating safety and efficacy of rivastigmine for use in pediatric patients with Down syndrome, no reports exist regarding safety and efficacy of rivastigmine for treatment of pediatric ACD. Due to the potentially prolonged duration of ACD, the slower onset and longer duration of action of transdermal rivastigmine compared to physostigmine may provide smoother recovery. Although both oral and transdermal formulations of rivastigmine are available, oral administration may be precluded in severe ACD.
Conclusions: In this single pediatric patient, transdermal rivastigmine 0.2 mg/kg/24 hours was a safe, effective, long-acting treatment for ACD without significant side effects. Further study is required, especially dosing in children and the role of combined oral and transdermal formulations.

KEYWORDS Anticholinergic delirium; diphenhydramine; rivastigmine

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45. Rivastigmine to treat anticholinergic toxicity following drug overdose

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Background: Anticholinergic toxicity commonly causes significant delirium and agitation requiring either sedation with benzodiazepines or antidotal therapy with physostigmine. Due to physostigmine unavailability, rivastigmine has been proposed as an alternative therapy. Rivastigmine is another acetylcholinesterase inhibitor and is available in oral and transdermal patch formulations. We aim to assess basic safety and potential efficacy of rivastigmine for anticholinergic toxicity.
Methods: Retrospective review of one regional poison center's records of patients who received rivastigmine to treat anticholinergic toxicity between 1 January 2021, and 31 March 2023. No

exclusion criteria were applied. Data collected included age, gender, reason for exposure, medical outcome, level of care provided, drug ingested, rivastigmine dosing, rivastigmine benefit and adverse effects, and sedation provided before and after rivastigmine. Data was collected by two reviewers and conflicts were resolved by a third independent reviewer.
Results: Thirty cases received rivastigmine for anticholinergic toxicity. Most exposures occurred in females (19, 63.3%) and the median age was 17.5 years old (range: 13-67 years). The most common exposure was diphenhydramine (28, 93.3%) of which 23 were single substance. The majority of exposures occurred following suspected suicide (25, 83.3%). Moderate and major outcomes occurred in 93.3% ($n = 28$) and 6.7% ($n = 2$) of cases respectively. 17 cases (56.7%) were admitted to non-critical care and 10 cases (33.3%) were admitted to critical care. Every patient received oral rivastigmine, 2 patients (6.7%) received transdermal rivastigmine in combination with oral rivastigmine, and 2 patients (6.7%) received intravenous physostigmine followed by oral rivastigmine. Patients received rivastigmine on average 12.3 hours (range: 1–84 hours) after ingestion or hospital presentation. The most common initial oral rivastigmine dose provided was 3 mg (range: 1.5–4.5 mg). 13 patients (43.3%) received additional rivastigmine doses. Following rivastigmine administration, 20 patients (66.7%) demonstrated symptom improvement, 8 patients (26.7%) had unclear benefit, and 2 patients (6.7%) showed no benefit. Symptom improvement occurred within 1 hour for 5 patients (16.7%), between 1–4 hours for 10 patients (33.3%), after 4 hours for 3 patients (10%), and timing was unclear for 10 patients (33.3%). 24 patients (80%) received sedation prior to rivastigmine. 18 patients (60%) received sedation after a dose of rivastigmine. One patient experienced bradycardia though this was prior to rivastigmine administration. No other cholinergic adverse effects were reported.
Conclusions: Rivastigmine, whether oral or transdermal, appears to be potentially beneficial and safe when treating anticholinergic toxicity. Many patients were too delirious to take rivastigmine by mouth and did not receive a dose until toxicity was improving. However, increased use of the rivastigmine transdermal patch may be useful in these patients, provided the diagnosis is not in question. The ideal dose of rivastigmine in anticholinergic toxicity is unknown. However, no cholinergic adverse effects occurred at the relatively low doses administered here and a higher dose may be more effective. The delayed onset of rivastigmine along with concomitant parenteral benzodiazepine use in many patients made efficacy difficult to assess. More research is warranted to determine appropriate starting doses, frequency of administration, and adverse effects of rivastigmine in treating anticholinergic toxicity.

KEYWORDS Anticholinergic toxicity; rivastigmine

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46. Abnormally high methemoglobin percentage requiring a second dose of methylene blue due to benzocaine administration for feeding tube placement

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Background: Methemoglobinemia due to the administration of oxidizing agents is not uncommon, with benzocaine spray (hurricane spray) for topical analgesia for procedures being one of the most classic causes. Based on one case series of 19 patients that developed methemoglobinemia due to benzocaine out of 28,478 patients, the average methemoglobin percentage was 32% with a standard deviation of 15%, ranging from 15 to 60%. Further based on the same case series one dose of methylene blue was successful in all but two patients, who only received 50mg of methylene blue. We present a patient with a higher-than-expected methemoglobin percentage than expected and requiring a second dose of methylene blue.
Case report: A 68-year-old female with a history of prior lumbar laminectomy, spinal instability, and traumatic L4 fracture, was admitted to the hospital for a staged operation. After her first operation she was admitted to the ICU after L2–S1 posterior fusion with spinal decompression was complicated by encephalopathy, so a feeding tube was required. Topical benzocaine spray was used for the procedure. Shortly after placement the patient's oxygen saturation by pulse oximetry was noted to be 80%. An arterial blood gas was sent, which showed a methemoglobin percentage of 60.0% and the patient was given 100 mg (1.5 mg/kg) of methylene blue. Thirty minutes later a repeat arterial blood gas was sent showing a methemoglobin percentage of 30%, and the patient was administered 62mg (0.9 mg/kg) of methylene was administered. A repeat arterial blood gas was sent 2 hours later showing a methemoglobin percentage of 20.3% and a hemoglobin of 9.4 g/dL, which is when poison control was contacted asking for information regarding a methylene blue infusion. On consultation the patient was showing no further evidence of symptomatic toxicity, so it was recommended to discontinue administration of methylene blue, keep the patient on oxygen supplementation, and to repeat an arterial blood gas. Repeat arterial blood gas 3.5 hours later showed a methemoglobin percentage of 1.3%.
Discussion: Topical benzocaine spray for local analgesia is commonly applied for many medical procedures. Due to the method of dosing, there is no way to accurately measure doses, making it easy to unintentionally administer high doses. Common teaching is that benzocaine induced methemoglobinemia rarely is severe and rarely require re-administration of methylene blue when adequately dosed. Our patient who was critically ill likely received an unintentionally high dose of benzocaine require repeat dosing of methylene blue.
Conclusions: "*Dosis sola facit venenum*" (only the dose makes the poison), is the most basic principle of medical toxicology. There is increasing awareness of the risk of developing methemoglobinemia due to the administration of benzocaine, and the timely administration of methylene blue. However, due to the means of administration, there needs to be improved education on limiting the dose applied when administering topical benzocaine spray, to prevent the development of severe methemoglobinemia requiring repeat administration of methylene blue

KEYWORDS Methemoglobinemia; methylene blue; benzocaine

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47. Presumed thiocyanate toxicity secondary to prolonged nitroprusside infusion managed with extracorporeal treatment: a case report

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Background: Sodium nitroprusside releases nitric oxide, causing vasodilation and decreased afterload. Prolonged nitroprusside infusion can lead to accumulation of toxic metabolites: cyanide and thiocyanate. Hallmark findings of cyanide toxicity include metabolic acidosis and hemodynamic instability. This contrasts with thiocyanate toxicity, which presents with nonspecific

symptoms, such as confusion and delirium, typically at thiocyanate concentrations > 60 mcg/mL. Thiocyanate is renally eliminated; in patients with chronic kidney disease, prolonged nitroprusside infusion can produce thiocyanate toxicity within 3–6 days. We present a case of prolonged nitroprusside use with elevated thiocyanate levels, worsening renal function, and altered mental status (AMS).
Case report: A 71-year-old female with end stage heart failure received an eight-day nitroprusside infusion (range: 0.25–3 mcg/kg/min) for afterload reduction in the setting of cardiogenic shock. A serum thiocyanate level was collected on day 5 as a safety check. The patient was asymptomatic but had an elevated serum creatinine (SCr) of 1.5 mg/dL. On day 8, the level returned elevated: 36.4 mcg/mL (reference range: 3–15 mcg/mL). A repeat level was collected, the infusion was discontinued, and she was maintained on milrinone. Later on day 8, she developed progressive confusion and lethargy prompting stroke workup. Her SCr was 2.37 mg/dL. She was tolerating oral intake without nausea or vomiting. Head computed tomography was normal and no lab work or infectious markers indicated other causes, yet she continued with fluctuating mental status. Thiocyanate toxicity was considered, and the poison center was consulted on day 10 regarding use of extracorporeal treatment. Her SCr remained elevated (2 mg/dL). An additional thiocyanate level was collected by the time of consult; however, repeat levels had not resulted. Dialysis was recommended to enhance elimination of thiocyanate for presumed toxicity with renal insufficiency. The patient received continuous renal replacement therapy (CRRT) from days 11 to 13 when she received a session of hemodialysis (HD) due to persistent AMS. Her SCr returned to baseline (1.11 mg/dL) on day 14. On the evening of day 14, she was awake, alert, and oriented. The thiocyanate level from day 8 resulted on day 14 as 13.9 mcg/mL. The day 10 level (pre-CRRT) was 17.6 mcg/mL, the day 12 level (CRRT day 2) was 13.6 mcg/mL, and the day 16 level (3 days post-dialysis) was 13.7 mcg/mL. Cyanide levels drawn on days 10 and 16 were < 0.1 mg/L. The patient remained admitted for medical management unrelated to thiocyanate toxicity.
Discussion: Thiocyanate toxicity should be considered in patients on prolonged nitroprusside infusions with acute mental status changes, especially in the setting of renal dysfunction which increases thiocyanate's half-life. Our patient's levels did not correlate with those expected in thiocyanate toxicity; however, results were not readily available. She improved following nitroprusside discontinuation and CRRT/HD, but this may have been confounded by other variables.
Conclusions: Thiocyanate levels should be monitored early and more frequently in patients with renal dysfunction receiving prolonged nitroprusside infusions. Extracorporeal treatment can be employed in severe cases.

KEYWORDS Thiocyanate toxicity; prolonged nitroprusside infusion; renal insufficiency

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48. Unintentional overdose during at-home ketamine therapy successfully treated with supplemental oxygen and atropine

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Background: New research in the treatment of psychiatric disorders has resulted in the increase in popularity of at-home ketamine therapy. This has coincided with an expansion of telemedicine since the COVID-19 pandemic allowing for exceptions to Schedule III prescribing practices.
Case report: This report describes a 35-year-old female who was instructed to swallow 1200 mg of oral ketamine during an at-home telehealth ketamine therapy session. She was brought by emergency medical services (EMS) to a community emergency department (ED) with altered mental status, hypoxia, and bronchorrhea. The medical toxicology service was consulted on her management. Her symptoms were successfully managed with supplemental oxygen and atropine.
Discussion: Our case highlights the management of adverse effects of ketamine in addition to overdose treatment. Here, refractory bronchorrhea and hypoxia were successfully managed with atropine resulting in clinical improvement and avoidance of intubation. Currently, there is little to no regulation of at-home ketamine therapy. This case report emphasizes the public health concerns posed by the proliferation of at-home ketamine prescribing practices.
Conclusions: With increasing utilization of off-label at-home ketamine-assisted therapy, poison control specialists and emergency medicine clinicians must be aware of this practice and know how to treat its complications.

KEYWORDS Psychiatry; ketamine; atropine

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49. Enzalutamide and elevated digoxin concentrations: drug-drug interactions & lab interference in prostate cancer patients

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Background: Enzalutamide (Xtandi ®) is an antiandrogen antineoplastic agent that was FDA-approved in 2012 to treat prostate cancer. Enzalutamide has multiple drug-drug interactions which may result in increased digoxin concentrations; however, it also interferes with multiple digoxin assays, causing falsely elevated serum digoxin concentrations [digoxin]. We present a case demonstrating the clinical challenges of these drug-drug and drug-lab interactions.
Case report: An 83 year-old man was started on digoxin, 250 micrograms daily, for atrial fibrillation after a recent hospitalization; his other home medications purportedly only included warfarin and insulin. One week follow-up routine [digoxin] returned elevated at 8.2 ng/mL and he was referred to the ED despite being asymptomatic. On ED arrival he had atrial fibrillation (a-fib) with occasional premature ventricular contractions and felt at his new baseline. The ED reported "his only complaint is he does not want to be here." Serum potassium was 3.5 mEq/L; serum creatinine was at his baseline of 1.45 mg/dL. A repeat [digoxin] required dilution prior to returning at 6.8 ng/mL. His digoxin was held, and he was admitted for observation. Repeat [digoxin] that day (hospital day [HD] #1) with the patient remaining in a-fib (rate of 80 beats/min, blood pressure 122/97 mmHg) was 6.6 ng/mL; serum potassium was 3.5 mEq/L. Twenty-four hours after admission he developed a-fib with rapid ventricular response (110–130 beats/min) that spontaneously resolved. On HD#2 [digoxin] was 7.0 ng/mL (potassium 4.0 mEq/L, creatinine 1.14 mg/dL), and on HD#3 [digoxin] was 7.2 ng/mL. On HD#4 it was discovered that the patient had recently been treated with enzalutamide. His

medications were adjusted, and he was discharged without ever receiving digoxin immune fab.
Discussion: Enzalutamide is a mild P-glycoprotein/ABCB1 inhibitor and may increase the serum digoxin concentration 1.25–2 fold when used concurrently. The enzalutamide package insert reports an increase in digoxin AUC of 33% and C max of 17%; thus, therapy modifications (e.g., 15–30% digoxin dose reduction common) may be needed. Case reports also describe falsely elevated [digoxin] in patients co-prescribed enzalutamide and digoxin, as well as therapeutic digoxin concentrations in patients not prescribed digoxin at all. Though enzalutamide is dosed daily, its half-life is 5.8 days (range: 2.8–10.2) making drug-drug or drug-lab interactions possible even if enzalutamide is held on hospital admission. Our patient was observed for four days and remained asymptomatic despite his elevated [digoxin]; indeed, the development of a transient tachydysrhythmia suggests he may have actually been subtherapeutic as his hospitalization progressed. As such, we suspect this case was predominantly of lab interference.
Conclusions: Toxicologists and emergency clinicians should be aware of both drug-drug and drug-lab interactions between digoxin and enzalutamide that result in elevated digoxin concentrations. In patients with a history of prostate cancer presenting with supratherapeutic digoxin concentrations, providers should inquire about enzalutamide use and use clinical signs and symptoms of digoxin toxicity rather than serum digoxin concentrations to guide digoxin immune fab therapy in patients taking enzalutamide.

KEYWORDS Digoxin; enzalutamide; drug-drug interaction

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50. A case of sodium oxybate withdrawal

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Background: Sodium oxybate is a gamma-hydroxybutyrate (GHB) analog used for the treatment of narcolepsy. GHB is both a metabolite and precursor to gamma-aminobutyric acid (GABA) and glutamate, but primarily increases GABA receptor activity, resulting in CNS depression. While GHB dependence and withdrawal are well established, sodium oxybate withdrawal has been controversial. A manufacturer-sponsored study has claimed that withdrawal is not possible with chronic therapeutic dosing. This has been disputed in a commentary reviewing the manufacturer's original data. We have been unable to find any case reports describing sodium oxybate withdrawal. We present a case report of suspected sodium oxybate withdrawal.
Case report: A 36 year-old female with a past medical history of anxiety and narcolepsy presented to the emergency department (ED) with 5 days of progressive jerking movements and worsening anxiety. The patient had been initiated on sodium oxybate 4.25 grams orally twice daily approximately 4 weeks prior. She began to experience gastrointestinal upset, which her prescribing physician attributed to the sodium oxybate, and reduced her dose to 3.25 grams twice daily approximately 24 hours prior to onset of presenting symptoms. The patient discontinued the medication entirely 3 days later, and her symptoms progressively worsened over the ensuing 48 hours. Her other home medications, which had not been adjusted, included bupropion XL 300 milligrams, buspirone 10 milligrams, escitalopram 20 milligrams, montelukast 10 milligrams, ondansetron 4 milligrams, cetirizine 10 milligrams, norgestimate and ethinyl estradiol 25 milligrams. On arrival in the ED, she was tachycardic and tremulous with myoclonic jerking, agitation and anxiety, without rigidity, hyperthermia, clonus or hyperreflexia. Her mental status was otherwise normal. Basic metabolic panel, liver function testing, complete blood count, urine pregnancy, urinalysis and urine drug screen were within normal laboratory parameters. Electrocardiogram revealed sinus rhythm with normal QRS and QTc intervals and morphology. Concern for tardive dyskinesia was expressed by the primary team. The patient was provided diphenhydramine 25 mg orally, and neurology and toxicology was subsequently consulted. Neurology expressed concern for serotonin toxicity. The patient had no history of antipsychotic use and adamantly denied medication overdose or any non-prescribed xenobiotic use. The patient was provided 1 mg intravenous lorazepam for 2 doses with rapid resolution of symptoms. She was discharged without recurrence of symptoms after brief observation in the ED.
Discussion: Xenobiotics such as ethanol, benzodiazepines, and barbiturates all produce withdrawal syndromes at least in part through decreased neurotransmission at GABA-A receptors, leading to decreased CNS inhibition. GABAergic withdrawal syndromes typically manifest as tremors, myoclonic jerkings, seizures, anxiety, agitation, diaphoresis and hyperadrenergic vital signs. Sodium oxybate, which is converted to GHB in vivo, would be expected to cause a similar syndrome and is consistent with this patient's clinical presentation. Serotonin toxicity is less likely given lack of hyperthermia or clonus. Limitations include the descriptive nature of this case report and lack of accepted diagnostic criteria.
Conclusions: Chronic use of sodium oxybate can lead to physiologic dependence, and rapid discontinuation of sodium oxybate can precipitate a withdrawal syndrome.

KEYWORDS Sodium oxybate; withdrawal; narcolepsy

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51. An *in vitro* study of the effect of intravenous lipid emulsion (Intralipid®) on routine laboratory coagulation assays

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Background: Intravenous lipid emulsion (Intralipid®) is used in the treatment of poisonings, most notably local anaesthetics. Lipaemia following its administration may affect laboratory analyses. The aim of this study was to use an *in vitro* model to determine the impact of Intralipid on routine laboratory analysis of coagulation parameters to determine if the analytical techniques remain reliable following its administration.
Methods: Samples were obtained from 19 healthy volunteers who were screened to exclude pre-existing coagulation disorders. Whole-blood samples of 10.5 mL were taken from each volunteer and divided in triplicate. One sample served as a control and the other two were diluted with the *in vitro* equivalent concentration to simulate treatment of an average adult with 100 ml of Intralipid 20% (Fresenius Kabi; dilution-1) or 500ml of Intralipid (dilution-2). Samples were centrifuged at 6000g for 3 minutes at

ambient temperature to produce platelet poor plasma. Coagulation tests performed were Prothrombin time (PT in seconds and International Normalised Ratio (INR)), Activated Prothrombin time (APPT in seconds and ratio), D-dimer (g/L) and Fibrinogen (mg/L). Coagulation testing was performed by three techniques, using routine validated and quality-controlled protocols. Test-1 was performed on a CN6500 analyser (Sysmex, Japan) which is the routine automated assay in this institution. Test-2 was performed with a manual mechanical endpoint method using the Semi-automated KC4 Delta (Stago), a test used in laboratories if there are problems with the automated assay. After analysis of the samples from the first participant, Test-3 was added: this involved high speed centrifugation (10,000g for 10 minutes) before repeat testing on the CN6500 automated analyser. Results were collected in Excel and analysed using IBM SPSS statistics (version-28), a paired t-test was done to compare the control sample and the Intralipid samples for each individual coagulation essay.

Results: For Test-1, only 47% (9) samples in dilution-1 could be analysed for coagulation tests, and no coagulation tests could be analysed for dilution-2 because of lipaemia. For Test-2 and Test-3 all samples could be analysed. Individual paired *t*-testing against the control sample showed a statistically significant difference in measurements ($P < 0.05$) for dilution-1 for APTTr using both Test-1 and Test-3; and for Fibrinogen using Test-1. For dilution-2, there was statistical significance for PT INR, APTTr and Fibrinogen using test-2 and for APTTr in test-3.

Conclusions: This *in vitro* model confirms that Intralipid interferes with routine coagulation studies. The most important effect was the inability to measure coagulation tests using the automated analysis for all samples spiked with intralipid consistent with high-dose clinical administration, and almost half of the samples simulating low-dose administration. These difficulties were overcome by either a mechanical end point detection method or by centrifuging samples prior to automated analysis. It is important that clinicians are aware of the potential for intralipid to interfere with routine coagulation assays, and to inform their laboratories of the Intralipid administration if these analyses are required.

KEYWORDS Lipid emulsion; coagulation; laboratory analysis interference

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52. Is calcium the precipitate in your calcium gluconate gel solution?

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Background: Treatment of topical, low concentration hydrofluoric acid (HF) exposures is typically application of topical 2.5% calcium gluconate gel to the affected area. Though a commercial gel exists, it is common for practitioners to create calcium containing solutions using either calcium gluconate solution or crushed calcium carbonate ts in gels that are commonly available in emergency departments. Previous experiences at our institution mixing calcium gluconate into various gels caused visual precipitation of a white substance in the gel, leading to concern for precipitation of calcium out of solution. As a result, we embarked on a study to identify readily available gel solutions in Emergency Departments that could be used to develop a homogenous topical calcium gel solution.

Methods: 15 mL of sample gel was placed in individual test tubes (2 oz amber PET liquid bottles). The four sample gels tested were: glycerin, lubricating gel, sterile ultrasound gel, and URO-Jet (Lidocaine HCl 2% (20 mg/mL)). 5 mL of Calcium Gluconate (100 mg/mL) was added to each sample. The tubes were subsequently capped and hand agitated. These individual containers were labeled with the corresponding sample gel solution. Observations were made prior to hand agitation, immediately after agitation, and at 24 hours. For quantification, 10 mL of 100 mg/mL Calcium gluconate solution was diluted into 30 mL each of deionized water, viscous lidocaine solution, lubricating jelly, glycerin, and ultrasound gel. All samples were mixed via vortex and let stand for 5 minutes. These samples were then centrifuged at 12,000 RPM for 2 minutes. Aliquots of the resultant supernatants were diluted into deionized water to contain 0.3 mg $Ca2^{+}$ ion based on the initial concentration of calcium gluconate. These samples were then prepared in triplicate for calcium ion quantification by absorbance at 575nM via a Colorimetric Calcium Assay (MAK022 Sigma Aldrich) according to the manufacturer's protocol. Calcium concentration from the samples was determined by comparing A575 values to a standard curve created from the calcium ion standard supplied with the kit.

Results: The lubricating jelly solution produced an opaque solution that transitioned into a sticky white precipitate that adhered to the sides and bottom of the vial. The ultrasound jelly produced an opaque white agglomeration at the bottom of the vial. The lidocaine and glycerin solutions remained clear. The assay suggested that despite the differences in appearance there was no significant difference in the concentration of calcium in glycerin, lubricating jelly, or ultrasound gel. We suspected significant calcium in lidocaine due to its appearance; however, the assay showed the lowest concentration of calcium in the lidocaine solution.

Conclusions: Our work shows that the use of calcium gluconate added to either glycerin, lubricating jelly or ultrasound gel yields similar concentrations of calcium ion to use as treatment for HF exposure. Despite its homogenous appearance, lidocaine solution yielded the least amount of calcium. Further investigation into causes of varying calcium concentration as well as determination of precipitant is necessary.

KEYWORDS Calcium gluconate; hydrofluoric acid

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53. Does mixing activated charcoal with cola improve tolerability without affecting pharmacokinetics? a randomized controlled crossover trial

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Background: Activated charcoal is the most common form of gastrointestinal decontamination used for the poisoned patient. It possesses a large surface area, allowing for xenobiotic to adsorb to the charcoal utilizing weak intermolecular forces. Various studies in both healthy volunteers and poisoned patients have shown the ability of activated charcoal to decrease absorption of ingested xenobiotics. However, one limitation to its use is patient tolerability due to taste and appearance. Some recommend mixing activated charcoal with something like cola to improve palatability. An important question is whether mixing activated charcoal with cola effects the ability of the activated charcoal to adsorb xenobiotic.

Methods: This was a prospective randomized controlled crossover trial. Five healthy non-pregnant adults aged 18–40 were recruited. Participants could not be on any daily medications, they could not have any pre-existing hepatic or renal disease, and they could not have a history of alcohol or substance use.

On study days, participants presented after fasting starting at 0400 the day of the study. They received 45 mg/kg acetaminophen in 325 mg ts rounded down to the nearest whole t. One hour later, they received 50 g of an activated charcoal-water premixture. The participants were randomized to either receive the activated charcoal-water premixture alone or mixed with 240 mL of cola. Acetaminophen levels were collected at 0, 15, 30, 45, 60, 75, 90, 120, 180, and 240 minutes. Serum was collected and analyzed utilizing a Sekisui Diagnostics Acetaminophen L3KÒ assay. The area under the curve (AUC) of acetaminophen concentrations over time was measured as a marker for degree of absorption. Participants also completed a questionnaire in which they rated the activated charcoal preparation on appearance, smell, flavor, texture, and overall appeal using a facial scale from 0 to 10, with 10 being the best. Participants would then return after at least seven days to repeat the study with the other activated charcoal preparation.

Results: Four male participants and one female participant were recruited, ages ranging from 28 to 36. There was no statistical difference in preference score for activated charcoal-water premixture alone versus when mixed with cola in appearance, smell, flavor, texture, or overall appeal. There was no statistical difference in the AUC of acetaminophen concentrations over time between activated charcoal-water premixture alone versus mixed with cola.

Conclusions: In a small healthy volunteer study, there was no difference in pharmacokinetics in decreased acetaminophen gastrointestinal absorption when an activated charcoal-water premixture is mixed with cola. However, there was no statistical preference for one charcoal mixture over the other. In summary, if a patient would prefer to drink charcoal with cola, the results of our small study suggest this would be reasonable.

KEYWORDS Activated charcoal; GI decontamination

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54. Retrospective review of large bupropion ingestions reported to one poison center 2013–2022

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Background: Bupropion is a commonly prescribed antidepressant possessing unique pharmacologic properties. Unfortunately, supratherapeutic bupropion ingestions are associated with significant adverse effects including seizure, cardiac dysrhythmias, and death. Treatment for these patients is limited; there is no antidote, and traditional treatments such as sodium bicarbonate, are not as effective as with toxicity from other antidepressants. The goal of this study was to evaluate medical outcomes based on the reported dose as well as the correlation of case outcomes and seizures with the use of activated charcoal (AC).

Methods: Retrospective review of single substance human bupropion exposure cases reported to one poison control center between 1 January 2013, and 31 December 2022. Cases were identified using bupropion product codes with free text notes taking precedence over coded data fields. Cases were included if the amount ingested was greater than 1500 mg, age was older than 12 years, and if they were followed for at least 18 hours. Cases were excluded for non-ingestion route of exposure, the outcome was unrelated to exposure, the ingestion was chronic (> 8 hours), the case was managed in a different state, or bupropion dose was unknown. Seizures were categorized as single or multiple/status epilepticus. Case outcome was categorized as No Effect, Mild, Moderate, Major or Death. Chronicity was acute or acute on chronic. Time until first seizure and until administration of first dose AC was abstracted. Ordinal logistic regression was performed for calculation of odds ratios. Cox proportional hazard model was used to calculate hazard ratios. Significance was defined as $P < 0.05$.

Results: There were 243 included cases with females making up the majority (63.8%). Median dose was 3150 mg [IQR 2400 - 5250]. At least one dose of AC was administered in 88 (36.2%) cases. Tachycardia was the most reported clinical effect in 188 (77.4%) cases. Seizure was reported in 92 (37.9%) cases; multiple seizures or status were reported in 45 (18.5%) cases of which 12 (4.9%) received AC and 33 (13.6%) did not. Median time for development of seizures was 5.3 hours [IQR 3.0 – 8.2]; the latest occurred at 21 hours. Most cases (51.0%) had Moderate outcomes with 20.2% having Major outcomes; there were two Deaths (0.8%). Bupropion dose was strongly associated with increased risk of seizure (odds ratio 1.478 per 1000 mg dose increase, $P < 0.0001$). AC was associated with reduced risk of escalating seizure severity (odds ratio 0.506, $P = 0.0279$) as well as having case outcomes of lesser severity (odds ratio 0.387, $P = 0.0006$). Additionally, patients who received AC prior to any seizure event had a significant reduction in seizures (hazard ratio 0.441, $P = 0.015$). Chronicity was not associated with greater case outcome or escalating seizure severity.

Conclusions: This is one of the largest case series of significant (> 1500 mg) bupropion ingestions that reports an association between the use of AC and decreased odds of more severe case outcomes and multiple seizures. Further research is warranted to evaluate if there is a link between administration of AC and improved outcomes in these patients.

KEYWORDS Bupropion; activated charcoal; seizures

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55. Trends in the in the intent and drug classes used in opioid overdose cases treated by medical toxicologists

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Background: The current epidemic of opioid-related deaths in the United States is largely characterized by data from medical examiners and coroners. Although some studies provide detailed data on patients with non-fatal opioid toxicity, these lack detailed patient-level data on why individual patients were opioid-exposed. This study assessed the reasons for deliberate opioid exposures resulting in serious toxicity from the Toxicology Investigators Consortium (ToxIC) Core Registry.

Methods: The ToxIC Core Registry collects pre-specified data on consecutive patients cared for by participating medical toxicologists. Cases due to intentional pharmaceutical or non-pharmaceutical opioid exposures in patients aged ≥11 between 2014 and 2021 were included. Pharmaceutical opioids were defined as Food and Drug Administration-approved medications. All other opioids were defined as non-pharmaceuticals. Sedative-hypnotics, non-opioid analgesics, and antidepressants were used as comparators. Because all cases in the Core Registry required medical toxicology consultations, they were deemed to be serious. Subjects were summarized by frequency count and percentages for the categorical variables. Linear regression analyses were

performed to evaluate the time trend in proportion of subjects with opioid suicide attempts and misuse. The ToxIC Core Registry was reviewed by a central Institutional Review Board (IRB) and by the IRBs of participating institutions.
Results: Of 62,833 total ToxIC cases between 2014 and 2021, 8460 involved opioids, and 8011 (94.7%) of these met inclusion criteria. 5450 (64.4%) had an intentional opioid exposure. Age, race, and ethnicity did not correlate with the reasons for intentional opioid exposures. There were significantly more females in the self-harm group, but almost two-thirds of the opioid misuse cases were males. ($P < 0.0001$). 1545 (28.3%) of intentional opioid exposures were self-harm attempts, of which 1268 (82.1%) expressed suicidal ideation. Opioid toxicity from misuse occurred in 3083 (56.6%) of intentional exposures. The remaining 822 (15.1%) intentional exposure cases were either from therapeutic use or indeterminant reasons. The proportion of total intentional opioid cases decreased significantly from 2014–2021 ($P = 0.02$). Total opioid self-harm cases decreased during this period ($P = 0.002$), but the change in misuse cases was not significant. Pharmaceutical opioid suicide attempts and misuse cases peaked between 2015 and 2017 and fell dramatically thereafter ($P = 0.009$). In contrast, an increase was observed for non-pharmaceutical opioid suicide attempts or misuse ($P = 0.02$). Exposures to sedatives showed a gradual downward trend after 2016 that was driven by a decrease in benzodiazepine cases for both self-harm and misuse. There was no corresponding decrease in the percent of cases involving non-opioid analgesics, non-benzodiazepine sedative-hypnotics, or antidepressants.
Conclusions: Over a quarter of intentional opioid overdoses in the ToxIC Core Registry were due to self-harm attempts, suggesting that intentional overdose should be considered in the interpretation of opioid overdose statistics. Cases of pharmaceutical opioid exposures for misuse and self-harm fell precipitously following the 2016 release of guidelines from the Center for Disease Control. In contrast, there was an increase in non-pharmaceutical opioid exposures for misuse and self-harm during the same period. There was a gradual decrease in benzodiazepine exposures during the study period, while exposures to non-opioid analgesics and antidepressants did not change.

KEYWORDS Opioid overdoses; overdose trends; ToxIC

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56. Xylazine trends over time

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Background: Xylazine is a veterinary anesthetic agent, which has been found increasingly in illicit fentanyl and other illicit opioids. This study attempted to determine variation in the frequency of samples containing xylazine over time along with stratification by geographic region.
Methods: The Toxicology Investigators Consortium (ToxIC) Fentalog Study is a regionally diverse multi-center toxico-epidemiology study which consists of patients presenting to 10 participating EDs with suspected acute opioid toxicity from 9/21/2020 to 5/1/2023. In addition to chart review of medical records, waste serum, drawn as part of routine clinical care, is collected and analyzed using liquid chromatography quadrupole time-of-flight mass spectrometry for the presence of over 1,000 novel psychoactive substances, drugs of abuse, and therapeutics. A central IRB approved this study with waiver of consent. For this interim analysis dates of active sample collection (11/2020–8/2021 and 2/2022–11/2022 were divided into five month periods; periods; 1: (11/2020–3/2021); 4/2021–8/2021); 3: (2/2022–6/2022); 4 (7/2022–11/2022). Regions were considered West (California, Oregon), Midwest (Michigan, Missouri); East (New York, New Jersey, Pennsylvania). Utilizing unadjusted bivariate regression, the four time periods and three regions were examined.
Results: Among the total sample of cases with analytes ($n = 740$), 20.4% ($n = 151$) biologic samples contained xylazine. Xylazine was detected in 36/96 (37.5%) samples in period 1, 56/211 (26.5%) in period 2; 22/149 (14.7%) of samples in period 3; and 38/177 (21.4%) of samples in period 4. These were not significantly different. However, there was a significant change when stratified by region. Xylazine was found in 2/85 (2.4%) of samples from the West; 17/184 (9.2%) of Midwest samples; and 133/464 (28.6%) of samples from the East. Thus, the odds of fentanyl containing xylazine is 13.1 (95% CI 3.19–54.1) comparing East to West. There was no significant difference in the odds of fentanyl containing xylazine in the East vs. Midwest.
Conclusions: Over the last 2 years, the number of patients testing positive for xylazine in our sample did not significantly change; however, regional sample variation was significant with xylazine more commonly detected in the East compared to the West.

KEYWORDS Xylazine; opiate; overdose

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57. Prevalence of HIV among patients presenting with acute opioid toxicity

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Background: People living with HIV have higher rates of substance use compared to the general population, but it's unclear what factors are associated with HIV among patients presenting to the ED with opioid overdose. The objectives of this study are to: (1) determine the prevalence of HIV in a sample of patients presenting to the ED with opioid overdose; and (2) identify demographic (age, sex, race, and ethnicity) and behavioral factors (current drug use patterns and route of drug use) associated with HIV.
Methods: The Toxicology Investigators Consortium (ToxIC) Fentalog Study is a regionally diverse multi-center toxico-epidemiology study, which consists of patients presenting to 10 participating EDs with suspected acute opioid toxicity from 9/21/2020 to 5/1/2023. In addition to chart review of medical records, waste serum, drawn as part of routine clinical care, is collected and analyzed using liquid chromatography quadrupole time-of-

flight mass spectrometry for the presence of over 1,000 novel psychoactive substances, drugs of abuse, and therapeutics. A central IRB approved this study with waiver of consent. The prevalence of HIV was determined and stratified by injectable vs. non injectable drug use. Medians and interquartile ranges (IQR) were obtained and compared between the HIV positive and negative groups. Logistic multivariable regression was performed to assess for confounding variables. All analyses were conducted in R v4.2.1.

Results: Among the 1,319 subjects identified, 762 (57.8%) were HIV negative, whereas 41 (3.1%) were HIV positive. The HIV status was unknown in 516 (39.1%). Males accounted for 70.5% of the HIV negative group, compared with 78% of the HIV positive group (P = NS). 332 (42.3%) of the HIV negative group had no psychiatric comorbidities, compared with 11 (26.8%) in the HIV positive group ($P = 0.05$). The median (IQR) age of the HIV negative cohort was 39 (23) years, compared with 57 (15) in the patients with HIV ($P < 0.001$). IDU was reported in 44 (10%), 2 (8%), and 60 (20.8%), of the HIV negative, HIV positive, and HIV unknown individuals, respectively ($P = 0.02$). Utilizing multivariable regression, age was the only associated factor with HIV status (OR: 1.04; 95% CI: 1.02, 1.07), with older ages more likely to be HIV-positive compared to younger ages. Although race was statistically significantly associated with HIV status in the unadjusted regression (Black vs. White race: OR: 3.11; 95% CI: 1.54, 6.49), this association was not significant when accounting for age, sex, ethnicity, and IDU.

Conclusions: Adults presenting to the emergency department with acute opioid toxicity should be considered high-risk for HIV, regardless of the route of drug use. IDU was common among individuals regardless of HIV status, which presents a modifiable risk factor for HIV prevention. The rate of HIV positivity in this population was approximately 10-fold higher than the US average (0.3%). The median age of HIV positive individuals presenting with opioid toxicity was significantly older than the rest of the population in this study.

KEYWORDS Opiate; overdose; HIV

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58. Use of naloxone upon discharge

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Background: As the opioid crises continues, there has been a movement to make naloxone directly available to those using opioids, rather than exclusively first responders. This study attempted evaluate the variation in dispensing/prescribing naloxone among patients admitted to the hospital and then discharged, vs. those discharged from the emergency department (ED). In addition, this study examined the relationship between medical toxicology consultations and the rate of naloxone prescribing.

Methods: The Toxicology Investigators Consortium (ToxIC) Fentalog Study is a regionally diverse multi-center toxico-epidemiology study which consists of patients presenting to 10 participating EDs with suspected acute opioid toxicity from 9/21/2020 to 5/1/2023. In addition to chart review of medical records, waste serum, drawn as part of routine clinical care, is collected and analyzed using liquid chromatography quadrupole time-of-flight mass spectrometry for the presence of over 1,000 novel psychoactive substances, drugs of abuse, and therapeutics. A central IRB approved this study with waiver of consent. Naloxone prescribing was defined as either dispensed or prescribed. Patients were excluded if their disposition (admission vs. ED discharge) was not recorded, the presence/absence of a toxicology consult was not recorded, or if the patient died. Odds ratios and 95% confidence intervals were calculated to determine factors associated with rates of naloxone prescribing.

Results: Out of 1319 eligible study patients, 94 were excluded (14 deaths 80 incomplete data) leaving 1225 patients analyzed. Toxicology consultations were obtained on 149 (12.2%). Naloxone was prescribed to 109 (73%) of those with toxicology consultation, compared with 405/1076 (37.6%) of those without (OR 0.22; 95% CI 0.151–0.32; $P = < 0.0001$). A total of 476 patients were admitted, and 749 were discharged directly from the ED. Among the admitted patients, 218 (45.7%) received naloxone upon discharge, whereas 296 (39.5%) of patients discharged directly from the ED received naloxone (OR 0.77; 95% CI 0.81–0.99; $P = 0.03$)

Conclusions: In this multicenter study of ED patients with confirmed opioid overdose, patients admitted to the hospital were slightly more likely to receive naloxone upon discharge than those discharged directly from the ED, but the rates were low in both groups. Patients were much more likely to receive naloxone upon discharge if a toxicologist was directly involved in their care. Future study is warranted to improve strategies for naloxone prescribing in this patient population.

KEYWORDS Naloxone; overdose; opiate

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59. Trends in non-fatal adolescent and young adult drug overdoses presenting to US emergency departments

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Background: Substance misuse and overdose remain a significant public health concern among youths, with CDC data pointing to rising rates of overdose deaths in this age group. Non-fatal drug overdoses have been identified as a key opportunity for reducing drug-related harms, though healthcare encounters for these events remain poorly described among adolescents and young adults. Our objective was to examine temporal trends and characterize non-fatal drug overdoses among youths presenting to the emergency department (ED), including associated 1-year ED revisits.

Methods: This is a retrospective cohort study of adolescents (12–17 years) and young adults (18–21 years) who presented with a non-fatal drug overdose between 1/2010 and 10/2022 to the ED of a hospital participating in the Pediatric Health Information System (PHIS), a consortium of 49 tertiary care pediatric hospitals across 27 states and Washington, DC. Index ED visits for opioid, benzodiazepine, cocaine, and stimulant overdoses were identified using ICD codes. One-year ED revisits were classified as "overdose, index" (same substances as index visit), "overdose, other" (different substance, e.g., acetaminophen, antipsychotic, or antidepressant), "mental/behavioral health" (e.g., suicidal ideation, depression, or anxiety), or "other". Regression analysis was used to assess trends in index ED visits for overdoses, with the incident rate ratio representing the average change in outcome rate for each one-year change over the study period.

Stimulant and cocaine overdoses were combined for trend analysis due to low numbers of cocaine overdoses. Kaplan-Meier survival analysis was used to assess time to first all-cause ED revisit.
Results: Among the 8,676 individuals with an ED visit for a non-fatal drug overdose, patients were predominantly adolescent (n = 8193, 94.4%), female (n = 4883, 56.3%), and non-Hispanic White (n = 4634, 53.4%). Overdoses with benzodiazepines were the most common, peaking in 2016 at 74.9 overdoses per 100,000 ED visits. Overall, opioid and benzodiazepine overdoses remained stable while stimulant/cocaine overdoses increased 3.4% (95% CI 1.9, 5.0) per year through 2022. There were 2,255 (26.0%) index visits with at least one ED revisit within one year. The median time to first revisit was 84 days [IQR 26, 193]. 175 (7.8%) overdose revisits involved the original index substances (median 112 days [IQR 41, 210]), while 519 (23.0%) were related to a different substance (median 108 days [IQR 45, 212]) and 519 (23.0%) to a mental health problem (median 78 days [IQR 31, 182]). The most common non-index overdose substances among revisits were antidepressants (n = 52, 2.3%), antipsychotics (n = 38, 1.7%), and acetaminophen (n = 34, 1.5%).
Conclusions: ED visits for non-fatal drug overdoses remain high among adolescents and young adults, with recent increases in stimulant-related overdoses. Only a quarter of this high-risk population had a repeat visit to the ED within one year, indicating that programs aimed at reducing overdose-related harms may need to focus on healthcare and community spaces outside of the ED to maximize opportunities for interventions. Limitations of this study include the use of a pediatric database, which may limit generalizability of findings to patients presenting to a general ED.

KEYWORDS Adolescent; overdose

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60. Ethanol and lactate: is there a direct association?

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Background: Ethanol intoxication is regularly seen in the Emergency Department (ED) and it is common for these patients to have comorbid pathology. One clinical biomarker used in evaluating severity of illness, the serum lactate, has been hypothesized to elevate in the setting of acute ethanol intoxication due to altered cellular redox state. Providers may defer lactate testing in ethanol intoxicated patients due to uncertainty in interpretation, however this relationship has never been quantified.
Methods: We performed a retrospective cohort study of adult patients who had a serum ethanol measured during an ED encounter in our large academic health system from January 1, 2013 to January 30, 2023. Using TriNetX, a de-identified cohort builder, we exported these cases and excluded cases that did not have a serum lactate drawn. We additionally excluded patients from this cohort that were found to have a medication or medical diagnosis associated with lactic acidosis. This de-identified list of patients was used to export laboratory data, basic demographics, and initial vital signs from the electronic medical record. Descriptive statistics and regression analysis were performed.
Results: Our initial search identified 13,240 patients with serum ethanol measured. Of these patients, 3,960 patients had serum lactate measured concurrently. We excluded 2,584 patients for potential confounders and an additional 207 patients due to missing data, leaving a final cohort of 1169. The final cohort was 73% male with age range of 18 to 90 years old, average age 48.9, and median age of 48. On regression analysis, there was poor correlation found between ethanol and lactate (r^2 = 0.00136). Subgroup analysis of ethanol levels above 0.08 (the legal limit) and ethanol levels above 0.2 also showed poor correlation with r^2 values 0.00091 and 0.00051, respectively.
Conclusions: In this retrospective data analysis of ED patients in one academic urban health care system, there was poor correlation between ethanol and lactate levels. This suggests that an elevated lactate level should not be attributed to ethanol. Additionally, alcohol intoxication should not be used as justification to forego lactate testing when otherwise indicated. While effort was taken to exclude potential confounders, the causes of lactic acidosis are numerous, and confounders may remain. In the future, a large prospective study could be performed to elucidate a possible relationship between ethanol intoxication and elevated lactate.

KEYWORDS Ethanol; lactate

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61. Comparison of laboratory confirmed drugs in acute recreational drug toxicity presentations to an urban hospital in London, UK, 2016/17 versus 2019/20

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Background: Acute recreational drug toxicity is a common presentation to emergency departments (EDs). The drugs available worldwide are changing over time, with increasing availability of new psychoactive substances (NPS) in addition to established illicit drugs. However, there are limited data available on the actual drugs involved as most acute drug toxicity presentations are managed on the basis of self-report of the drugs involved without analytical confirmation.
Methods: A prospective sample of adult individuals presenting to a tertiary care, urban, ED in London, UK, with acute recreational drug toxicity was collected during two periods: October 2016 – February 2017 (500 individuals), and February 2019 – February 2020 (1000 individuals). Demographics were recorded from the medical records. If blood was taken for routine biochemical analysis, any remaining sample was collected and saved for confirmatory toxicological analysis at an independent laboratory, and the individual was included in the final cohort. Qualitative analysis by high resolution mass spectrometry was performed, and compared to a database of drugs and their metabolites. Relevant ethics (IRB) approval was obtained. Descriptive statistical analysis was performed in R.
Results: In total, samples for toxicological analysis were available for 500 patients in 2016/17, and 939 in 2019/20. The groups were similar in sex distribution, 85% male in both cohorts (c2 0.01, P = 0.9192), with clinically similar but statistically different age distribution (mean 33.2 years in 2016/17, versus 34.8 years in 2019/20, t = 2.89, P = 0.0039). See 1 for a comparison of the frequency of substance groups by class identified in each data set. Compared to 2016/17, there was an increase in the detection of cannabis, ketamine, and opioids in the 2019/20 cohort, while there was a decrease in the detection of cathinones, gamma-hydroxybutyrate (GHB), alcohol, and 3,4-Methylenedioxy methamphetamine (MDMA). 2 details the 41 NPS that were detected – the most common NPS groups were cathinones, novel benzodiazepines and synthetic cannabinoids, there were no NPS opioids detected in either cohort. Twenty-one NPS were detected in both cohorts, 11 NPS were only detected in 2016/17 and 9 NPS were only detected in 2019/20.

Conclusions: In two large cohorts presenting to an urban ED in the UK with acute recreational drug toxicity, collected several years apart, there were significant changes in the drugs identified by confirmatory mass spectrometry. The most no changes were the decrease in the proportion of individuals in whom cathinones or alcohol were detected and the increase in the proportion of individuals in whom opioids were detected. A total of 41 NPS were detected, the earlier cohort contained more unique novel cathinones whilst the later cohort contained more unique novel benzodiazepines. Studies such as these are important to confirm trends in the drugs, particularly NPS, involved in acute recreational drug toxicity presentations to the ED to triangulate with other indicators of drug-related harm and inform public health interventions.

KEYWORDS Recreational drug; novel psychoactive substances

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62. Reported recreational drug and new psychoactive substance (NPS) use versus laboratory detection of substances by high resolution mass spectrometry in patients presenting to the emergency department with acute drug toxicity

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Background: Clinicians managing patients with acute recreational drug / new psychoactive substance (NPS) toxicity depend on patient self report on what drugs they have used. However, users may not be aware of what they have actually used, or may not be able to give a reliable history because of drowsiness/agitation. To establish concordance of self-report this study compares users' self-report (and/or reported drug(s) from other sources e.g. first responders or bystanders), to the compound(s) that were subsequently identified in serum by confirmatory laboratory analysis.
Methods: A prospective sample of 1000 adults presenting to a tertiary care, urban, emergency department, with acute recreational drug/NPS toxicity was collected from February 2019 – February 2020. Inclusion criteria included patients having a blood sample taken for routine clinical care with residual serum remaining for subsequent confirmatory toxicological analysis. A total of 939 appropriate samples were identified, anonymized, frozen, and then batch delivered to an independent laboratory. Qualitative analysis by high resolution mass spectrometry was performed, and compared to a database of drugs and metabolites. Data on stated substance(s) used were extracted from the routine medical chart/records; this along with analysed results was batched by drug class where appropriate, and analysis performed in R to assess concordance. Relevant ethics permission was obtained prior to study commencement.
Results: Individuals were very accurate in naming certain classes; for example, self-reported opioid use had a PPV of 0.9053, or a 90.53% likelihood that opioids were present in the analyzed sample. Conversely, hallucinogens were only present in 18.75% of samples when reported used, or GHB in 53.39%. Individuals were also mostly quite accurate in not-underreporting substances, for example those not explicitly reporting GHB use were 97.49% to be truly negative (NPV 0.9749). Neither PPV or NPV was closely associated with either reported or analysis prevalence measures.
Conclusions: Overall, most users were relatively accurate in their self-report of what class of drugs they had, used recreationally. Certain substances are associated with users also being quite accurate in knowing that they had not used, for example GHB. However, drugs that might be pervasive, could have been used contemporaneously as prescriptions or in acute treatment, or might be cut into other drugs were present even when not reported, for example opioids or benzodiazepines. There was poorer concordance with positive self report for some drugs including cannabis and cathinones. Clinicians cannot rely on self-report, or other collateral reports, in all instances to have high concordance with the likelihood that a substance was, or was not, recently used, with interesting no exceptions.

KEYWORDS Recreational drug; novel psychoactive substances; self report

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63. Pediatric cannabis ingestions reported to poison centers in a state where recreational use is illegal

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Background: Legalization of cannabis in the United States (US) is increasing. Similarly, pediatric cannabis exposures have increased. Adverse effects associated with pediatric cannabis exposure include drowsiness or lethargy, ataxia, tachycardia, mydriasis, hypotonia, muscle rigidity, seizures, and agitation or irritability. The objective of this study was to characterize cannabis exposures by young children reported to poison centers in a state where recreational use is illegal but medical use of low-tetrahydrocannabinol (THC) oil is legal.
Methods: Data were obtained from the database of a statewide poison center network. Cases were cannabis exposures (Generic codes 0083000, 0200618, 0310033, 0310034, 0310035, 0310036, 0310096, 0310097, 0310121, 0310122, 0310125, 0310124, 0310125, 0310126, 0310146, 0310160) reported during 2000-2022 where the patient age was 0-5 years and the exposure route was ingestion. The distribution of pediatric ingestions was determined for various factors related to patient demographics, exposure circumstances, management, and outcome.
Results: A total of 1,608 cannabis ingestions involving patients age 0–5 years were identified. The annual number of ingestions ranged 3–12 during 2000–2015, 22 in 2016, 27 in 2017, 59 in 2018, 137 in 2019, 233 in 2020, 401 in 2021, and 605 in 2022; 2021–2022 accounted for 62.6% of the ingestions. Patient age distribution was 136 (8.5%) < 1 year, 347 (21.6%) 1 year, 428 (26.6%) 2 years, 326 (20.3%) 3 years, 223 (13.9%) 4 years, 142 (8.8%) 5 years, and 6 (0.4%) exact age unknown; 807 (50.2%) patients were male, 783 (48.7%) female, and 18 (1.1%) unknown sex. The ingestion site was 1,463 (91.0%) own residence, 65 (4.0%) other residence, and 80 (5.0%) other/unknown. The exposure reason was 1,533 (95.3%) unintentional, 2 (0.1%) intentional, 1 ((0.1%) adverse reaction, 14 (0.9%) other, and 58 (3.6%) unknown. No other non-cannabinoid substances were reported in 1,515 (94.2%) of the ingestions. Of these 1,515 ingestions, the management site was 353 (23.3%) on site, 668 (44.1%) referred to a healthcare facility, 432 (28.5%) already at/en route to a healthcare facility, and 62 (4.1%) other/unknown. The medical outcome was 258 (17.0%) no effect, 270 (17.8%) minor effect, 288 (19.0%) moderate effect, 46 (3.0%) major effect, 24 (1.6%) not followed-judged nontoxic, 263 (17.4%) not followed-minimal clinical effects possible, 362 (23.9%) unable to follow-potentially

toxic, and 4 (0.3%) unrelated effect; no deaths were reported. A clinical effect was reported in 803 (53.0%) of the ingestions. The most frequently reported clinical effects were central nervous system depression/drowsiness/lethargy (n = 776, 51.2%), vomiting (n = 85, 5.6%), agitation (n = 55, 3.6%), ataxia (n = 52, 3.4%), and tachycardia (n = 52, 3.4%). The most commonly reported treatments were intravenous fluids (n = 313, 20.7%), dilute/irrigate/wash (n = 246, 16.2%), and food/snack (n = 152, 10.0%).
Conclusions: The annual number of pediatric cannabis ingestions began increasing around 2018, increasing greatly in the last few years. The highest proportion of patients were age 2 years followed by 1 year, and more patients were male. Most patients were managed at a healthcare facility although slightly more than half did not have a serious outcome.

KEYWORDS Cannabis; pediatric; illicit

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64. Uncanny results: cannabidiol exposures treated at hospital emergency departments

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Background: Cannabidiol (CBD) is a compelling cannabinoid candidate for medical use due to its lack of psychoactivity and favorable safety profile, making it the subject of clinical studies in treating psychiatric, neurodegenerative, and anti-inflammatory diseases. In the United States (US), in 2018, the Food and Drug Administration (FDA) approved CBD to treat rare forms of epilepsy. Currently, hemp-derived CBD products that contain 0.3% or less tetrahydrocannabinol (THC) are federally legal and promoted as a supplement, with unproven claims of therapeutic effects. This study aimed to characterize CBD exposures treated at US hospital emergency departments (EDs).
Methods: Data were obtained from the National Electronic Injury Surveillance System (NEISS), a database of consumer product-related injuries collected from a representative sample of approximately 100 US hospital EDs. National estimates are calculated from database records according to the sample weight assigned to each case based on the inverse probability of the hospital being selected for the NEISS sample. Cases were all CBD exposures reported to the NEISS during 2000–2021. Cases were identified by searching the Narrative field for "CBD" or "cannabidiol." The case distribution was determined for various factors.
Results: National estimates were not calculated due to the small number of cases. 47 CBD exposures were identified in a sample of US hospital EDs. No exposures were reported in 2000–2017, 2 (4.3%) in 2018, 8 (17.0%) in 2019, 13 (27.7%) in 2020, and 24 (51.1%) in 2021. The formulation was 19 (40.4%) gummy, 9 (19.1%) oil, 4 (8.5%) t/pill 2 (4.3%) unspecified edible, 2 (4.3%) e-cigarette, 1 (2.1%) candy, 1 (2.1%) cream, and 9 (19.1%) unknown. Other cannabis ingredients, such as THC, were also present in the product in 16 (34.0%) exposures. Route of exposure was 40 (85.1%) ingestion, 4 (8.5%) inhalation, 1 (2.1%) dermal, and 2 (4.3%) unknown. Age distribution was 28 (59.6%) 0–5 years, 1 (2.1%) 6–12 years, 1 (2.1%) 13–19 years, and 17 (36.2%) 20 years or older; 29 (61.7%) patients were male, and 18 (38.3%) were female. Patient race was 18 (38.3%) White, 9 (19.1%) Black/African American, 2 (4.3%) Other, and 18 (38.3%) not stated in the ED record. Location of the incident was 32 (68.1%) home, 2 (4.3%) place of recreation or sports, 1 (2.1%) street or highway, 1 (2.1%) other public property, and 11 (23.4%) not recorded. Patient disposition was treated or examined and released [25 (80.6%) CBD alone, 7 (43.8%) CBD and other/THC], treated and admitted for hospitalization [5 (16.1%) CBD alone, 6 (37.5%) CBD and other/THC], treated and transferred to another hospital [1 (3.2%) CBD alone, 1 (6.3%) CBD and other/THC], and held for observation [0 (0.0%) CBD alone, 2 (12.5%) CBD and other/THC].
Conclusions: CBD exposures reported to US hospital EDs after 2018 gradually increased, with over half reported in 2021. Exposures involving other cannabis ingredients/THC were more likely to be admitted or held for observation. Thus, the safety and purity of CBD products remain obscure without FDA regulation.

KEYWORDS Cannabidiol; hemp; cannabinoid

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65. Cannabis intoxication in the emergency room. a review of 11 years in a hospital of México State

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Background: In recent years, the increasing decriminalization of recreational marijuana use in North America has facilitated its acquisition and has expanded the supply of products containing cannabinoids. The aim of this study is to describe the clinical characteristics of cannabinoid intoxicated patients attending the emergency room in the State of Mexico.
Methods: An observational, retrospective, cross-sectional, descriptive, retrospective study was carried out on patients who were evaluated by toxicology in Huixquilucan, State of Mexico, from January 2012 to March 2023. A total of 1426 cases were analyzed, of which 58 were patients intoxicated by cannabinoids. Information on the number of patients, age group, subject for consultation, route of exposure, treatment and days of hospital stay during the study period was examined.
Results: A total of 58 cases of cannabinoid intoxication were reported, with 35 male patients (60.34%) and 23 female patients (39.65%), with an average age of 31 years. The age groups with the highest consumption were 21 to 30 years old, with 21 patients (36.20%), and 11 to 20 years old, with 12 cases (20.68%). In 2012, 2 cases were reported, in contrast with 2022 that had an increase of 15 patients (25.86%). The most frequent subject for consultation was anxiety with 32 patients (55.17%). Exposure was oral in 40 cases (68.96%) and smoked in 18 cases (31.03%). Cannabis was ingested by means of brownies in 11 patients (18.96%) and cannabis gummies in 7 patients (12.06%). Associated exposures were ethanol in 16 patients (27.58%) and energy drinks in 11 cases (18.96%). In 2 pediatric patients (3.4%), orotracheal intubation was performed, with gastric decontamination by orogastric lavage and activated charcoal administration. The inpatient hospital stay was less than 24 hours in 52 patients (89.65%) and more than 24 hours in 6 patients (10.3%), with an average of 2 days.
Conclusions: Our study found higher cannabis use in 2022 compared to the years of the previous decade in the study hospital, which is probably due to a decrease in the perception of risk associated with cannabis use among the general population. The sex of highest consumption was male, predominantly in young adults, who went to the emergency room for anxiety and nausea due to oral cannabis consumption in the form of brownies, some of them associated with ethanol and energy drinks. On the other hand, the oral route and pediatric age together, were related to severity, since 2 cases of accidental ingestion at 1 and 5 years of age presented with neurological deterioration and seizures, respectively.

Likewise, it was observed that inpatient hospital care was less than 24 hours; however, in severe cases, it was 2 days on average.

KEYWORDS Cannabis abuse; marijuana use; emergency room

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66. The truth about Delta 8-THC: findings from partnerships with community-based organizations to measure parents awareness about the impact of Delta 8-THC on adolescents

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Background: The Centers for Disease Control has noted growing concern about a form of cannabis called Delta-8-THC. Not much is known about the exact effects Delta-8-THC has on adolescent development. Still, research suggests that adolescents have a higher sensitivity to THC which can result in inhibition and dysregulation of dopamine function. Using a mixed methods approach, this study investigated community members' knowledge about Delta-8. Researchers partnered with a Community-Based Organization (CBO) and a Regional Poison Center to conduct the study.
Methods: Researchers conducted a multi-faceted project to gather insight into community awareness of Delta-8-THC. First, a baseline survey was given to parents of suburban middle-class English-speaking adolescents to measure their knowledge of Delta-8-THC ($n = 91$). The survey consisted of 17 items (i.e., closed-ended, Likert-scale, rank order, and rating questions). Second, environmental scans ($n = 13$), a tool to survey the landscape of organizations to observe trends in the industry, were conducted of commercial businesses selling hemp-derived products within the county where the study occurred. The questionnaire consisted of 16 questions focusing on access to hemp-derived products, labels, packaging, etc. Third, semi-structured interviews ($n = 6$) were conducted with key community stakeholders, voluntarily recruited through community agencies networks. The interviews were conducted virtually and consisted of 7 interview questions about policy, health risks, and potential recommendations for Delta-8-THC.
Results: For the community survey, descriptive statistics were used to examine frequencies, mean distributions, and standard deviations across items. 68% of the respondents answered "I don't know" to all 17 questions about Delta-8-THC knowledge and awareness. For the environmental scans, descriptive statistics were used to examine frequencies, mean distributions, and standard deviations across items. Results revealed that a majority of Delta-8-THC is sold in vape shops (58%), but the product is also sold in gas stations (28%) and small markets (14%). Results of the environmental scan showed most of the stores had no signs for minimum age of purchase, warning signs about potency, or signs saying that they checked I.D for purchase of Delta-8-THC products. The environmental scans also revealed that a majority of the stores sold products that had more than 400 mg THC per package as well as marketing of products that looked like popular children's candy. Interview transcripts were analyzed for common themes through a thematic analysis approach. The results we gathered from the interviews were three overarching themes: dissemination of Delta-8-THC knowledge, lack of regulation, and public awareness.
Conclusions: The study revealed community members were unaware of the impact of Delta-8-THC. Overall, stakeholders felt that more awareness needs to be raised about the potential impact of Delta-8-THC on adolescent well-being. Awareness campaigns should be disseminated to the community, and especially parents, to educate individuals about the potential dangers associated with Delta-8-THC such as where it can be sold, lack of information at the point of sale, marketing techniques, and provide resources like the Poison Help line number.

KEYWORDS Delta-8 THC; parents & community awareness; poison prevention

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67. Rick Simpson oil (RSO) overdose: a THC concentrate getting "higher" on the differential

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Background: This case report is written to formally describe Rick Simpson Oil (RSO), a concentrated Tetrahydrocannabinol (THC) oil, in the literature as a foundation for future reference and research. We want to highlight potential toxicities associated with this potent THC formulation as well as potential treatment options. We also identify shortcomings of current resources available for RSO users and ways that clinicians can intervene to promote patient safety.
Case report: A 48-year-old female presents to the emergency department after self-administration of an inappropriate dose of RSO as a sleep aid, which caused the patient to require treatment for bradycardia in the emergency department. Subsequent admission to the intensive care unit for monitoring of cardiorespiratory depression resulted in recovery and discharge from the hospital.
Discussion: Marijuana is a naturally occurring plant from which cannabinoids are extracted including tetrahydrocannabinol and cannabidiol. Rick Simpson Oil is derived from a recipe that yields highly concentrated THC compounds. The main receptors activated are in the endocannabinoid system, which cause clinical effects of altered perception and disruption of psychomotor behavior. Our described case highlights the dangerous scenario where RSO packaging instructions do not reference any specific measurable quantities. This unfortunately puts users at high risk for accidental overdose. With little consensus and lack of validated trials for dosing of these compounds, it becomes the onus of the user, to use their own experimentation to find a dosing that works for them. Initial triage of a patient with suspected overdose with RSO involves calculating how much THC the patient ingested and at what time, in order to predict estimated complete metabolism. Along with a broad differential involving other causes of acute neurological changes, we recommend discussion with local toxicologists and Poison Control Center. Expect tachy-brady syndromes in monitored patients, which is seen in published literature. Marijuana highly concentrates in most major organs allowing for storage and a long release potential. Toxicity exists in both physiological and psychobehavioral forms. Important physiologic effects include rapid changes in heart rate, diastolic blood pressure, and central nervous system (CNS) depression among others. Prior literature aligns with our case of bradycardia in ingestion versus tachycardia in inhalation. Behavioral changes include euphoria, relaxation, panic and paranoia. Because there is no antidote or reversal agent for THC, time is the only treatment and therefore inpatient observation may be required as well as exploring alternatives options for pain management. It is usually expected that effects of a THC overdose are self-limiting.
Conclusions: Rick Simpson Oil (RSO) is a concentrated form of THC, the psychoactive component of marijuana. Toxicity includes

physiological changes such as tachy-brady syndromes, bradypnea, and CNS depression. Psychobehavioral changes include euphoria, panic, and paranoia. Treatment is supportive, including airway precautions, continuous cardiac, and respiratory monitoring, until THC can be metabolized. THC use is becoming more commonplace in many populations; therefore, clinicians should be aware of their increasing potential misuse and overdose along with associated toxicities.

KEYWORDS THC; RSO; overdose

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68. Cannabinoid hyperemesis syndrome: clinical trajectories and patterns of use two weeks following a visit to the emergency department for cyclic vomiting

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Background: Cannabinoid hyperemesis syndrome (CHS) is a clinical condition of cyclic vomiting, nausea, and abdominal pain associated with chronic cannabis use. Due to acuity of symptoms patients with cyclic vomiting frequently present to the Emergency Department (ED). Understanding what happens in the period surrounding the ED visit, including symptoms and cannabis use practices, can help inform development of patient-centered interventions for patients with CHS.
Methods: A prospective observational cohort study of participants with suspected CHS ($n = 39$) were recruited from the ED at the time of a symptomatic cyclic vomiting episode. Eligible individuals were: (1) English-speaking; (2) aged $\geq$18 years; (3) had a positive urine toxicology immunoassay for THC on ED visit; (4) reported severe cyclic vomiting (i.e., $\geq$ 2 episodes within six months prior to the index ED visit); (5) epigastric or periumbilical abdominal pain; (6) chronic, daily cannabis use ($>$ 20 days per month; duration $\geq$1 year); (7) and onset of cyclic vomiting after initiation of cannabis use. Exclusion criteria included: (1) pregnancy; clinically unstable; in police custody or incarcerated; (2) ED urine toxicology positive for non-prescribed drugs besides THC; (3) active suicidality; (4) an alcohol use disorder as determined by the ED physician. Patients with overlapping disease processes or alternate diagnoses that could account for vomiting symptoms (e.g., inflammatory bowel disease) were excluded based on consultation with the treating physician. Symptoms of CHS (cyclic vomiting, nausea, and abdominal pain) and cannabis use practices were recorded via texted or emailed daily surveys for 14 days.
Results: A total of 35 of 39 participants (94%) completed the two-week daily assessments. 1 provides participant demographics. Most participants (66%) returned to cannabis use within 48 hours of the enrollment ED visit. Median days of cannabis use over the two-week follow-up period was 12 days (IQR 2, 13). Five participants abstained from cannabis use during the full two-week follow-up period. All participants reported at least one symptom (nausea, abdominal pain, or cyclic vomiting) during the 14 days after the ED visit. Median days with any CHS symptoms was 7 out of 14 days (IQR 3, 13). A total of 23 participants (66%) experienced cyclic vomiting during the 14 days after the ED visit. Among participants who did not report cyclic vomiting in the 14 daily surveys (34%): 2 reported nausea only, 3 reported abdominal pain only, and 7 reported both nausea and abdominal pain. The median days out of 14 with cyclic vomiting, abdominal pain, and nausea respectively were 3 days (IQR 0, 4), 6 days (IQR 2, 13), 4 days (IQR 2, 8). Percent of participants reporting symptoms by day for 14 days is provided in.
Conclusions: Participants reported high rates of ongoing CHS symptoms (i.e., abdominal pain, nausea, or cyclic vomiting) in the period following an ED visit. Cannabis use was reduced immediately after the ED visit, but most participants returned to cannabis use patterns similar to pre-ED visit within a few days. Longitudinal study beyond two weeks is needed to better understand the clinical course of patients with suspected CHS.

KEYWORDS Cannabinoid hyperemesis syndrome; CHS; cyclic vomiting

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69. Effect of state level cannabis legalization on pediatric exposure calls to Poison Control Centers

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Background: Significant changes in the legal status of cannabis have occurred in many states. State-level data suggest that cannabis legalization results in increased pediatric cannabis exposures, however these studies do not control for national patterns and could reflect changing attitudes towards cannabis that lead to state-level legal status changes. We aim to evaluate the effect that state-level legal status changes had on pediatric cannabis exposure calls to poison control compared to states without a legal status change.
Methods: All pediatric exposure calls in the National Poison Data System between January 1, 2009, and December 31, 2019, were included. Annual rates in the number of exposure calls were compared between states with a legal status change and those that did not have a legal status change using a conditional negative binomial regression model for longitudinal data. Given the high degree of variability in the timing of legal status changes, the year of the change was excluded from the analysis.
Results: There was a total of 26,870 pediatric cannabis exposure calls during the study period. Thirty-one states had a cannabis legal status change during the study period. Overall, pediatric exposure calls in states without a legal status change increased from 371 calls in 2009–1304 calls in 2019 (351% increase), while calls in states with a legal status change increased from 823 calls in 2009–4249 calls in 2019 (516% increase). States that legalized medicinal cannabis saw a yearly 10.2% (95% confidence interval (CI) 1.2–20.1%, $P = 0.025$) increase in pediatric cannabis exposure calls after the legal status change while states that legalized recreational cannabis saw a yearly 55.5% (40.9–71.6%, $P < 0.00$) increase in pediatric cannabis exposure calls after the legal status change.
Conclusions: Changes in the state-level legal status of cannabis were associated with a significant increase in pediatric exposure calls when compared to states without a legal status change. This suggests that the increase is due to the legal status change and not pre-existing trends in pediatric exposures. Efforts should be taken to educate cannabis consumers on the risks of pediatric exposure.

KEYWORDS Cannabis; pediatric exposure; drug legalization

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70. Trends in pediatric cannabis exposures reported to poison control centers in states bordering Colorado after recreational cannabis legalization

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Background: Legalization of cannabis for medicinal and recreational use has occurred in many states over the past several years. Colorado was one of the first states in the nation to legalize the use and possession of cannabis for recreational use in 2012. Previous analysis of state level data suggests that both medicinal and recreational cannabis legalization result in increased pediatric cannabis exposures, however, an analysis on the effect in bordering states has not been done. We aim to evaluate the effect that legal status changes in Colorado had on pediatric cannabis exposure calls to poison control centers in neighboring states.
Methods: All pediatric (age < 18 years) cannabis exposure calls to poison control in states sharing a border with Colorado (Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming) between 1 January, 2009, and 31 December 2019, were eligible for inclusion. Information calls and calls regarding synthetic cannabinoids were excluded from the analysis. Annual call volume was compared before and after recreation cannabis was legalized in Colorado (2012) using population averaged Poisson regression with a correction for collinearity. We also evaluated for the year 2014, when recreational sales began. Outputs are reported as incident rate ratios (IRR).
Results: There was a total of 2,169 pediatric cannabis exposure calls meeting inclusion criteria during the study period. Prior to recreational cannabis legalization (2012), pediatric exposure calls in neighboring states were decreasing by 3% (IRR 0.97, 95% confidence interval (CI) 0.91–1.03) per year. Following legalization, calls began increasing by 35.3% (IRR 1.35, 95% CI 1.25–1.46) per year. A similar effect was seen with implementation of recreational sales in 2014. Before sales started pediatric exposure calls were increasing by 4% (IRR 1.04, 95% CI 0.99–1.08) per year and afterwards began increasing by 30.3% (IRR 1.30, 95% CI 1.22–1.38) per year.
Conclusions: Poison control centers in states neighboring Colorado saw a significant increase in pediatric cannabis exposure calls after both legalization of recreation cannabis and implementation of cannabis sales. The greater affect was seen after legalization suggesting that a change was occurring even before recreational sales started. This suggests that more education is needed for prevention of these exposures, even in states where the legal status has not changed.

KEYWORDS Cannabis; pediatric exposure; drug legalization

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71. Is visiting stores selling cannabis products and distributing poison center cannabis education cards an effective way to share knowledge of products' effects on children?

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Background: From 2017 to 2021 pediatric edible cannabis exposures increased by over one thousand percent in children less than six years of age. Effects of edible cannabis products, when ingested by children, can include life-threatening central nervous system depression.
Methods: Specialists of Poison Information (SPIs) visited twenty-two stores in one state selling edible cannabis products. SPIs handed out cards detailing possible effects of cannabis in children and poison center (PC) contact information, requesting stores display cards and distribute them to customers. Cards were double sided with one side printed in English and the other in Spanish. A secondary objective was to survey edible cannabis products available. The Institutional Review Board at the university affiliated with this PC did not consider this project human subject research.
Results: Twelve of eighteen stores reached by phone in the two months following SPI visits reported displaying and distributing cards. All who displayed reported staff were more aware of cannabis effects in kids related to PC outreach. Some comments: "Staff referred to postcards when (they) were called about product's effects." "This is good information to have available." "This has made staff more confident about products." One store alerted SPI to an online pledge available in a neighboring state encouraging safe use of this type of product, which this PC will review. Two stores were unreachable and two did not return calls. Cannabis products noted by SPIs were varied and many. Few products had resistant packaging. Examples included cheese flavored tortilla chips, candy ropes, pop rocks, cookies, cereal bars, brownies, gummies, popcorn and chocolate bars. Most were labeled and claimed a range of content of cannabidiol (CBD), Delta-8 tetrahydrocannabinol (THC) and/or Delta-9 THC. Serving size and total active ingredient content varied widely. Honey sticks, taffy, and some gummies were without labeling.
Conclusions: The serious effects edible cannabis products can have in children and increased number of exposures warrant a variety of education strategies. Visiting stores selling these products and asking them to display and distribute PC information to customers yielded a two-thirds success rate of stores reachable when informally surveyed by telephone in the two months following. Most edible products were snack food type products without resistant packaging, and some were without any labeling. Other PCs may want to develop similar strategies.

KEYWORDS Cannabis

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72. Pediatric exposures to cannabis edibles in Connecticut following implementation of legislation

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Background: Availability of recreational cannabis for adult use following legalization has resulted in an increase in rate and severity of pediatric exposures in many states and jurisdictions. The State of Connecticut's (CT) law on cannabis differs significantly from that of other states. It limits the amount of tetrahydrocannabinol (THC) per edible to ≤ 5 mg, limits the total THC per package to ≤ 100 mg, limits the appearance of edibles, and has strong labelling requirements. Most importantly, the law

requires that edibles be individually wrapped and be dispensed (even multi-serving products) in child-resistant containers that satisfy the standard set forth by the 1970 Poison Prevention Packaging Act. We analyze the impact of this legislation on pediatric exposures to cannabis edibles.
Methods: A pre- and post-intervention analysis of poison center data was conducted. The pre-intervention period was 10 January 2022 to 9 January 2023 (12 months). The post-intervention period was 10 January 2023 to 2 May 2023 (4 months). Inclusion criteria: children under 6 years of age, exposure to cannabis. Exclusion criteria: product was not a cannabis edible, exposure via breast milk, confirmed non-exposure. Specific origin of the edible was determined prospectively: purchased in CT dispensary, purchased out-of-state, purchased on internet, homemade, or unknown. All pediatric exposures to all substances were the offset variable. Chi square analysis was performed.
Results: A total of 69 exposures to cannabis edibles in children under 6 years of age were analyzed. Exposures per 4-weeks pre- and post- are illustrated. A 42.3% increase in exposures was observed (3.69/4-weeks to 5.25/4-weeks). This increase was not statistically significant ($P = 0.20$). The origin of the edible was documented in 75% of exposures. None (0%) were licit cannabis edibles purchased from brick-and-mortar CT dispensaries. The majority (60%) were cannabis edibles purchased out-of-state or from internet.
Conclusions: From 2017 to 2021, the number of Americans who gained access to legal recreational cannabis, including cannabis edibles, nearly doubled from 68 to 134 million persons. This doubling was associated with a 1375% increase in pediatric exposures to cannabis edibles reported to poison centers. The Illinois Poison Center reported 1300% increase in exposures to cannabis edibles in children under 6 years old following the implementation of recreational cannabis legislation. Another center reported a > 500% increase in exposures in children under 10 years old in Colorado from 2009 to 2015. Ontario, Canada reported a statistically significant increase in emergency department visits for cannabis exposures in children under 10 years old. Connecticut Poison Control Center reports a 42.3% increase in exposures to cannabis edibles in children under 6 years old following implementation of its recreational cannabis law. This increase was not statistically significant when compared to pre-period. It contrasts sharply and favorably with previously reported increases. Cannabis edibles ingested in the post-period were mostly (60%) from out-of-state/internet. Measures such as child-resistant packaging and individual wrapping may be associated with a lower increase in pediatric exposures to cannabis edibles. More longitudinal studies are needed to better examine these results.

KEYWORDS Cannabis edibles; pediatrics; Connecticut

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73. That's not your grandfather's pot: cannabis exposure in the elderly

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Background: Recreational cannabis use is increasingly common as multiple states have legalized cannabis. Delta9-tetrahydrocannabinol (THC), the predominant cannabinoid in cannabis, agonizes CB1 and CB2 receptors, which has effects on vascular tone, hemodynamics, and central nervous system (CNS) functioning. There are case reports of intracerebral hemorrhage and myocardial infarction temporally associated with cannabis exposure. Cannabis potency has increased dramatically and ready-made consumer edible products containing hundreds of milligrams of THC have arisen as legalization becomes more widespread. It is not known how these higher-intensity exposures specifically affect the elderly.
Methods: A retrospective review of cannabis exposures reported to a regional poison center (RPC) from 1 January 2017 to 31 December 2022 was performed. Inclusion criteria were patients 60 years and older with single-substance cannabis exposures. Specific data queried included number of cases by year, form of cannabis exposure (edible, smoked, etc.), clinical characteristics (initial vital signs, presenting symptoms and signs), diagnostic workup obtained, and medical outcome. Of note, recreational cannabis use was legalized in the RPC state on 1 January 2020.
Results: There were 79 cases that met inclusion criteria. The mean age was 69.3 years (range 60–91), with an increase in the cases per year from pre-legalization (8) to post-legalization (18.33). 40 (51%) presented to an emergency department, with the remainder being managed on site. Oral cannabis consumption was reported in 60 cases, of which 15 (25%) were due to mistaking a cannabis edible for a food product. Although most patients had minor effects (40.5%), an appreciable minority were judged to have moderate (30.4%) or major (3.8%) effects. Vital sign derangement included bradycardia (heart rate < 60 bpm) in 7 (9%) and tachycardia (HR > 100) in 8 (10%). 5 patients had systolic blood pressure < 100 mmHg, and 11 (14%) had systolic blood pressure z 150 mmHg. 8 cases underwent computed tomography (CT) of the head (10%), including 1 patient who underwent a focused stroke evaluation by the stroke team. 3 patients (4%) presented with chest pain and had no history of coronary artery disease (CAD), 8% presented with syncope, 32% were confused, and 48% were lethargic. 2 patients underwent lumbar puncture (LP) to evaluate for other causes to their change in mental status. There were 6 total ICU admissions (8% of the cohort), 5 of which occurred after cannabis legalization. 24% of the cohort was admitted to the hospital for further evaluation and management. There were no fatalities.
Discussion: In this cohort of cannabis exposures in elderly adults reported to a single RPC from 2017 to 2022, there were multiple patients who presented to emergency departments, with 24% requiring hospital admission, including 6 ICU admissions. Initial presentations varied, but confusion and lethargy were common, including depressed mental status severe enough to provoke CT imaging (in 10%) or lumbar puncture (3%).'
Conclusions: Cannabis exposure in the elderly resulted in multiple hospital and ICU admissions and led to both non-invasive and invasive diagnostic testing. Edible products made up 75% of exposures to the RPC with a marked increase after legalization.

KEYWORDS Cannabis; geriatrics; intensive care

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74. That's not xanax: a cluster of bromazolam overdoses presenting with seizures, hyperthermia, and myocardial injury

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Background: Bromazolam is a triazolobenzodiazepine synthesized in 1979 but never approved for therapeutic use. It was first detected in the illicit drug supply in Sweden in 2016 but has

been increasingly seen since. It is often co-detected with fentanyl but is also sold as an ersatz legal benzodiazepine (BZD). We present a cluster of 3 cases of patients who consumed bromazolam that was sold as alprazolam.
Case series: Three previously healthy patients (a 25-year-old man, patient A; a 25-year-old man, patient B; and a 20-year-old woman, patient C) ingested bromazolam that they believed to be alprazolam. They were found unresponsive by patient A's mother 8 hours later. All three received naloxone in the field from EMS with no response. They were unresponsive on arrival to the emergency department. Patient A was hypertensive, tachycardic, and hyperthermic (38.7 °C), and examination revealed dilated but reactive pupils and multiple generalized seizures; the patient was intubated for airway control. Lab work revealed rhabdomyolysis and myocardial injury. Patient B arrived at the same hospital and was also intubated due to unresponsiveness and multiple generalized seizures. He also had myocardial injury and hyperthermia (38.0 °C). Patient C was taken to another hospital and similarly arrived obtunded. She had focal seizures and was also intubated. Her workup showed myocardial injury. The regional poison center was contacted for assistance and the three patients were admitted to ICU. Patient A required intubation until hospital day 5 due to depressed mental status. Post-extubation, he was noted to have moderate aphasia and dysphagia, and was discharged on HD 11 with persistent deficits. Patient B's mental status improved and was extubated on HD 1. He was discharged on HD 4 with mild hearing difficulty but otherwise neurologically intact. Patient C progressed to status epilepticus and required multiple anti-epileptics. Her neurological exam revealed persistent coma and she was transferred to another hospital on HD 11. She was unfortunately lost to follow up at the second institution. Serum from all 3 patients on the day of hospital presentation was sent to the University of California, San Francisco (UCSF) via the Drug Enforcement Administration's Toxicology Testing Program (DEA TOX). Comprehensive liquid chromatography-quadrupole time-of-flight mass spectrometry (LC-QTOF/MS) testing revealed high levels of bromazolam in all 3 cases. Patient A's level of 207 ng/ml was the highest recorded by DEA TOX.
Discussion: Bromazolam is usually detected alongside opioids, but it can be misrepresented as a legal benzodiazepine. In this case series, the patients ingested bromazolam and presented with a pattern of hyperthermia, seizures, and myocardial injury. This toxidrome is unexpected for a BZD overdose, which may be a product of anoxic brain injury due to prolonged unconsciousness, or it may represent additional features of bromazolam in overdose.
Conclusions: Bromazolam may be sold as counterfeit alprazolam, and overdose can result in an unexpected toxidrome of hyperthermia, seizures, and myocardial injury.

KEYWORDS Bromazolam; liquid chromatography-quadrupole time-of-flight mass spectrometry

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75. Trends in the incidence of alcohol and cannabis-related emergency department visits among college students (July 2018 to April 2023)

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Background: Alcohol misuse is a significant public health concern among college students. Recently, incidents related to edible cannabis have also emerged as a crucial public health issue. In this study, we seek to investigate the patterns of emergency department (ED) visits related to overall overdoses as well as alcohol and cannabis misuse related visits among college students aged 17–23 years over a period of 4 years. Specifically, we sought to analyze trends at a single center-university teaching hospital over four academic years (2019, 2021–2023). Furthermore, we identified and compared trends before and during the COVID-19 pandemic to determine if there were significant changes.
Methods: We conducted a retrospective analysis of ED visits of college students aged 17–23 years to a single university teaching hospital over 4 academic years. We included cases where the chief complaint was related to an overdose, to an alcohol overdose, or to cannabis toxicity. We compared trends in overall overdoses, alcohol overdose, and cannabis toxicity (per 1000 ED visits) during the following periods: academic year 2019 ("reference" and pre-pandemic period 9/1/2018 – 5/31/2019), academic year 2021 (9/1/2020 – 5/31/2021: period marked by virtual learning but onsite university living), academic years 2022 and 2023 (9/1/21–5/31/2022 and 9/1/2022–4/30/2023, respectively), using Poisson regression methods.
Results: During the study period, 1060 cases met inclusion criteria. A total of 726 cases were alcohol overdoses and 75 were cannabis toxicity related ED visits. There was a significant decrease in the number overall overdoses ($P < 0.001$) and alcohol overdose related ED visits ($P = 0.002$) during the pandemic period of virtual learning compared to the reference period. However, these numbers increased during the academic year 2022 and 2023 periods ($P = 0.02$). In contrast, cannabis toxicity related ED visits steadily increased during the entire study period. There was an overall increase in overdose-related ED visits between the reference period and academic year 2023 (49.7 per 1000 ED visits; 95% CI [43.8–55.5] vs. 62.8 per 1000 ED visits; 95% CI [55.9–69.7]). The incidence of alcohol overdose related ED visits did not change significantly during the period of virtual learning; however, those increased significantly from 30.7 (95% CI [2.6–3.5], pre-pandemic, to 42.4 (95% CI [37.0–47.7]) during academic year 2022 and 47.7 (95% CI [41.6–53.8]) during academic year 2023, when in-person learning resumed for both years. The study found that cannabis toxicity related incidents steadily increased between academic years 2019 and 2023.
Conclusions: This study highlights a significant increase in the incidence of collegiate ED visits related to alcohol and cannabis misuse complications as we emerge from the pandemic. These findings underscore the need for continued monitoring and targeted interventions to prevent and manage morbidity related to alcohol and cannabis misuse, particularly in the vulnerable collegiate population of individuals aged 17–23 years.

KEYWORDS Cannabis toxicity; alcohol misuse; college students

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76. Top substances reported to US poison centers associated with major outcome or death

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Background: Medical outcome severity in cases reported to United States Poison Centers (PCs) has been increasing. This trend has been seen in both intentional and unintentional exposures. This study was conducted to determine the top substances responsible for this trend.

Methods: A retrospective review of the National Poison Data System (NPDS) was conducted over a 15 year period, between 1 January 2007 and 31 December 2021. The NPDS was queried for the top substances resulting in severe outcome or death in both the adult (age $>$ 19) and pediatric (age $\leq$19) populations. This was divided into three, five year blocks (2007–2011, 2012–2016, 2017–2021) for categorization. Each block was divided into intentional and unintentional exposures.
Results: During the study period there was a total of 411,056 cases of major outcome or death. There were 275,246 intentional adult exposures. For adult intentional exposures, acetaminophen combination products were the leading substance associated with severe outcome or death for the entire study period with 104,328 total cases. For both periods from 2007 to 2011 and 2012 to 2016, acetaminophen combination products, benzodiazepines, and ethanol were the top three substances. For 2017 to 2022, acetaminophen combination products, acetaminophen alone, and benzodiazepines were the top three. There were 31,355 number of unintentional adult exposures. The overall leading substance was carbon monoxide with 2,816 cases. From 2007 to 2011, the top three substances were carbon monoxide, benzodiazepines, and acetaminophen alone. From 2012 to 2016, the top three were carbon monoxide, acetaminophen alone, and benzodiazepines. From 2017 to 2021, the top substances were acetaminophen combination products, carbon monoxide, and acetaminophen alone. There were 41,442 number of intentional pediatric exposures. Atypical antipsychotics were the overall leading substance with 4,524 cases. From 2007 to 2011, the top three were atypical antipsychotics, acetaminophen combination products, and benzodiazepines. From 2012 to 2016, atypical antipsychotics, benzodiazepines, and bupropion were the top substances. From 2017 to 2021, acetaminophen alone, bupropion, and atypical antipsychotics were the leading substances. There were 17,205 number of unintentional pediatric exposures. Clonidine was the top substance throughout the study period with 1967 cases. From 2007 to 2011, the top substances were clonidine, atypical antipsychotics, and carbon monoxide. From 2012 to 2016, clonidine, carbon monoxide, and laundry detergents were the top three. From 2017 to 2021, clonidine, carbon monoxide, and buprenorphine were the leading substances.
Conclusions: Acetaminophen and acetaminophen combination products continue to play a major role in cases with severe outcome or death in both intentional and unintentional cases for all age groups. Carbon monoxide remained a top substance for unintentional exposures across all age groups within the study period. In the pediatric age group specifically, atypical antipsychotics was in the top three substances for intentional exposure during the entire study period, with bupropion emerging in recent years; in the unintentional exposure group, clonidine remained in the top three for the entire study period, with buprenorphine emerging in recent years.

KEYWORDS Severe medical outcome; top substances; NPDS

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77. Liver injury trends due to poisoning as reported in the National Poison Data System (2000–2022)

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Background: The liver is one of the most susceptible organs to drug toxicity with hundreds of substances reported to cause drug induced liver injury (DILI). DILI remains the most common cause of acute liver failure in the United States (US) and in most Western countries, and its diagnosis and management can be challenging given the numerous causes and varying clinical course of hepatotoxicity. This study aims to examine the US national trends in severe liver injury (SLI) due to toxic exposures.
Methods: The National Poison Data System (NPDS) was queried for all human exposures reported to US poison centers (PCs) from 1 January 2000 to 31 December 2022. We assessed trends in SLIs, as defined by aspartate aminotransferase (AST) or alanine aminotransferase (ALT) $>$ 1000 IU/L, among adults (age $>$ 19 years) by reason for exposure and sex using Poisson regression methods. Cases experiencing rhabdomyolysis were excluded. Data were analyzed using SAS statistical software (version 9.4; SAS Institute).
Results: During the study period, 45,005 toxic exposures resulted in SLIs. The majority of these exposures were intentional (80.3%), and 58.7% occurred among females. SLI was more prevalent among females compared to males (7.0 per 10000 intentional exposure vs. 6.2 per 10000 intentional exposure; $P < 0.001$). There was a significant increase in trends of SLI among intentional exposures from 703 cases (0.43%) in 2000 to 1627 (0.59%) in 2012 and 2,220 (0.85%) in 2022 ($P < 0.001$). These trends were also seen when the data was stratified by sex. SLI was reported in 397 (0.44%) females in 2000 compared to 1,243 (0.90%) in 2022 ($P < 0.001$), and in 306 (0.47%) males in 2000 and 977 (0.89%) in 2022. SLIs were less common in unintentional exposures, however a significant increase in trends of SLI was also observed from 170 (0.03%) in 2000 to 322 (0.06%) in 2012 and 817 (0.13%) in 2022 ($P < 0.001$). The increase was seen among both females (80 [0.03%] in 2000 to 491 [0.13%] in 2022; $P < 0.001$) and males (90 [0.04%] in 2000 to 326 [0.14%] in 2022; $P < 0.001$) when stratified by sex. In both intentional and unintentional exposures leading to SLI, the most frequent substance reported in all years between 2000 and 2022 was acetaminophen (alone). This substance led to 35% of both the unintentional and intentional cases in 2000, and 55% of the unintentional and 39% of the intentional cases in 2022. The next most frequent substances reported were acetaminophen in combinations with other substances and ethanol.
Conclusions: PC data demonstrated that the rate of exposures that resulted in SLI significantly increased from 2000-2022. This trend persisted when the exposures were stratified by intentionality and sex, suggesting that toxic exposures more frequently resulted in SLI independently of these factors. Acetaminophen remains the substance most commonly associated with SLI.

KEYWORDS Severe liver injuries; NPDS; epidemiology

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78. Characteristics and trends in buprenorphine administration during emergency department visits and prescribing at discharge from 2014–2020: a national analysis

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Background: Emergency department (ED) initiated buprenorphine provides a low barrier access point and safety net to mitigate opioid overdose risk and increase treatment engagement. We sought to describe trends in buprenorphine utilization and naloxone co-prescribing from the ED using national data.
Methods: This is a retrospective review of the National Hospital Ambulatory Medical Care Survey (NHAMCS) between 2014 and 2020. Our primary outcomes were the trends in ED buprenorphine administration and discharge prescriptions for buprenorphine products (including buprenorphine-naloxone products). We described patient demographics, hospital characteristics, visit characteristics, and the rate of naloxone co-prescribing at ED discharge. We used descriptive statistics, and Spearman's rho (SR) or Pearson's correlation coefficient (PC) as applicable to describe the trends.
Results: Between 2014 and 2020, there were 302,384 visits where buprenorphine was administered, with an increase over time (PC: 0.73, $P = 0.03$). There were 284,099 visits where buprenorphine was prescribed at ED discharge, with an increase over time (SR: 0.71, $P = 0.036$). The largest rise in rate for discharge prescriptions occurred between 2019 and 2020: (37,737 (0.03%) visits versus 126,041 (0.10%), (233% increase in rate, $P < 0.0001$). For both populations, most patients were between the ages of 25–44 years (66.3 and 77.1%, respectively), and had Medicaid (32.7 and 60.5%, respectively). Hospitals were primarily non-academic (63.2 and 72.8%, respectively), and located in urban settings (94.4 and 82.3%). Among patients administered buprenorphine in the ED, 51,015 (16.9%) received naloxone in the ED and 18,361 (6.1%) visits where naloxone was prescribed at discharge with no trend over time (PC: 0.24, $P = 0.3$; SR: 0.61, $P = 0.07$, respectively). Among patients who were prescribed buprenorphine at discharge, there were 0 visits where naloxone was given in the ED and 44,290 (15.6%) visits where naloxone was co-prescribed at discharge. Among those visits that involved admissions, none received naloxone during the ED visit.
Conclusions: There was an increase in buprenorphine administration and prescribing at ED discharge over time. The no acceleration in prescriptions at ED discharge between 2019 and 2020 may indicate that the ED may have been a safety net for patients who lost access to addiction care during COVID-19 or that the pandemic exacerbated the need for OUD treatment. Rates of naloxone co-prescribing were low. Future studies should explore barriers to buprenorphine prescribing, particularly following removal of the "X"-waiver, and targeted interventions such as clinical decision support for buprenorphine and naloxone prescribing.

KEYWORDS Buprenorphine; NHAMCS; emergency department

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79. Incidence of buprenorphine precipitated withdrawal in emergency department patients with opioid use disorder in Philadelphia

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Background: The incidence of precipitated withdrawal (PW) after induction with buprenorphine is unclear for individuals with opioid use disorder (OUD). Adverse outcomes from buprenorphine induction may deter efforts to expand this evidence-based practice in emergency departments (EDs). Although evidence from patient surveys report high rates of PW, secondary analyses of an ED-based multicenter clinical trial estimated low incidence. The objective of this study was to estimate the incidence of PW in a real-world retrospective cohort of patients with OUD who presented to the ED.
Methods: We obtained electronic health record data for adult patients with OUD at three academic hospitals in Philadelphia between January 2020 and December 2021. We included patients who received an initial sublingual dose of buprenorphine greater than 2 mg in the ED or soon after hospital admission from the ED. We included patients with a documented score of > 8 on the Clinical Opiate Withdrawal Scale (COWS) prior to receiving buprenorphine. We excluded patients who lacked documentation of COWS after receiving buprenorphine. We defined PW as an increase in COWS > 5 within two hours of the first dose of buprenorphine. We report PW incidence overall, by initial buprenorphine dose, by withdrawal severity, and for patients with urine drug testing (UDT) and fentanyl detected.
Results: Of 374 patients who received buprenorphine, 160 (43%) met inclusion criteria. Patients had mean age of 39 years; 51 (32%) patients were female, and 56 (35%) reported Black race. Overall, 22 (14%) patients met criteria for PW. The incidence of PW by initial dose was 2 of 29 patients (7%) for 2 mg; 13 of 96 (14%) for 4 mg; and 7 of 35 (20%) for 8 mg or greater. Among patients with COWS between 8 and 12 prior to induction, 13 of 102 (13%) met criteria for PW, compared to 9 of 58 (16%) with COWS > 12. Among 89 patients with fentanyl detected by urine drug screen, 17 (19%) met criteria for PW.
Conclusions: In this cohort of patients with OUD who presented to EDs in Philadelphia, the incidence of PW was more than tenfold higher than that reported for patients enrolled in a recent clinical trial. PW was more common for higher initial doses of buprenorphine. Limitations of this study include small sample size as well as high rates of missing documentation of withdrawal scores. New approaches are needed to measure the incidence, anticipate, and manage symptoms due to PW to sustain access to this highly effective treatment for OUD in the ED.

KEYWORDS Opioid use disorder; fentanyl

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80. Clinical characteristics of patients with suspected overdose based on urine xylazine test results: a retrospective cohort study

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Background: Xylazine is increasingly found with fentanyl in the illicit drug supply and was recently categorized as an emerging threat by the White House. There is little evidence on the effects of co-exposure of fentanyl and xylazine in overdose, but some experts have raised concern for synergistic toxicity. We obtained a cohort of patients with suspected opioid overdose who underwent additional urine drug screening to assess for the presence of xylazine. We compared the clinical features of those in whom xylazine was and was not detected.
Methods: In March 2022, our health system, composed of 4 urban academic hospitals in Philadelphia, Pennsylvania implemented a gas chromatography-mass spectrometry (GC-MS) urine

xylazine test. The decision to order urine xylazine tests was made by the treating clinician. From June 2022 to December 2022, there were 8 patients with a diagnosis of "drug overdose" and a urine xylazine test ordered. Xylazine was detected in 4 of 8 patients; all 8 patients had detected concentrations of fentanyl in the urine.

Results: Patients who were xylazine positive presented with similar initial heart rate and systolic blood pressure compared to those patients who were xylazine negative. The average initial heart rate among xylazine positive patients was 76 (SD 6.7) compared to the xylazine negative patients initial heart rate of 103 (SD 26.9), $P = 0.1$. The average initial systolic blood pressure among xylazine positive patients was 86.7 mmHg (SD 6.6) compared to the xylazine negative patients initial systolic blood pressure of 92.7 mmHg (SD 12.8), $P = 0.4$. One of the four xylazine positive patients were admitted to the ICU while the other three were discharged from the ED. Two of the xylazine negative patients were admitted to the ICU, one was admitted to a Medicine floor, and one was discharged from the ED. All of the patients presenting with overdose had fentanyl detected and were managed with naloxone and supportive care. Among all 8 patients, 3 patients reported that they were using cocaine and it was suspected that it was adulterated with fentanyl.

Conclusions: Patients presenting to the ED after a fentanyl overdose may be co-exposed to xylazine, especially in areas of high xylazine prevalence. Patients who tested positive for xylazine on urine drug testing had similar initial heart rate and systolic blood pressures, although the point estimate suggests lower heart rates and systolic blood pressure in the xylazine positive group. Patients who use cocaine may inadvertently be exposed to fentanyl and xylazine. In this series, more of the xylazine negative patients were admitted to the hospital compared to the xylazine positive patients. In this health system in Philadelphia, half of the patients presenting with overdose who had a urine xylazine tested were positive for xylazine. More research is needed to determine the clinical characteristics of xylazine use and optimal management of xylazine overdose, particularly when combined with opioids such as fentanyl.

KEYWORDS Opioid use disorder; xylazine; fentanyl

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81. Benzodiazepine co-exposure among patients treated in the emergency department with suspected opioid overdose

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Background: Simultaneous exposure to both benzodiazepines and opioids can lead to synergistic respiratory depression and sedation, increasing the likelihood of overdose. Co-exposure of benzodiazepines with opioids may complicate the effectiveness of antidotal treatment and result in the need for further medical care. Our objective was to report on the detection of prescription and illicit benzodiazepine co-exposures among patients treated in emergency departments with suspected opioid overdoses. We aimed to compare the demographic characteristics, clinical manifestations, treatments, outcomes, and regional differences of patients with opioid overdose who were also exposed to benzodiazepines, versus those without benzodiazepine co-exposure.

Methods: The Toxicology Investigators Consortium (ToxIC) Fentalog Study is an ongoing, cohort study of patients presenting to 10 emergency departments across the US with suspected opioid overdose. Discarded blood/serum were analyzed using liquid chromatography quadrupole time-of-flight mass spectrometry for over 1,100 drugs of abuse, novel psychoactive substances, and pharmaceutical drugs. As of 18 April 2023, 1,264 cases met inclusion, and 735 cases had complete data including analytes. The analytic sample was restricted to only cases with opioids present ($n = 670$). A central IRB approved this study. All analyses were conducted in R v4.2.1.

Results: Among the cases with opioids present, 33.4% of cases tested positive for benzodiazepines. 28% of cases tested positively for prescription benzodiazepines, and 9% of cases tested positively for illicit benzodiazepines. The most commonly detected prescription benzodiazepine was alprazolam (42.2% of prescription benzodiazepines); the most common illicit benzodiazepine was clonazolam (72.9% of illicit benzodiazepines). One-third of patients had either an illicit or prescription benzodiazepine present alongside at least one opioid. Fentanyl was the most frequently detected opioid in patients with opioid and benzodiazepine co-exposure (74.1%), followed by methadone (29.5%). No statistically significant differences were found for age, sex, and race/ethnicity between the benzodiazepine group and the no benzodiazepine group. A higher percentage of benzodiazepines were found alongside opioids in the Northeast (68.8%) compared to opioids alone (59.9%) ($2 = 9.61$, $df = 2$, $P = 0.01$). While a higher percentage of patients with only opioids received naloxone (80.7%) compared to patients with both opioids and benzodiazepines (71.7%, $P = 0.01$), there was no statistically significant difference between the total naloxone dosage in mg between the two groups. The benzodiazepine group had double the prevalence of intubation (10.3%) compared to the opioid only group (4.9%) ($2 = 5.95$, $df = 1$, $P = 0.01$). No patient received flumazenil. There were no statistically significant differences in other clinical outcomes between those with benzodiazepines present and those without (e.g., cardiovascular events, neurological events, medical outcome, and length of stay).

Conclusions: We identified a high rate of benzodiazepine and opioid co-exposure, suggesting concomitant use or addition to the opioid supply. A higher percentage of benzodiazepines were found alongside opioids in the Northeast. Patients in the benzodiazepine/opioid group had significantly higher rates of intubation, suggesting greater severity of overdose.

KEYWORDS Opioids; overdose; benzodiazepines

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82. Alcohol and drug use among youth presenting to the pediatric emergency department: an opportunity for intervention

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Background: Limited research exists on substance use among youth presenting to emergency departments (EDs). Better understanding of youth substance use can help develop ED-initiated substance use interventions. We aimed to determine the frequency and type of substance use in youth presenting to our

pediatric ED and identify characteristics associated with high-risk substance use.

Methods: We conducted a computer tablet-based, anonymous, self-reported survey of patients 14–21 yrs presenting to an urban pediatric ED from February to April 2023. The survey was a modification of the Screening to Brief Intervention substance use screening tool, combined with components of the modified Alcohol, Smoking and Substance Involvement Screening Test, and included detailed questions regarding frequency of use for tobacco, alcohol, marijuana, and other substances (cocaine, methamphetamines, heroin, K2, hallucinogens, inhalants), as well as prescription medication (stimulants, benzodiazepines, and opioids) and over-the-counter medication misuse. Demographic characteristics (age, sex, race/Hispanic ethnicity) also were collected, as well as information on attitudes toward ED screening and interventions for substance use. Frequency and type of substance use was analyzed based on age groups (14–17 yrs and 18–21 yrs). Logistic regression was used to identify demographic characteristics associated monthly use or more of any substance (high-risk use).

Results: Of 155 pediatric ED patients approached, 135 (87.1%) completed the survey. Average age was 17.5 yrs (SD = 2.3), 61.5% were female, 54.1% were Hispanic. Among participants 14–17 yrs, 37.7% (n = 26) reported substance use in the past year; 29.0% (n = 20) with monthly use or more of at least one substance. Among participants 18–21 yrs, 75.8% (n = 50) reported substance use in the past year; 68.2% (n = 45) with monthly use or more of at least one substance. For both age groups, alcohol (14–17 yrs: 26.1% (n = 18); 18–21 yrs: 65.2% (n = 43)), marijuana (14–17 yrs: 23.2% (n = 16); 18–21 yrs: 62.1% (n = 41)), and tobacco (14–17 yrs: 11.6% (n = 8); 18-21 yrs: 28.8% (n = 19)), were the most common substances used. Within the past year, 26.1% (n = 18) of participants 14–17 yrs and 62.1% (n = 41) of those 18–21 yrs reported using multiple substances. In the regression analysis, older age (18–21 yrs) was associated with high-risk substance use (aOR 6.1, 95% CI (2.75 – 13.57). The majority of patients reported that it was important/very important for youth to be asked about substance use in the ED (n = 90, 66.2%) and for the ED to offer help for youth with substance use, (n = 111, 81.6%).

Conclusions: Substance use was common in youth presenting to this urban, academic pediatric ED, with alcohol, marijuana, and tobacco most often used. Many patients reported high-risk substance use, and the majority of youth believed that the ED was an important setting for substance use screening and interventions, highlighting the need for universal ED substance use screening and ED-based, targeted interventions for youth.

KEYWORDS Adolescent; substance use

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83. A shaky situation: impact of the 2021 chlordiazepoxide shortage on the management and outcomes of emergency department patients with alcohol withdrawal

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Background: Alcohol withdrawal syndrome (AWS) is an emergent condition that is frequently managed in the Emergency Department. Benzodiazepines are the primary treatment, and chlordiazepoxide is a preferred oral agent. In 2021, a five-month shortage of chlordiazepoxide limited its availability across the Mount Sinai health system. We assessed the shortage's effect on ED management and outcomes of AWS patients.

Methods: We conducted a retrospective time series cohort analysis of patients presenting to Mount Sinai EDs from 01/29/2021 to 05/02/2022. Encounters were identified from Epic's data warehouse. Inclusion criteria were a primary or secondary ED diagnosis of alcohol related disorders. Exclusions included age < 18, pregnant patients, police custody, and non-ethanol intoxication/withdrawal. Data was analyzed using univariate comparisons, logistic regression, and mixed-effects linear regression. Anonymized patient keys were treated as random effects to account for subject-specific variability in the outcomes of interest.

Results: 3,050 encounters were identified (874 during the shortage; 2,176 non-shortage). Baseline characteristics were similar (median age 46, 76% male). PO diazepam use increased from 4 to 19% ($P < 0.001$) and PO lorazepam use increased from 25 to 31% ($P < 0.001$) during the shortage. IV diazepam use increased from 11 to 15% ($P = 0.027$). Post-shortage, chlordiazepoxide use remained lower (29%) than pre-shortage (38%, $P < 0.001$). Medication associations with ED length of stay (LOS), hospital LOS, and odds of admission were compared pre- and post-shortage. Total chlordiazepoxide dosage positively predicted ED LOS post-shortage (beta = 0.01, P = 0.018) compared to pre-shortage (beta = 0.0, P = 0.8). PO diazepam dosage predicted hospital LOS (beta = 0.02, P = 0.001) and hospital admission (OR = 1.19, $P < 0.001$) post-shortage compared to pre-shortage (beta = 0.02, P = 0.2; OR = 1.04, P = 0.5). IV diazepam dosage positively predicted ED LOS pre-shortage (beta = 0.14, $P < 0.001$) compared to post-shortage (beta = 0.05, P = 0.063). PO and IV lorazepam dosage positively predicted ED LOS and admission both pre- and post-shortage. Across the entire time period, PO lorazepam dosage negatively predicted intubation (OR = 0.38, P = 0.007), while IV lorazepam dosage positively predicted intubation (OR = 1.45, P = 0.017). IV diazepam dosage negatively predicted death (OR = 0.87, P = 0.051), while chlordiazepoxide dosage positively predicted death (OR = 1.01, P = 0.005).

Conclusions: The chlordiazepoxide shortage prompted changes in benzodiazepine use patterns that persisted post-shortage. Our findings suggest that the choice of benzodiazepine and total dosages may influence patient outcomes such as ED/hospital LOS, admission, intubation, and mortality.

KEYWORDS Ethanol; withdrawal; shortage

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84. A systematic review of phenibut withdrawal with a focus on treatment strategies

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Background: Phenibut is an unregulated supplement in the United States. It acts as a GABA-B agonist and is commonly used to manage social anxiety, induce euphoria, or as an adjunctive therapy for withdrawal from other substances. Chronic use of phenibut can lead to physiologic dependence and subsequent withdrawal when use is stopped. Withdrawal from phenibut can cause severe symptoms such as delirium, hallucination, and

seizure. Numerous treatment strategies for withdrawal have been reported and there is no consensus on the optimal strategy. The purpose of this systematic review is to characterize the natural history of phenibut withdrawal and summarize treatment strategies published in the literature.

Methods: A systematic review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Checklist. English language peer-reviewed articles or abstracts in humans describing phenibut withdrawal after cessation of phenibut were included. Databases searched were Ovid/MEDLINE, Web of Science, and Science Direct. Studies were appraised using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Case Reports. Key outcomes, including patient demographics, withdrawal characteristics, and treatment characteristics, were collected into a predefined data collection sheet by six independent reviewers.

Results: Search results yielded 505 articles of which 25 were included. All articles were case reports or published abstracts. All of the cases (100%) involved male patients and the median age was 30.5 years (IQR 24.75–34.25 years). Median daily phenibut use prior to experiencing withdrawal was 10 g (IQR 4.75–21.5 g, $n = 23$ reporting). The shortest duration of phenibut use prior to withdrawal was one week (two grams daily). Median time from stopping use to presentation was 2 days (IQR 0.25–5 days, $n = 11$ reporting). Withdrawal symptoms occurred as quickly as two hours after the last phenibut dose. Sixteen patients (64%) reported progression of withdrawal severity within the first 24 hours of healthcare contact. Seizures were reported in two patients (8%), intubation in six patients (24%), and ICU admission in 11 patients (44%). Withdrawal treatment strategies varied widely. Two cases (8%) reported outpatient clinic management of withdrawal. Both utilized a phenibut taper, one cross tapered adjunctive baclofen. All patients undergoing medication-assisted abstinence required initial inpatient management and received a drug that acts on GABA receptors. Seventeen cases (68%) utilized a benzodiazepine and 15 cases (60%) utilized baclofen. Drugs utilized in withdrawal are displayed in. Twenty patients (80%) required at least two drug therapies to manage symptoms. Two patients using baclofen monotherapy outpatient, after initial stabilization with multiple drug classes, reported adverse effects. One patient had a seizure and the other experienced relapse with need for definitive benzodiazepine treatment.

Conclusions: Phenibut withdrawal can cause severe symptoms. Treatment strategies vary. Phenibut dose tapering or medically assisted abstinence with a GABA agonist have both been employed. There is a need for further research to establish clear guidance on both assessment and management of phenibut withdrawal. The role of baclofen in managing withdrawal warrants scrutiny to identify an appropriate place in therapy.

KEYWORDS Phenibut; baclofen; withdrawal

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85. A retrospective look at kratom withdrawal from regional poison center data

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Background: Kratom, a xenobiotic derived from the Mitragyna speciosa tree, has been increasingly used in the United States over the last decade. Currently, kratom is in a legal gray area, lacking federal regulation and legality differing from state to state. Kratom usage ranges from recreational to therapeutic, including emerging considerations for usage in opioid withdrawal. Kratom usage and subsequent dependence can lead to a clinical withdrawal state. The purpose of this study was to quantify and characterize kratom withdrawal reported to a regional poison center.

Methods: We performed a retrospective chart review of all kratom cases from a regional poison center from 1 January 2016 to 31 December 2022. Cases were identified using the generic code for kratom. Details of withdrawal cases were abstracted including demographics, clinical effects, and disposition.

Results: A total of 330 cases relating to kratom were identified, 39 (12%) of which were reported as kratom withdrawal. Annual kratom exposure and withdrawal cases rose through the study period. Among the withdrawal cases, 28 were male (72%) and ages ranged from 4 days to 77 years with a median of 33.5 years. (IQR: 30–42.3). There were two pediatric cases (4%). Most common symptoms were agitation (12, 31%), vomiting (8, 21%), diaphoresis (5, 13%), and tachycardia (5, 13%). Most withdrawal patients experienced minor effects (24, 62%) with seven experiencing moderate (18%) and two experiencing major effects (5%), and no deaths. Five of the nine patients with moderate or major effects were experiencing polysubstance withdrawal. Eight (21%) withdrawal patients required admission. Intensive care unit admissions included: an infant with prenatal kratom exposure, a patient with evolving withdrawal during an unrelated trauma admission, and an intubated patient with polysubstance withdrawal. Floor admissions included: two cases of polysubstance withdrawal, a patient with evolving withdrawal during an unrelated admission and isolated kratom withdrawal presentation.

Conclusions: Overall, there was a rise in kratom and kratom withdrawal cases reported to the poison center during the study period. This may suggest increased kratom use regionally or increased utilization of poison centers for management guidance. Few pediatric cases were reported, with one neonatal withdrawal presentation. Most withdrawal patients that experienced moderate or major clinical effects experienced polysubstance withdrawal, while the preponderance of isolated kratom withdrawal were able to be discharged home with minor effects. The study may under-represent prevalence of withdrawal as the dataset is dependent on voluntary reporting to the poison center. As the number of people using kratom continues to grow, so will the need for further education of medical providers and investigation regarding optimal management of its withdrawal states.

KEYWORDS Kratom; withdrawal

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86. When you give naloxone rescue kits to people who use drugs, guess what happens: they save lives

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Background: Communities began equipping non-medical laypersons with naloxone rescue kits in 1996. Since then, hundreds of thousands have been saved nationwide. Syringe exchange and harm reduction programs have proven to be the most successful access points for placement of these kits. Partnerships that place naloxone directly in the hands of people who use drugs (and those around them) have demonstrated crucial strides in preventing preventable deaths. Data from these settings provides frontline information about naloxone use in the most at risk populations using substances we may know the least about. This

study describes the reported use of intramuscular (IM) injectable naloxone rescue kits (containing 0.4 mg/ml naloxone doses) within a population of layperson participants in multiple syringe exchange services (SES) and harm reduction programs.
Methods: Anonymous self-reporting of naloxone rescue kit use including: the number of 0.4 mg naloxone doses/vials used in an opioid overdose reversal, who it was used on, if EMS was called, and if the individual survived. Participant kits each contain two doses of 0.4 mg naloxone (single dose vials), two syringes, and instructions. SES participants were encouraged to obtain multiple kits. Reversal data was collected anonymously by trained staff of each SES and aggregated by the lead agency.
Results: 6463 individual reports of naloxone rescue kit use were documented over 73 mos (02/17-03/23), data points were obtained on 4927 of these reversals. Kits were furnished by one central agency to 5 community-based organizations (CBOs), and were provided to participants during SES outreach services. 97.5% (4803) of the reports described a successful reversal and survival. The reported use was on a friend/acquaintance (79%), self (10%), stranger (4%), family member (6%), spouse (0.5%), dog (0.01%), unknown (3%). One dose of naloxone (0.4 mg IM) was used to reverse an overdose in 22% (1067) of the reports, two doses 53% (2568), 3 doses 10% (464), 4 doses 10% (502), 5+ doses 2.5% (134), unknown doses 2% (98). There were 124 unsuccessful reversal reports during this time period using between 1 and 6 vials of naloxone. EMS was reportedly called 30% of the time when a layperson kit was used in this setting.
Conclusions: Individuals participating in SES and harm reduction programs self-reported use of naloxone rescue kits that had been furnished to them. 97.5% of those administered layperson naloxone in this setting survived. The majority of the reversals were on a friend/acquaintance, but also on family members, the participants themselves, and even strangers. Over 75% of the reversals were reported successful with 1 or 2 doses of 0.4 mg IM injectable naloxone in a community with known fentanyl saturation. These results do not indicate that an increased dose of naloxone is required in laypersons rescue kits. These results do suggest that individuals in the SES setting should have access to multiple kits or kits with at least 3-4 doses given that 70% of the reports did not include a call to EMS. Increased education about the role of EMS, enhancing Good Samaritan legal protections for those who call 911, and ensuring individuals in this setting have access to multiple kits/doses is recommended. People who use drugs are saving the lives of those around them.

KEYWORDS Layperson naloxone; opioid overdose; harm reduction

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87. Abuse of bupropion by insufflation and ingestion is increasing in the United States: a national poison data system review

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Background: Bupropion is a cathinone that inhibits dopamine and norepinephrine uptake and has abuse potential due to its psychostimulant effects. The clinical effects from the insufflation of bupropion have been described in literature and include seizures, tachycardia, agitation, and anxiety. Reports of bupropion abuse have been increasing in the last two decades. However, there is limited data available on the differences in clinical effects and treatment of bupropion abuse via insufflation versus ingestion. The aim of the study was to compare the clinical effects and healthcare outcomes in cases of insufflated bupropion with cases of ingested bupropion with recreational intent.
Methods: The National Poison Data System (NPDS) was searched for all cases of bupropion exposure with intent of recreational use or abuse from 1 January 2013 to 31 December 2022. Cases with single agent exposure were included. Cases in which bupropion was insufflated were compared with cases in which bupropion was ingested. The incidence of cases, patient age, clinical effects, healthcare utilization, and medical outcome were explored. Pearson's chi-square calculations were used to compare proportion of patients admitted to the hospital after insufflation and ingestion as well as the major outcomes after each method of abuse.
Results: A total of 892 cases of bupropion insufflation and 1,351 cases of bupropion ingestion with intent of recreational use or abuse were reported to Poison Centers. The number of ingestion cases increased from 2013 to 2020 with a drop in 2021. The most common symptoms of bupropion insufflation reported were tachycardia (18.3%), hypertension (9.1%), agitation (8.7%), single seizure (6.4%), and tremor (4.8%). The most common symptoms of bupropion ingestion were tachycardia (17.8%), agitation (8.3%), hypertension (7.4%), single seizure (6.5%), tremor (5.7%), and hallucination (4.9%). Of all cases with bupropion insufflation, 45.1% involved non-psychiatric hospital admission compared with 58.1% of cases involving ingestion ($P < 0.00001$). Major effects, meaning effects that were life threatening or likely to cause residual disability or disfigurement, were recorded in 10.0% of the ingestion group and 6.8% in the insufflation group ($P < 0.0001$). Only one death was recorded in the patients who ingested bupropion, and no deaths were recorded in the insufflation group.
Conclusions: The proportion of patients who developed seizures and tachycardia were similar in the insufflation and ingestion groups. Hospital admissions were higher for the ingestion group. A higher percentage of patients in the insufflation group were treated and released compared to ingestions. The data suggest that patients who insufflate bupropion are as likely to experience adverse effects as patients who ingest bupropion. Clinicians should consider closer observation or admission of patients who present to hospitals after bupropion insufflation, and Poison Center staff should consider referral to healthcare facilities in these patients. As bupropion insufflation is becoming more common, prescribers and patients should be aware of the risks of bupropion misuse.

KEYWORDS Bupropion; insufflation; abuse

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88. A two-year observational review of a state poison center providing addiction medicine consult to rural clinicians

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Background: The overdose epidemic continues to worsen across the nation with more than 106,000 deaths in 2021. Deaths are largely being driven by fentanyl and stimulants. At the beginning of 2023, federal legislation put an end to the "x-waiver" that was required to prescribe buprenorphine for opioid use disorder (OUD), meaning all prescribers, with a valid DEA license can prescribe buprenorphine. Poison Centers (PC) sits at a strategic crossroads to provide 24/7 365 service for medical advice across

the nation for callers. Starting 1 January 2020, a state/academic Poison Center in a rural western state, began providing addiction treatment advice across our region. We describe the first two years of our experience. Funding for this effort was provided by the State Opioid Response Grant.

Methods: The PC staff of Certified Specialist in Poison Information (cSPIs), is made up of pharmacists. To build capacity to address addiction calls, staff completed the 8-hour x-waiver course plus an additional 4–6 hours of education provided plus regular updates. Additionally, four physicians board certified in addiction medicine or addiction psychiatry serve as back-up. Availability is 24/7, 365 days a year. Advertising the new service has included flyers emailed and faxed to acute care and outpatient settings statewide, posting on state-funded behavioral health webpages, promotion at educational venues with providers and workforce and outreach programs involving the PC medical director. We created a field in Toxicall®, called "OUD cases" that the cSPI must select to track cases. This field was queried for all OUD cases/calls from 1 January 2020 through 5 May 2023. Calls were screened and abstracted for location, age, sex, date of call, and reason for call. Descriptive statistics were tabulated.

Results: Over nine quarters the PC received 168 OUD calls. 153 (91.1%) calls were from hospitals and 15 (8.9%) were home calls. Hospitals represented a large geographic coverage across the region with 60.6% of counties calling. The mean and median age of patient is 38.3 and 36 years of age respectively with nine cases of unknown age. Ninety-five (56.6%) were male and 72 (42.9) were female with one unknown. The reason for calls where primarily related the management of patients with OUD who use primarily fentanyl, and the transition from fentanyl use to buprenorphine treatment. Other reasons, for call included management medications for opioid use disorder in pregnancy (MOUD), MOUD perioperative, general information, one of the on-call addiction attending was consulted in 73 (43.2%) cases.

Conclusions: Data from implementation of this initiative demonstrates that PCs can provide support for addiction related calls and build this service into current working operations. We expect calls to increase as awareness and use of the services expands.

KEYWORDS Opioid; treatment; addiction

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89. Pediatric exposures to methadone reported to poison centers following the COVID-19-related loosening of federal regulations

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Background: Methadone is a highly effective treatment for opioid use disorder. In the United States (US), its use is regulated at both the federal and state level. The regulations related to methadone were loosened in 2020 because of the 2019 Novel Coronavirus public health emergency declaration. March 16, 2020 marks the date of loosening of methadone regulations, allowing for more take-home doses to be dispensed to more patients. These doses should have respected all federal and state dispensing laws and been provided in child-resistant containers that met the standard set forth by the Poison Prevention Packaging Act of 1970. This study aims to assess the effect of loosened regulations on pediatric exposures to methadone reported to poison centers in the US

Methods: Retrospective analysis of methadone exposures in children younger than 6 years of age reported to the National Poison Data System from 2010 to 2020 (10 years). A quasi-experimental design was used to compare exposures one year pre- and one year post-intervention. Intervention was 16 March 2020. Inclusion: methadone exposures, children less than 6 years old. Exclusion: no known outcome, confirmed non-exposures. US population estimates of children was used as the offset. Incidence density rates were compared using Poisson regression. Two-sample *t*-test and Fisher's exact test were used.

Results: A total of 2629 exposures to methadone in children under 6 years of age were analyzed over the 10 year study period (2010–2020). Rates of exposure to methadone for year 2020 decreased by 25.4% compared to the average spanning 2011–2019 ($P = 0.0003$). When comparing the 303 exposures in the pre- and post-periods, exposure rates increased 18.3%. This increase was not statistically significant ($P = 0.15$). There was no statistically significant difference in distribution of age, gender, hospitalizations, therapies, or medical outcomes, including deaths pre- vs post-. One exposure was intentional.

Conclusions: Rates of exposure to methadone among children decreased over the last 10 years. This mirrors decreases in methadone mortality in the National Vital Statistics System and in methadone non-fatal overdoses in the Centers for Disease Control and Prevention (CDC) National Syndromic Surveillance Program. An increase in rates of methadone exposures in children under 6 years of age was observed when comparing the one year pre- and one year post-period. This increase was not statistically significant. These results were observed in the context of increased dispensing of methadone from Opioid Treatment Programs (OTPs). Many OTPs require home lock boxes (not usual for other opioids). Combined with child-resistant containers, lock boxes may have prevented or limited children's access to methadone and help explain some of the results. The loosening of methadone regulations was not associated with a statistically significant increase in rates of methadone exposures in children under 6 years old. As federal officials consider possible permanent changes to the methadone regulations, it is important to evaluate risks to children. OTPs should continue to educate patients and use various means to try to protect children from exposure.

KEYWORDS Methadone; pediatrics

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90. Differences in naloxone dosing by gender in emergency department opioid overdose: results of a multicenter study

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Background: Research suggests that opioid overdose and opioid overdose deaths have increased rapidly among women in the United States. Few studies have examined differences in overdose treatment for men and women in the emergency

department. We hypothesized that there would be no difference in the total amount of naloxone administered to men and women with opioid overdose.
Methods: The Toxicology Investigators Consortium (ToxIC) Fentalog Study is a multicenter, prospective cohort study screened adult (> 18) patients with suspected opioid OD who presented to one of ten participating EDs in the US between September 2020 and December 2022. Waste serum from each patient was analyzed via liquid chromatography quadrupole time-of-flight mass spectroscopy to detect all current opioids, fentanyl analogues, and adulterants. Patients without available waste serum were excluded. Medical record data was abstracted, de-identified, and entered into a REDCap database. The study was approved by a central institutional review board with waiver of informed consent. Chi-square analysis and *t*-tests were performed using SAS.
Results: Out of 4,294 patients screened, 1,256 were enrolled and 755 had blood toxicology results at the time of the data extraction (12 April 2023). Two transgender patients were excluded from the analysis ($n = 753$). Median age in years was 39 for males and 38 for females. Regional distribution (65.8 vs. 57.1% Northeast/MidAtlantic region), and race (48.1 vs. 53.3% White) were similar across males and females, respectively. Among those with a suspected opioid overdose, the mean total naloxone dose was 3.39 mg for females and 2.62 mg for males ($P = 0.012$). Among patients who were administered naloxone, the mean total naloxone dose was 4.58 mg for females and 3.66 mg for males ($P = 0.012$). Among patients with at least one confirmed opioid analyte detected ($n = 687$), the mean total naloxone dose was 3.51 mg for females and 2.70 mg for males ($P = 0.011$). Among patients who had at least one confirmed opioid analyte detected and received naloxone, the mean total naloxone dose was 4.72 mg for females and 3.68 mg for males ($P = 0.006$).
Conclusions: Among ED patients with suspected opioid overdose and those with a confirmed opioid analyte, female patients received nearly 1 mg higher average total dose of naloxone compared to male patients. Differences in naloxone dosing may be attributed to differences in physiology, hormones, or substance use patterns. Future studies should evaluate sex as a biological variable for naloxone dose and response.

KEYWORDS Naloxone; opioid; overdose

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91. Descriptive characteristics of persons who use fentanyl within the ToxIC Core Registry, 2014–2022

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Background: Illicitly manufactured fentanyl (IMF) has reshaped the sphere of the United States' (US) illicit drug supply (IDS). Powdered IMF and counterfeit pills containing IMF (CP) seizures increased 710.2% and 4,850.4% from Q1 in 2018 to Q4 in 2021, respectively. Further, the proportion of CP seizures increased from 13.8 to 29.2%. In 2021, 106,699 drug overdose (OD) deaths occurred in the US with synthetic opioid-involved OD deaths increasing 21.8% from 2020 to 2021, primarily driven by IMF. From 2020 to 2021, OD death rates increased among those aged ≥25 years with the largest increase occurring among ages 35–44 years. We examined consultations involving fentanyl in the Toxicology Investigators Consortium (ToxIC) Core Registry, a case registry of medical toxicology consultations, from January 2014–December 2022.
Methods: We limited the analytical sample to consultations involving intentional exposure and acute opioid withdrawal as the reported reasons for the medical toxicology encounter. Patient demographics, suspected CP involvement (i.e., specific mentions of pills or tablets, "Blues", "M30s", or "Street Xanax/Percocet" within the record), and annual counts are described. Descriptive analysis was performed in SAS 9.4.
Results: Overall, from 2014–2022, 1,225 consultations involving fentanyl were identified: 66% intentional exposures ($n = 808$) and 34% acute opioid withdrawals ($n = 417$). Proportionally, consultations increased annually, nearly quadrupling from 2014 (2.6%) to 2020 (9.7%), more than doubling from 2020 to 2021 (22.2%), and increasing again in 2022 (38.6%). Within the analytical sample, 16.1% were suspected to involve CP: 6.4% of intentional exposures and 34.8% of acute opioid withdrawals. Among suspected CP involvement, 73.1% of exposures mentioned CP terms ($n = 38$) while 53.8% of withdrawals reported pills or tablets ($n = 78$). Among patients who used fentanyl, nearly one in five exposures were aged 12–19 years ($n = 151$, 19.0%) while two in five were aged 20–34 years ($n = 318$, 40.1%). Nearly one in four withdrawals were aged 30–34 ($n = 98$, 23.7%); more than half were aged 20–34 years ($n = 215$, 51.9%). Age ranges shifted over time with the largest proportion of 2014 consultations comprising patients aged ≥50 years ($n = 19$, 65.5%) to 30–34 years ($n = 99$, 21.0%) in 2022. Patients aged 30–34 years increased from 6.9% of the sample in 2014 ($n = 2$) to 21.0% in 2022 ($n = 99$). Patients aged 25-29 years first presented in 2016 ($n = 6$, 15.4%) and remained steady through 2022 ($n = 78$, 16.5%) (range: $n = 11$, 13.8% to $n = 25$, 21.4%). Further, patients aged 12–19 years were first captured in 2015 ($n = 4$, 13.8%) and remained present through 2022 ($n = 36$, 7.6%) (range: $n = 36$, 7.6% to $n = 27$, 23.1%). Over time the concentration of cases shifted, with patients aged 20–39 years comprising 13.7% of 2014 consultations ($n = 4$) compared to 60.6% in 2022 ($n = 286$).
Conclusions: Among persons who use fentanyl within the ToxIC Core Registry, 2014–2022, represented ages have shifted to younger patients over time and followed similar trends among reported OD in the US. Further, many consultations were suspected to involve CP. Fentanyl test strips and naloxone are invaluable tools in combating OD with the ever-increasing presence of fentanyl in the IDS.

KEYWORDS Drug overdose; fentanyl; suspected counterfeit pills

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92. The power of partnerships to amplify messaging through free traditional media and social media

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Background: Limited funding and tight budgets leave little room for Poison Centers to purchase expensive TV, newspaper and radio advertising. This has forced many centers to focus their outside messaging on their own social media channels. Most centers have a limited number of followers and limited audience reach through their own accounts. While a fractured media landscape has diminished the impact of traditional media, traditional channels still feed the largest audience (reach.) Viewers also need to hear a message multiple times before they are likely to act (frequency.) To amplify the reach of messaging and place messages on enough channels to make an impactful frequency for International Overdose Awareness Day (31 August 2022), we

created a partnership to produce coordinated messaging for multiple traditional and social channels.
Methods: We created a partnership with multiple non-profits to amplify messaging on this advocacy day. In addition to sharing consistent messaging on our own social media channels, the group convened a meeting with the #1 rated local television news operation. With the power of three non-profits, we were able to secure an agreement to help produce content about the overdose crisis for all newscasts from 7 am to 11pm on August 31. The content ranged from prevention, to data, to treatment options. The coalition provided story ideas, interview subjects, data and content to the station. The key to creating the content was providing personal stories in addition to the facts, figures and experts we also supplied. The coalition provided experts to staff a phone-bank to take calls during the early evening news. By creating a "take-over" day, the television station felt compelled to produce commercials promoting the day's coverage further amplifying our message. Additionally, the station took the television content and created digital content for their website and social media platforms.
Results: The coalition achieved an audience reach and frequency previously not achievable through our own social media channels. The television coverage reached 121,070 of the roughly 700,000 households in the TV market. The TV station's website drew nearly 22,000-page views on the special overdose content. Over two days (30th and 31st August), the coalition of non-profits posted content 32 times on their individual channels (Facebook, Instagram, Twitter, LinkedIn and TikTok) to a combined reach of 27,108. The Poison Center added 23 tweets reaching 1,602 people and added a Facebook post with a reach of 3,996 impressions. The combination of the television station and the coalition's efforts reached more than 500,000 of the roughly 2 million people who live in the television market. The messaging ran in more than 10 newscasts, on two websites, on three Facebook feeds, four twitter accounts, three Instagram accounts and 1 TikTok account.
Conclusions: The power of the partnership created the leverage to garner a major television partner. The reach and frequency from the coverage was far greater than our individual social channels. However, the combined efforts on our social channels augmented the TV messaging and introduced our brands to like-minded consumers.

KEYWORDS Media; advertising; overdose

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93. Incidence of kratom-related poison control calls before and after kratom legalization in Thailand: current trends

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Background: Kratom (*Mitragyna speciosa*), is an indigenous tree in Southeast Asia. Currently, Kratom is popular and easily available worldwide, especially in Europe and the US via shops or internet to use as a substance of abuse, opioid alternative, or pain killer. In Thailand, Kratom was illegal until August 2021, kratom is legalized to possess and use. The data of impact after legalization is limited. Our objective was to describe and evaluate the incidence of, clinical characteristics of, consequences of and the trend of Kratom-related poison control calls before and after legalization in Thailand.
Methods: We performed a retrospective cross-sectional study by analyzing data from the Ramathibodi Poison Center for 36-month periods as the first period (6 months after legalization during 24 August 2021 to 23 April 2022), the second period ((6 months before legalization during 24 February 2021 to 23 August 2022), and the third period (the same period (months) as the first period that was in last year during 24 August 2020 to 23 April 2021).
Results: There were totally 173 calls or cases consulted to our poison center which were 96, 38 and 39 cases in the 1st, 2nd and 3rd periods, respectively. The mean age of all, cases in the 1st, 2nd and 3rd periods were 29.4, 29.7, 29.0 and 28.9 years old. Most of all (84.4%) and cases in each period were male. Most (about 60%) of all and cases in every period used or co-ingested kratom with other substances. The common clinical manifestations included palpitation (35.8%), nausea/vomiting/abdominal pain (22.5%), seizure (22.0%), agitation (18.5%), tremor (11.6%) and dystonia (5.2%). Interestingly 2 cases developed status epilepticus. The abnormal vital signs were tachycardia (43.4%) high blood pressure (22.5%) and high body temperature (6.9%). No patients presented with obvious respiratory depression or low oxygen saturation. Forty-six cases (26.6%) were admitted. Two cases (in the 1st period) were intubated due to depressed consciousness. Death was not found. We compared the clinical characteristics of cases among 3 periods. No significant differences were found in age, sex, regions, co-ingestion and incidence of clinical effects including seizure among these 3 periods. However, cases in the 1st period were admitted (37.5%) more statically significantly when compared to the previous 2 periods (15.8%, 10.3%) ($P < 0.001$).
Conclusions: Kratom-related calls increased about 2 times after legalization. The trends of consultation and hospitalization were on the rise. This might be explained by the wide availability of Kratom in the market. Most were young male and used with other substances. Most cases in our study were the poly drug users, so kratom might be used as substance of abuse. Seizure was reported commonly in every period; however, its incidences showed no differences. Our study supported that seizure was one of the toxicities of kratom. Although the incidences of clinical effects were not different among periods, but the admission rate was higher after legalization. This needs further study to elucidate this finding.

KEYWORDS Mitragyna speciosa; adverse effect; seizure

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94. Access to medications for opioid use disorder for methamphetamine and opioid co-users between 2015–2020: a national analysis

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Background: The increase in deaths due to opioid use have led to policies that encourage access to medications for opioid use disorder (MOUD) such as methadone, buprenorphine, and naltrexone. According to the CDC, there have been recent increases in deaths related to co-use of opioids and stimulants, particularly cocaine and methamphetamine. However, less is understood about access to MOUD for those patients. Consequently, using national data, we aimed to analyze access to MOUD for patients that use both methamphetamine and opioids compared to all opioid users.
Methods: We conducted a retrospective review using the Treatment Episode Data Set (TEDS) between 2015 and 2020 of

patients who were discharged after treatment for substance use and had MOUD as a part of their treatment plan. Our primary outcome was the proportion of such patients who initially reported use of both opioids and methamphetamine compared to those that reported use of any opioids. We assessed this using the chi-squared difference of proportions test. We determined predictors of receiving MOUD for patients who were co-users by conducting a binomial logistic regression. We also used Pearson's correlation (PC) or Spearman's rho (SR) as applicable to determine if there was a trend in access to MOUD for co-users within the study time frame. Descriptive statistics were used to describe the data. All *P*-values were reported to the 0.05 significance level.

Results: Between 2015 and 2020, there were a total of 3,573,333 patients who reported use of opioids at the time of admission, and a subgroup 549,712 patients who reported use of both methamphetamine and opioids. Over the study period, of patients who reported use of any opioid, 981,853 (27.5%) had MOUD incorporated into their treatment plan, with an increase over time ($pc = 0.99$, $P < 0.001$). Of those who reported using both opioids and methamphetamine, 17.9% (98,198) had MOUD incorporated into their treatment plan ($P < 0.0001$, compared to all opioid users), with an increase over time ($pc = 0.94$, $P = 0.002$). In 2015, there were 8,264 (13.6% of patients who used both methamphetamines and opioids) that were provided access to MOUD, and in 2019 there were 21,987 (22.3%) patients ($P < 0.001$). Predictors of utilization of MOUD among co users included marital status ($P < 0.001$), presence of co-occurring mental and substance use disorders ($P < 0.001$), employment status ($P < 0.001$), race ($P < 0.0001$), health insurance ($P < 0.0001$), and which region ($P < 0.0001$). Non-predictors included gender, age at admission, previous substance treatment episodes, veteran status, and attendance at substance use self-help groups within the past 30 days prior to admission.

Conclusions: Our study found that among patients who were discharged after treatment for opioid use, there was a greater use of MOUD as a part of their treatment plan for all opioid users than forco-users with methamphetamine. However, there were increases in provision of MOUD for both groups over time. Future studies should aim to investigate reasons for lack of access to MOUD for this subpopulation as well as to investigate differences in risk factors and outcomes between the population of co-users and others.

KEYWORDS Methamphetamine; opioids; medications for opioid use disorder

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95. Comparison of QTc duration versus reported daily loperamide dose in chronic loperamide cardiotoxicity

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Background: Loperamide is an over-the-counter mu-opioid receptor agonist that can cause central mu-opioid stimulation and cardiotoxicity., Interaction with inward potassium rectifier (IKr) channel is thought to slow repolarization, manifested as QRS and QTc abnormalities. In severe cases, this can predispose to polymorphic ventricular tachycardia (torsade's de pointes), which is treated with intravenous magnesium. Reports of loperamide abuse with severe cardiotoxicity have continued to occur. One question in management is the relationship between total loperamide exposure and IKr channel interference in severe cardiotoxicity. We hypothesize that maximum QTc length is directly associated with estimated daily loperamide dose.

Methods: We retrospectively reviewed cases of chronic loperamide toxicity cases managed by the by poison center staff at our host institution between 1/1/2017 and 12/31/2022. We collected demographic information, electrocardiograms (EKG) and laboratory data. All EKGs were visually assessed for QRS and QT interval. QTc was evaluated via Bazzett's method. Correlation coefficients between self-reported loperamide daily dosage, magnesium administration, and EKG results were calculated.

Results: We identified 7 patients with chronic loperamide abuse with average age of 35.8 years (range 28–44 years) (71% male). The mean self-reported loperamide exposure reported was 171.14 mg (36–400 mg) per day. Mean QTc duration was 682.6 ms (range 458–33 ms). The correlation coefficient between self-reported daily dose and QTc was 0.3532. All patients were treated with magnesium (mean 30.5 grams/patient). Patients had QRS widening ranging from 110 to 216 ms (mean 162 ms). The correlation coefficient between dose and QRS was 0.02557. Two of the patients were also treated with sodium bicarbonate for their QRS widening. Average length of stay was 5.77 days (0.68–11.41 days), by which point the QTc had normalized at discharge in all patients.

Conclusions: Although cardiotoxicity was demonstrated in all patients, we could not identify a specific precipitating daily dose associated with QTc prolongation. Although we did not find strong correlations between self-reported daily dose and QTc, the 3 patients with the longest QTc had the longest hospital stays and two had the highest amount of magnesium administered. Healthcare professionals, as well as the public, should be aware that loperamide can cause significant cardiotoxicity when abused. Limitations of the study included a small number of patients, accuracy of reported chronic dose, and unknown length of time of abuse. Future directions include correlating loperamide and n-desmethyl-loperamide levels with QTc duration.

KEYWORDS Loperamide; QTc prolongation; magnesium

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96. A rare presentation of opioid induced sudden sensorineural hearing loss

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Background: Opioid-induced ototoxicity is a rare complication that may manifest as sudden sensorineural hearing loss (SSHL) in both chronic and acute opioid use. We present the case of an adolescent female with audiometry confirmed bilateral SSHL following opioid and benzodiazepine overdose.

Case report: A 16-year-old female was brought to the ED after insufflating alprazolam and fentanyl. The patient was found by her family with depressed mental status and respiratory depression. EMS administered 4 mg of naloxone without improvement. Police performed colorimetry testing on blue powder found on the patient, which confirmed the presence of opioids. In the ED she received flumazenil 2 mg IV without effect and was subsequently intubated for airway protection. Non-contrast CT and MRI brain were performed which were normal. Urine drug screen was positive for cannabinoids and benzodiazepines and negative for opioids. The patient was extubated the next day and endorsed significant hearing difficulty. Medical toxicology was consulted given the concern for opioid-induced SSHL. Recommendations were

made to obtain audiometry. Hearing thresholds were plotted to display the quietest sound perceptible at least 50% of the time, measured in decibels hearing level (dB HL). A normal audiogram displays bone and air conduction lines with thresholds < 25 dB HL at each tested frequencies in both ears. The patient's audiogram demonstrated bilateral sensorineural hearing loss, as indicated by the overlapping lines representing air conduction and bone condition. Severity of hearing loss was 90dB HL at 2000 Hz, consistent with severe impairment (normal range 10–25 dB HL between 250 and 8000 Hz). Following otolaryngology guidelines for all-cause SSHL we recommended corticosteroids (prednisone 1 mg/kg/day for 14 days), avoidance of ototoxic agents (e.g. NSAIDS, salicylates, aminoglycosides, etc.), and outpatient follow up with ENT. On six-month follow-up the patient reported improved but persistent bilateral hearing loss necessitating hearing aids.

Discussion: Much remains to be elucidated in regards to risk factors for development, etiological mechanisms, and prognosis of opioid-induced SSHL. The pathophysiology has been purported to be due to hypoxia, hypotension, or direct cochlear injury. Our patient may have experienced hypoxia and/or hypoperfusion prior to mechanical ventilation though advanced neuroimaging did not show evidence of anoxic injury. Audiometry was consistent with SSHL in a pattern similar to other rare case reports. The benefits of high-dose steroids for this indication remain unclear given the paucity of evidence. Given the potential for benefit and absence of contraindications empiric therapy seemed reasonable. Outcomes are variable and permanent hearing loss has been previously described. Although our patient endorsed hearing improvement during her follow-up, she also now requires hearing aids.

Conclusions: Opioid-induced SSHL is a rare complication of opioid use. Our case highlights the development of severe bilateral SSHL in a 16-year-old patient following opioid and benzodiazepine overdose with improved yet ultimately persistent hearing impairment.

KEYWORDS Opioid; ototoxicity; sensorineural

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97. Adulterants found in the San Diego county fentanyl supply: a laboratory analysis of law enforcement samples

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Background: Simultaneous with the "opioid epidemic," there is a second on-going public health crisis: the presence of adulterants within drug supplies. The landscape of drug adulterants is complex and rapidly evolving, often subject to various economic and law-enforcement pressures experienced by illicit drug manufacturers. Here we report our efforts to characterize the adulterants present within the local fentanyl supply of San Diego County, obtained from undifferentiated drug samples seized by local law enforcement over the calendar year 2021.

Methods: From 4 January 2021 to 30 December 2021, 53 law enforcement agencies across San Diego County submitted over 312 kg of illicit substances to the San Diego County Sheriff's Department Regional Crime Laboratory for identification, constituting 4838 individual samples. Once samples were received the general analysis flow began with illicit drug confirmation via less specific, qualitative colorimetric testing and moving towards higher discriminating qualitative testing via Fourier Transform Infrared Spectrometry (FTIR) and finally Gas Chromatography Mass Spectrometry (GCMS).

Results: Qualitative analysis of these fentanyl samples revealed the presence of 52 unique adulterants and contaminants. Ten compounds comprised more than 90% of all identified adulterants and contaminants: 4-methylaminoantipyrine (4-MAAP) (10.9%), mannitol (9%), acetaminophen (8.5%), methamphetamine (4.2%), diacetylmorphine (3.6%), tramadol (1.9%), and xylazine (1.7%). Various fentanyl analogues were identified, namely fluorofentanyl, acetylfentanyl, benzylfentanyl, and methyl acetyl fentanyl. Several other commonly used opioids were detected including dextromethorphan, morphine, 6-monoacetylmorphine, oxycodone, codeine, and methadone. Finally, three novel synthetic opioids were isolated: fluonitazene, protonitazene, and isotonitazene. Other pharmaceutically active adulterants included acetaminophen, methamphetamine, xylazine, lidocaine, cocaine, alprazolam, procaine, caffeine, clonazolam, clonazepam, levamisole, phenobarbital, etizolam, benzeneethanamine, phenothrin, delta 9-tetrahydrocannabinol, carisoprodol, bupivacaine, and diazepam. The most common contaminants were fentanyl precursors. Among those precursors, 4-anilino-N-phenethylpiperidine (4-ANPP) and phenethyl-4-anilino-N-phenethylpiperidine (phenethyl 4-ANPP) were the most common of the nine total identified. Other contaminants included 1-hexadecanol, 1-hexadecene, papaverine, mannitol, and sorbitol.

Conclusions: In this study, we enumerate several identified illicit drug adulterants and review their relative potentials for pathology. Some additives can act synergistically with opioids, increasing the likelihood of overdose and death, and can give rise to idiosyncratic and deleterious health effects. However, the extent to which these unique adulterants truly impact drug use as well as associated morbidity and mortality remains uncertain and an area of interest for further study. This study demonstrates that within San Diego County, one of the nation's epicenters for opioid trafficking, adulterants are common, numerous, and diverse. We feel this information is vital for both clinical public health use and for harm reduction at the level of the individual consumer. All would benefit from a better understanding of the heterogenous and changing nature of the drug supply, and the various clinical presentations and negative health impacts that drug adulterants can have. Improved awareness of these adulterants and the role they play within the domestic opioid supply is essential to reducing harm over the long term.

KEYWORDS Adulterants; fentanyl

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98. Cocaine-induced pulseless ventricular tachycardia in an 11-month old male

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Background: Cardiac arrest after acute cocaine exposure is thought to be associated with non-perfusing ventricular dysrhythmias or cardiac ischemia. We report on an 11-month-old male with an oral and nasal exposure to cocaine resulting in cardiac arrest secondary to ventricular tachycardia.

Case report: A previously healthy 11-month-old male weighing 12 kg was playing in a parent's discarded clothes on the floor. He suddenly became unresponsive. A white powder covered his nose and perioral area. His parents brought him by car to the emergency department 10 minutes away. At triage, the patient was unresponsive and cyanosed. He was brought to the resuscitation room, where he was found to be in pulseless ventricular

tachycardia. No temperature was recorded on presentation. CPR was started and the patient was intubated. He received four shocks (2, 4, 10 J/kg ×2), IV epinephrine (0.1 mg/kg ×2 doses), IV lorazepam (0.1 mg/kg ×1 dose). In discussion with a toxicologist at a regional poison centre, hypertonic sodium bicarbonate ($NaHCO_3$, 1 mEq/kg) was administered. Return of spontaneous circulation (ROSC) was achieved approximately one minute after administration of $NaHCO_3$ and the fifth defibrillation attempt. Electrocardiogram (ECG) post-ROSC showed a supra-ventricular tachycardia with persistent sodium-channel blockade and QTc prolongation. Hypertonic $NaHCO_3$ (1 mEq/kg) and lidocaine (1 mg/kg) were administered. Two minutes after the administration of lidocaine, he had a generalized tonic-clonic seizure which was treated with lorazepam 0.1 mg/kg and intralipid emulsion (ILE) 1.5 ml/kg. He was given phenobarbital (20 mg/kg) and levetiracetam (60 mg/kg). He was transferred to a quaternary pediatric centre with neuroprotective measures in place. There was no further seizure activity or dysrhythmias. The child was extubated on Day 3 post-exposure. An echocardiogram and brain MRI were within normal limits for age. He was discharged home on day 5 neurologically intact. Serum toxicology testing from presentation (LC-MS/MS) confirmed the presence of cocaine and benzoylecgonine. The father reported having cocaine in his clothing pocket where the child was playing.

Discussion: Cocaine has both direct and indirect cardiotoxic affects through sodium channel blockade and a resultant increase in circulating catecholamines, respectively. Management of cocaine-associated wide-complex dysrhythmias includes benzodiazepines, hypertonic sodium bicarbonate, and possibly lidocaine. The evidence regarding the use of lidocaine includes some animal studies suggesting an increased incidence of seizures. In refractory settings, there may be a role for ILE. This patient presented with pulseless ventricular tachycardia secondary to an acute cocaine exposure. Administration of $NaHCO_3$ (after epinephrine and defibrillation) restored a perfusing rhythm. He received additional $NaHCO_3$ and then lidocaine, after which he seized. The etiology of the seizure may have been secondary to cocaine toxicity, but it is possible that lidocaine could have contributed.

Conclusions: This is a rare case of cardiac arrest secondary to a cocaine-induced wide-complex tachycardia in a pediatric patient that in addition to pediatric advance cardiac life support measures, was treated with lorazepam, sodium bicarbonate, lidocaine and ILE.

KEYWORDS Cocaine cardiotoxicity; pediatric overdose; cocaine-induced dysrhythmia

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99. History of overdose and psychiatric comorbidities among medical toxicology consultations in the ToxIC Core Registry, 2021–2022

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Background: Non-fatal overdoses are one of the strongest predictors of subsequent overdose and represent an optimal prevention point. Psychiatric comorbidities may complicate recovery for individuals after an overdose. Our objective was to identify the prevalence of prior overdose history among patients receiving a medical toxicology consultation for intentional exposure and/or opioid withdrawal, and to compare the prevalence of psychiatric disorders, demographics, and substance exposures between those with and those without prior overdose history.

Methods: The Toxicology Investigators Consortium (ToxIC) Core Registry includes data from medical toxicology consultations on poisonings, including drug overdoses. In 2021, history of overdose and psychiatric comorbidities were added. This secondary analysis includes cases from 2021 to 2022 involving intentional exposure and/or acute opioid withdrawal as the reason for a medical toxicology consultation. Additionally, only cases with known medical history and history of prior overdose were included. Bivariate statistical tests were utilized to determine differences in demographic correlates, psychiatric disorders, and primary agent of exposure between patients with a history of overdose and without a history of overdose (Chi-square and Fisher's Exact tests for categorical variables and Mann Whitney *U* tests for continuous variables). All analyses were conducted in R v4.2.1.

Results: Among the 8,922 total cases which were classified as intentional and/or opioid withdrawal, 1,900 patients had a history of prior overdose, 4,063 patients had no history of prior overdose, and 1,686 had an unknown history of prior overdose. Additionally, 1,273 cases did not have known medical histories. Therefore, all unknown overdose/medical histories ($n = 2{,}959$) cases were excluded from this analysis. The total sample included 5,963 patients with 31.9% ($n = 1{,}900$) having a prior history of overdose. Those with prior overdose history were more likely to be older compared to those without an overdose history (median age =25 vs. 19, respectively, $P < 0.001$). Moreover, the prevalence of transgender individuals was substantially higher in the prior overdose group compared to the no prior overdose group (3.4 vs. 1.9%, $P = 0.002$). Among those with a history of overdose, 77.0% were classified as having a diagnosed psychiatric disorder compared to 51.9% of the no prior overdose history group ($P < 0.001$). The group with a prior overdose history also had a higher prevalence of specific psychiatric disorders, including anxiety, bipolar disorder, depression, PTSD, and schizophrenia. The prior overdose group had a higher prevalence of current exposures for alcohol (ethanol), sympathomimetics, and opioids. However, there was no difference in prior overdose history regarding cardiovascular agents.

Conclusions: The majority of individuals presenting with prior overdose history also had previously diagnosed psychiatric disorders. Those with prior overdose history had a high prevalence of presenting with alcohol, sympathomimetic, and opioid exposures. Targeted approaches that are culturally and psychologically appropriate for individuals with psychiatric disorders may mitigate future overdose risk. Additionally, proper linkages to care for individuals with psychiatric disorders are critical after presenting with an overdose.

KEYWORDS Psychiatric disorders; prior overdose; opioids

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100. ED dispensed naloxone improves distribution compared to pharmacy dispensed naloxone

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Background: In the ongoing opioid epidemic, fentanyl has increased the danger of overdose and death and has quickly become one of the leading causes of mortality nationally. The

opioid antagonist naloxone exists as a possible preventative measure against mortality. Distributing naloxone to at risk populations remains a challenge. Barriers such as cost and transportation to the pharmacy may decrease the ability to successfully distribute naloxone. We sought to evaluate the quantity distributed and success of distributing naloxone to emergency department (ED) patients by comparing providing patients with naloxone in-hand at discharge versus discharging a patient with a prescription for naloxone to fill at the in-hospital discharge pharmacy.

Methods: From January 2020 to January 2021, patients were offered naloxone from the ED Discharge Pharmacy at no-cost. The number of ED Discharge prescriptions written to the hospital discharge pharmacy and number of ED Discharge prescriptions filled at the discharge pharmacy were recorded each month. Starting in February of 2021 through February of 2022, naloxone was handed directly to patients in the ED. The quantity of naloxone distributed was recorded each month.

Results: From January of 2020 to January of 2021, on average 28.8 prescriptions were written from the ED each month. Of those 28.8 prescriptions written, an average of 11 prescriptions were filled each month. The success rate of prescriptions filled was 39.2%. Comparatively, an average of 53.4 prescriptions were filled each month starting in February of 2021 through February of 2022. Of note, naloxone supplies were exhausted in January of 2022, which led to only 17 prescriptions being dispensed. No naloxone was refused for in-hand distribution in the ED.

Conclusions: Distributing naloxone in-hand to patients directly increased the quantity and success rate of naloxone distribution compared to discharging patients with a prescription for naloxone. Requiring patients to fill a prescription may create a barrier to naloxone distribution and pose an obstacle to preventing morbidity and mortality from opioid use.

KEYWORDS Naloxone; opioids

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101. Naloxone practices and overdose history among patients presenting to the emergency department with non-fatal drug overdose

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Background: As fentanyl has entered "non-opioid" drug supplies (e.g., cocaine, methamphetamine) and caused overdoses in populations that do not intentionally use opioids, it is important to re-evaluate and expand our understanding of which populations are at high risk for fatal drug overdoses. The goal of this study is to characterize substance use and overdose history including details of naloxone access, possession, and administration in individuals presenting to the emergency department (ED) with non-fatal overdose to better understand naloxone distribution needs and inform future harm reduction efforts.

Methods: A consecutive sample of ED patients undergoing treatment for non-fatal overdose were prospectively recruited for study participation at time of the ED visit. Participants completed REDCap surveys at the time of their ED visit, reporting history of substance use over the last six months, recent and lifetime overdose, and naloxone receipt and administration history.

Results: A total of 76 eligible participants were enrolled over the course of seven months. Participants reported high rates of opioid (56%), stimulant (57%), and cannabis use (59%). Self-reported polysubstance use, defined as self-reported use of more than one substance, was 82%. Of enrolled participants, 67% had overdosed at least once before their index overdose ED visit, and 39% reported three or more lifetime overdoses. 33 patients (43%) had no self-reported opioid use in the last six months. Participants with no self-reported opioid use ($n = 33$) in the last six months had fentanyl positive urine drug screen 82% of the time (versus 88% in the overall study population). Participants who did not report opioid use in the last 6 months were generally less likely to possess (36 vs. 55%) or to know how to acquire (52 vs. 74%) naloxone compared to participants with reported history of opioid use.

Conclusions: This study provides evidence for using data gathered in the ED to inform upstream harm reduction training and naloxone distribution initiatives.

KEYWORDS Naloxone; overdose; harm reduction

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102. Neonatal and maternal dermopathy in association with kava use during pregnancy

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Background: Kava is a fat-soluble resin from the root of the *Piper methysticum* plant that has been used for medicinal and ceremonial purposes in South Pacific cultures for centuries. It is increasingly used as an alternative medicine in the United States due to its anxiolytic and analgesic effects. Kavalactones are the compounds that mediate these clinical effects with a variety of proposed mechanisms, including $GABA_A$ agonism. A frequently reported adverse effect of kava ingestion is an ichthyosiform dermopathy. Though well-documented in adults, literature regarding its use during pregnancy and fetal effects is lacking.

Case report: Case A 41-year-old female with a history of anxiety, depression, and daily nicotine vaping began drinking a blend of kava and kratom leaf extract daily. After some months of use, an ichthyosiform skin rash developed on her bilateral lower extremities and shoulders, characterized by non-pruritic, non-erythematous, dry, scaly skin. She continued to use this product until she became pregnant, at which time she attempted to self-taper the kava/kratom mix. At 32 weeks of gestation, she was prescribed buprenorphine to help with kratom withdrawal but could not tolerate more than 1 mg sublingual daily due to somnolence. She continued using the kava/kratom product at a reduced dose for the duration of her pregnancy and delivered a healthy male at 36 weeks without complication. After delivery, the patient stopped using the product and her dermopathy resolved within three weeks. The newborn was admitted to the Neonatal Intensive Care Unit for Neonatal Opioid Withdrawal Syndrome (NOWS) and treated with morphine and clonidine. He was noted to have diffuse ichthyosis-like dry skin lesions on day of life (DOL) 2. On DOL 4, he had a seizure and was started on phenobarbital, and was placed on mechanical ventilation for persistent apnea. Blood cultures grew Group B *Streptococcus* and *Serratia marcescens*, for which he received appropriate antibiotics. Electroencephalogram and MRI did not reveal any obvious seizure etiology. During this time period, he was noted to have excessively dry and peeling skin, inability to close his eyes or mouth due to skin contractures, and eclabion. He was extubated on DOL 6. His skin lesions were treated with topical emollients and resolved by DOL 22. The infant was discharged from the

hospital on DOL 25 and completed outpatient morphine weaning without incident.
Discussion: This description of ichthyosiform dermopathy in a mother and neonate associates *in utero* kava exposure to kava dermopathy in the fetus and neonate. While several mechanisms for this skin condition have been proposed, the cause is unknown. Kava dermopathy is known to resolve after cessation of use, consistent with the resolution of the skin lesions in both the mother and infant within 3-4 weeks after cessation of exposure.
Conclusions: Maternal kava use during pregnancy may cause fetal dermopathy presenting as acquired ichthyosis. Additional research is needed to elucidate the effects of fetal exposure and abrupt cessation in a neonate. More public education is needed about potential consequences of kava use, particularly during pregnancy.

KEYWORDS Kava; neonate; pregnancy

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103. Acute poisoning relates to novel psychoactive substances: an Italian case series

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Background: Novel psychoactive substances (NPS) are a wide and heterogeneous group of substances associated with severe toxicity and fatal intoxications. The word 'novel' does not necessarily refer to newly created molecules but also to old drugs rediscovered or known molecules used in an innovative or unusual manner. NPS include synthetic cannabinoid receptor agonists (SCRAs), cathinone derivatives, psychedelic phenethylamines, synthetic opioids, tryptamine derivatives, phencyclidine-like dissociatives, piperazines, designer benzodiazepines (DBZDs), psychoactive plants/herbs. Their recreational use has been increasing dramatically worldwide since 2000s. By the end of 2021, more than 880 NPS had been reported to the European Monitoring Centre for Drugs and Drug Addiction (EMDCCA). The increasing number of new compounds requires a rapid and continuous updating of the analytical methods in clinical laboratories. The challenge is about the difficulties in detecting new substances due to analytical limits. We report our experience of acute NPS poisoning between April 2018 to April 2023. All analytically confirmed positive test cases for NPS were reviewed and assessed to describe clinical aspects and their management.
Case series: Over the study period, 11 patients tested positive for NPS. The age of intoxicated patients ranged from 17 to 58 years (mean 34.6) and ten were male. In 8 cases a cathinone derivative was found (4 MDPHP, 1 N-ethylpentylone, 1 eutylone, 1 MDPHP and clephedrone, 1 alfa-PHP). All cathinone-positive patients had agitation, visual hallucinations, confusion, delirium, tachycardia and rhabdomyolysis. They were treated with benzodiazepines. Two patients tested positive also for cocaine. One patient was positive for cumyl-pegaclone, a SCRAs. He had severe neurological effects (drowsy, confused) with tonic-clonic muscle contractions in upper limbs, and cardiological effects (atrial fibrillation with rapid ventricular response) treated with IV flecainide. A patient was referred to the emergency room for ingestion of clonazolam, a DBZDs, bought on the Darknet. He was sedated and received only supportive treatment with IV fluids. No flumazenil was needed. The last patient, a prisoner, arrived with visual and auditory hallucinations, agitation, tachycardia, after crushing and smoking butylscopolamine. He was treated with IV lorazepam. Among 11 patients, 3 had a previous positive history for psychiatric disorder and 2 had a history of cocaine, cannabis or MDPV use disorder. Five patients (45%) were unaware of the substance used (4 cathinones and 1 SCRAs). Most patients (82%) recovered without consequences and were discharged within 48 hours from ED admission. Two patients, positive for N-ethylpentylone and eutylone required hospitalization in a psychiatric ward for seven days.
Discussion: In our case series, neuropsychiatric and cardiovascular effects due to NPS were the most common presentation. Management strategies are often limited to supportive and symptomatic care. NPS may also exacerbate or trigger mental disorders. Benzodiazepines should be of choice in case of agitated patients after NPS use.
Conclusions: NPS are a large class of recreational substances emerged as legal or cheaper alternative to illicit drugs. They are a challenge for clinicians, unfamiliar with their acute poisoning and for the difficulties about analytical identification in biological fluids. Also, the users may be unaware about the substance.

KEYWORDS Novel psychoactive substances; cathinones; cannabinoids

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104. Sleep through the withdrawal as additional buprenorphine takes effect—ultrarapid detox with buprenorphine? Nope, it's droperidol and buprenorphine

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Background: Precipitated withdrawal can occur in opioid dependent patients when either an antagonist (naloxone) or high-affinity partial agonist (buprenorphine) is administered while there is still substantial amount of full agonist present. Rates of buprenorphine-precipitated withdrawal have increased with increasing use of fentanyl as the pharmacology of fentanyl is substantially different than other opioids. Fentanyl is highly lipid soluble; prolonged use creates a depot in users, like using transdermal fentanyl. Initiation of buprenorphine in this context using standard doses often triggers precipitated withdrawal. While it is generally recommended to add additional doses of buprenorphine, unless high doses of full agonists are used, treating precipitated withdrawal is challenging. Most clinicians also use adjunctive agents to control symptoms and relax patients while additional buprenorphine takes effect. Common adjunctive agents include clonidine, benzodiazepines, and even ketamine. We describe two patients with buprenorphine-precipitated withdrawal treated with the antipsychotic droperidol. In both cases, a single dose of droperidol caused rapid onset of relaxation and sleep after which the patients' withdrawal symptoms were largely diminished.
Case series: Case #1: 58-year-old female presented with buprenorphine-precipitated withdrawal after taking one-half of an 8–2 mg buprenorphine-naloxone film two hours after using intranasal fentanyl. Her withdrawal symptoms included agitation, diaphoresis, tachycardia, tachypnea, abdominal pain, and myalgias. Initial Clinical Opioid Withdrawal Scale (COWS) was 27. She received buprenorphine-naloxone 8–2 mg, clonidine 0.2 mg, and intravenous fluids without improvement. Despite two additional doses of 2–0.5 mg buprenorphine-naloxone films, clonidine 0.2 mg, and 10 mg oral diazepam over the next two hours, severe

withdrawal symptoms persisted. At this point, 1.25 mg intravenous droperidol was administered with another 8–2 mg buprenorphine-naloxone and 0.3 mg clonidine. 48 mg of buprenorphine was given before discharge the next day with buprenorphine-naloxone 8–2 mg BID. While she received multiple buprenorphine doses, clonidine and diazepam, the point when her symptoms markedly started improving was after droperidol administration. Case #2: 40-year-old male presented with buprenorphine-precipitated withdrawal after taking 2–0.5 mg buprenorphine-naloxone 11 hours after using two bags of intravenous fentanyl. Withdrawal symptoms included anxiety, myalgias, rhinorrhea, restlessness, yawning, piloerection, nausea and vomiting. Initial COWS was 16. He was given 5 mg oral diazepam followed by oral ondansetron without resolution of vomiting. His symptoms improved rapidly after administration of 2.5 mg intravenous droperidol.

Discussion: Many experts focus on administering additional buprenorphine and using adjunctive medications for buprenorphine-precipitated withdrawal. Droperidol, a butyrophenone, is an antipsychotic useful for its antiemetic and sedative properties. In the ED, it has been used to treat migraines, nausea/vomiting, and agitation. The FDA issued a block box warning in 2001 for QT prolongation and Torsades de Pointes. Recent evidence describes low risk of arrhythmias in administered doses of 2.5 mg or less, renewing interest for ED patients. There are no prior case reports describing droperidol for buprenorphine-precipitated withdrawal.

Conclusions: Droperidol may be useful with additional buprenorphine for patients who present with buprenorphine-precipitated withdrawal.

KEYWORDS Buprenorphine precipitated withdrawal; precipitated withdrawal; droperidol

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105. "Strips": a surge in cases of a novel drug misused by prisoners

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Background: Novel drug misuse within incarcerated populations is a growing public health concern. According to a report released by the Bureau of Justice Statistics, a federal agency in the US Department of Justice, drug and/or alcohol intoxication deaths in state prisons rose over 600% from 2001 to 2018. One such drug that has gained local attention in our area is "strips." "Strips" are pieces of paper that are soaked in liquid formulations of various drugs, suspected to be opioids, synthetic cannabinoids, and household products such as pyrethroid-containing pesticides. These drug-saturated pieces of paper are mixed into normal pieces of paper such as reading materials and smuggled into jail. Paper is then divided into small strips and smoked by inmates. We have had a surge in bedside consults at our local hospital from inmates after "strips" exposure.

Case series: During a two-month period, twelve patients presented to our emergency department (ED) from jail with symptoms including obtundation, seizure-like activity and respiratory distress. All patients had onset of symptoms after smoking "strips." According to jail medical staff, patients are found in their jail cells, unresponsive or with seizure-like activity; often with emesis. Most patients are managed on site, are responsive to IV fluids and naloxone administration, and are back to baseline within 45 minutes to 2 hours. Patients who experience more severe toxicity or have prolonged toxicity are sent to the ED. The clinical presentation upon arrival to the ED includes hypotension, bradycardia, hypoglycemia, hypoxia, and hypothermia. Of patients seen in the ED, 3/12 presented with seizure-like activity. One patient was intubated for hypoxic respiratory failure. He was extubated on hospital day 3. 6/12 patients were admitted, and 6 were discharged after an observation period in the ED.

Discussion: Similar previous misuse of substances containing insecticides have been reported in Indiana and Kentucky; however, to our knowledge, "strips" use in prison settings has never been described in the literature. "Strips" are suspected to contain synthetic pyrethroids. Pyrethroids produce sympathetic activation, salivation, hyperexcitability, and seizures. Misuse of these household products is uncommon and is reported to give the user a methamphetamine-like high, likely from the sympathetic activation that results from pyrethroid intoxication. Other drugs contained in "strips" may include synthetic cannabinoids and opioids.

Conclusions: Substance use among inmates is a common scenario. "Strips" are an emerging public health threat within our local jail population. Most patients exhibit a self-limited illness with a mix of neurologic, respiratory, and gastrointestinal symptoms. Most are effectively managed with supportive care. In the near future, we plan to characterize exact substances found in "strips" with testing of the drug samples themselves as well as blood testing of patients presenting to the ED.

KEYWORDS Strips; drugs of abuse

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106. Designer benzodiazepines are not your parents' benzo's and can kill

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Background: Benzodiazepines (BZDs) are a family of psychoactive compounds used clinically for their anxiolytic, hypnotic, and anticonvulsant effects. In recent years, structurally modified designer BZDs have emerged from clandestine labs. Bromazolam is a triazolobenzodiazepine first synthesized in 1976, but never brought to market; however, clandestine labs have synthesized and marketed it online. In 1988, Congress passed the Anti-Drug Abuse Act and established the Joint Federal Task Force to eradicate clandestine laboratories. We describe a case of a patient who purchased bromazolam online, and developed acidosis, cerebral edema, and cardiac arrest.

Case report: A 27-year-old male with a history of BZD and opioid use disorder was found down at home and was transported by family to the emergency department (ED). On arrival the patient was cyanotic and in cardiac arrest. Initial cardiopulmonary resuscitation had been performed, followed by advanced cardiac life support measures in the ED. The patient received "several doses" of naloxone and flumazenil with no change. The urine drug screen was positive for BZD. The patient was flown to a hospital with a higher level of care. The patient was intubated, but quickly developed acidosis and multiple neurological deficits including cerebral edema. He was not a candidate for extracorporeal membrane oxygenation due to the suspected anoxic brain injury. In the intensive care unit, the patient was treated with intravenous fluids, sodium bicarbonate, norepinephrine, epinephrine, vasopressin, and dopamine. Pupils were fixed and dilated. Vital signs showed blood pressure 97/85 mmHg, pulse 129 beats per minute, respirations 32 per minute, and temperature 97.6 degrees. Blood gas showed pH 7.06, CO2 34.8, oxygen 130, and bicarbonate 10. The patient passed large amounts of bloody stool. He died from cardiac arrest on hospital day 2,

approximately 30 hours after presentation. Notably, the patient had presented to the ED two days prior with a bromazolam overdose but had left against medical advice after flumazenil administration. The family produced a receipt showing the purchase of bromazolam (2 mg/mL; 30 mL vial) with instructions to take a "dropperful"; the product was acquired from novelscienceshop.com for $39.99 USD.
Discussion: Non-pharmaceutical benzodiazepines from clandestine laboratories can have increased potency and unusual pharmacokinetics that make their level of central nervous system depression less predictable and present a challenge to staff who primarily manage pharmaceutical benzodiazepine overdoses. This clinical effect is potentiated when combined with other sedative/hypnotic co-ingestions, which are common. Most people that use these drugs for recreational use do not plan on dying from them, but it happens regularly – over 110,000 times a year. Several states have established clandestine drug laboratory eradication programs.
Conclusions: Increased funding for state programs to eradicate clandestine laboratories is needed. Given the growing prevalence of BZD use, clinicians need to understand the pharmacology and toxicology of these compounds to develop effective treatment strategies and prevent patient harm.

KEYWORDS Designer benzodiazepines; clandestine labs.; benzo fatality
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107. Renal failure after ingestion of lysergic acid diethylamide sold as "magic mushroom" candy bar

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Background: The use of psilocybin, "magic mushrooms," and other hallucinogens date back to ancient times. In recent years, there has been growing interest in research and a push to decriminalize the substances for mental health disorders and chronic pain. One study found an almost three times increase in hallucinogenic use in 2020 compared to 2019. With growing popularity, it has become easier to obtain over the internet in various forms such as mushroom caps, pills, gummies, and chocolates. Studies have analyzed adulterations or "cutting agents" for other street drugs, however there is scant data published covering the harmful effects of "street magic mushrooms." How well do we know the ingredients and quantity in such substances that are not FDA approved?
Case report: 28 y/o M, with a history of keratoconus, corneal neuralgia, presented to the emergency department with five days of nausea, vomiting, diarrhea, and blurry vision. After being discharged for possible enterocolitis, he returned with similar symptoms demonstrating worsening acute kidney injury, thrombocytopenia, and eosinophilia. During this stay the patient endorsed that just prior to his symptoms he took a large amount of "magic mushroom" chocolate. He developed oliguria, was admitted to the intensive care unit, and was started on dialysis. He was worked up for possible microangiopathic hemolytic anemia, vasculitis, and accidental nephrotoxic mushroom ingestion, treated with supportive care and corticosteroids. A sample of the chocolate bar was submitted for targeted analysis and suspect screening facilitated by liquid chromatography-quadrupole time-of-flight mass spectrometry (LC-QTOF/MS). No psilocybin, psilocin or other compounds typically associated with magic mushrooms were found. Instead, lysergic acid diethylamide (LSD) at 1.53 ug/g chocolate was confirmed. Renal biopsy was consistent with acute tubulointerstitial nephritis. After nine days, he was weaned off dialysis and ultimately discharged from the hospital with minimal complications.
Discussion: Foraging for mushrooms requires experienced mushroom hunters to correctly identify specific hallucinogenic species rather than their toxic mimics. The medical team considered adulteration with orellanine (*Cortinarus* sp.) and allenic norleucine (*Amanita smithiana*) as an explanation for his renal failure. Literature search demonstrates cases of young adults developing interstitial nephritis after accidental *Cortinarius orellanus* toxicity masked as "magic mushroom" ingestion. However, the pathology report for our patient concluded that LSD was present and found no compounds consistent with mushroom poisoning. LSD has been correlated with rhabdomyolysis and consequently renal injury, and while this is a possibility for our patient, his labs and renal biopsy are not consistent with the diagnosis.
Conclusions: This case brings to light the variety of non-FDA approved substances being sold over the internet. Furthermore, with the relative ease and decreased cost of synthetic hallucinogens such as LSD compared to the cost of consistently producing psilocybin, the products are ripe for mislabeling in the future. It is paramount for care providers to keep an open differential when considering the different possible toxicities and exposures when evaluating a patient who ingested one of these products.

KEYWORDS Magic mushroom; renal failure; lysergic acid diethylamide
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108. Diffuse pulmonary hemorrhage in an adolescent: rethinking the differential diagnosis during an opioid overdose epidemic

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Background: Adolescent overdose rates have risen in the past 3 years with the CDC reporting that median monthly overdose deaths among persons aged 10–19 years increased 109%. This has been attributed to illicitly manufactured fentanyls. This health crisis highlights the need for interventions to better care for our youth as well as the recognition of common and uncommon presentations of opioid overdoses. We present the first case to our knowledge of an inhaled illicit m-30 pill leading to diffuse pulmonary hemorrhage in an adolescent.
Case report: A 17-year-old male with depression, multiple suicide attempts, and substance use disorder presented to the emergency department (ED) after being found unresponsive. He received naloxone en route with clinical improvement. On arrival to the ED, he reported that he smoked what he believed was "Percocet" after crushing the pill, heating it on aluminum foil and inhaling the fumes. During observation, he developed altered mental status refractory to naloxone and was intubated for airway protection. Bleeding was noted from his nares and oropharynx concerning for massive pulmonary hemorrhage. He was taken for imaging with computed tomography (CT) angiogram of the head/neck and CT chest with findings consistent with diffuse pulmonary hemorrhage. His complete blood count, serum chemistries and coagulation studies were normal. He had elevations in his creatinine kinase to 331 units/L, troponin to 1,597 ng/L, and lactate to 2.36 mmol/L. Additionally, he was incidentally positive for coronavirus (COVID-19). Initial toxicology screening labs were negative, with ethanol $<$ 3 mg/dL, acetaminophen 2 ug/mL, salicylate 3 mg/dL, and an undetectable toxic alcohols panel. His in-house urine drug screen was positive

for benzodiazepines (post-intubation) and negative for opiates. However, fentanyl is not included on this screen and a separate fentanyl urine drug screen was not obtained at this time. On hospital day three, his comprehensive urine drug screen resulted positive for norfentanyl and fentanyl as well as acetaminophen, norketamine, ketamine, midazolam, and fluoxetine. By hospital day four, he was weaned off vasoactive support and extubated to room air. He was then transferred to the acute care floor to complete a sedation wean and further care coordination.
Discussion: Diffuse pulmonary hemorrhage is a rare complication of opiates. Inhaling illicit pills containing fentanyl by "smoking" them is the most common form by which adolescents are abusing these pills. In pediatrics, the differential diagnosis for pulmonary hemorrhage typically includes autoimmune conditions, infectious diseases, or trauma. However, substance use is an atypical presentation, and it is prudent to recognize this previously uncommon connection. Furthermore, it is important that we do not rely solely on urine drug screening to identify and detect substance use in our patients.
Conclusions: This case highlights the relationship between diffuse pulmonary hemorrhage and substance use. Education on the trends and dangers of adulterated substances should be part of our efforts in combating the increasingly fatal opioid overdose epidemic. This case also emphasizes the importance of monitoring following an opioid overdose.

KEYWORDS Pulmonary hemorrhage; opioids; adolescent

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109. Not the usual rub – a case report of severe toxicity from isopropanol ingestion

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Background: Isopropanol, or isopropyl alcohol, is a frequently reported ingestion given its ubiquity and accessibility. Most cases involving isopropyl alcohol ingestion are mild, and patients typically do well with supportive care alone. We present a case in which a patient manifested severe toxicity after confirmed isopropanol ingestion, ultimately requiring intubation, vasopressor support and hemodialysis.
Case report: A 50-year-old male with a history of alcohol use disorder presented to the Emergency Department (ED) after being found unresponsive by his family. He reportedly ingested a 1- liter bottle of isopropanol around 20 hours prior to arrival. The patient was hypoxic and intubated immediately upon hospital presentation. His initial vital signs were: BP, 89/43 mmHg; HR, 110 beats/minute; RR, 12 breaths/minute; T, 97.7°Fahrenheit; O_2 Sat, 100% (FiO_2 100%). His laboratory studies were significant for pH, 6.97; PCO_2, 53 mmHg; HCO_3, 12 mmol/L; lactate, 10 mmol/L; creatinine, 2.8 mg/dL; initial anion gap, 20 mEq/L; osmolar gap, 101 mOsm/kg; ethanol was undetectable; urine was negative for ketones. Given the patient's severe acidemia, apparent kidney injury, and oliguria, hemodialysis was attempted, however the patient became hemodynamically unstable and was placed on continuous veno-venous hemofiltration (CVVH). The patient ultimately required vasopressor support with IV norepinephrine, vasopressin, and phenylephrine. Over the next several days, the patient was weaned off the vasopressors. He was extubated on hospital day five and returned to his normal baseline mental status. Laboratory studies drawn on arrival revealed a serum isopropanol concentration of 189 mg/L and acetone 193 mg/dL; with negative ethylene glycol and methanol concentrations.
Discussion: Isopropanol is commercially sold as rubbing alcohol and is a frequently reported ingestion. It is rapidly absorbed in the gastrointestinal (GI) tract and is metabolized by alcohol dehydrogenase to acetone. Both parent compound and acetone are thought to contribute to toxicity. Clinically, isopropanol poisoning predominantly presents with central nervous system (CNS) and respiratory depression, though local irritation of mucosal surfaces can lead to GI disturbances. Laboratory studies will classically show ketosis without acidosis. The nitroprusside reaction that tests for urine ketones is most sensitive for acetoacetate and less so for acetone, which is likely why the patient's urine was negative for ketones. Most patients with isopropanol poisoning do not require any treatment beyond supportive care. Mild acidosis resulting from isopropanol poisoning has been suggested to occur due to severe hypotension or respiratory depression. However, patients with significant ingestions can exhibit respiratory and circulatory collapse and metabolic derangements including severe metabolic acidosis and renal failure. The reason for this variability in severity of presentation is unclear. Though this patient's measured isopropanol concentration was relatively low, his elevated acetone concentration suggests that he metabolized a significant amount prior to presentation. Thus, his delayed presentation and metabolic derangements may have also contributed to the severity of his illness.
Conclusions: Some patients with isopropanol poisoning can present with severe morbidity, though the reason behind why this variability occurs is unclear and further investigation is warranted.

KEYWORDS Isopropanol; acetone

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110. A case of the inpatient hospital stay blues

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Background: Jungle® Juice Platinum is a volatile solvent marketed as a cleaner but its recreational misuse as an inhalant "popper" is common. It contains isobutyl nitrite 90% a vasodilator used to enhance sexual performance by relaxing the involuntary muscles of the anus, throat, and vagina. While low doses can produce mild euphoria and arousal, overdose can cause headache, flushing, hypotension, reflex tachycardia and methemoglobinemia.
Case report: A 30-year-old female with a history of alcoholism, cirrhosis, and psychiatric comorbidities, was admitted to the hospital for hematemesis related to drinking and started on an alcohol withdrawal protocol. Four days into her hospital stay she suddenly became hypotensive with a blood pressure of 50/40, and her oxygen saturation dropped to 91% despite being on 10 liters of oxygen. Her blood was noted to be very dark when an intravenous tube was placed for fluid administration. She admitted to inhaling 3 puffs of Jungle® Juice Platinum to ease her anxiety and speed up her alcohol withdrawal treatment. Her methemoglobin level resulted as an unmeasurable value $>$ 20%. The treating team was concerned for additive serotonergic effects with methylene blue because her medications included escitalopram, trazodone and buspirone. She was given 1 dose of 1 mg/kg methylene blue, which dropped her methemoglobin level to 18.7% in a few minutes. A repeat methemoglobin level measured a few hours later was back in the normal physiologic range of 1%. She recovered from the nitrite exposure within 12 hours.

Discussion: Nitrites are commonly used recreationally, but in this case, the patient used it therapeutically to relax and aid her alcohol withdrawal. Nitrites can act as a pool of nitric oxide, which acts as a messenger in the central nervous system and may mediate the effects of alcohol. The first-line treatment for methemoglobinemia is methylene blue, but it can exacerbate serotonin syndrome due to monoamine oxidase A inhibition, especially in patients taking other serotonergic agents. Ascorbic acid is a less effective alternative.
Conclusions: Nitrite misuse can occur even in the inpatient population. Early recognition and prompt treatment with methylene blue can help manage morbidity.

KEYWORDS Nitrites; methemoglobinemia; poppers
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111. 3, 2, 1: Novel use of clonidine patch to treat tizanidine withdrawal

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Background: Tizanidine is commonly prescribed for muscle spasticity and pain. Yet, withdrawal is rarely reported. Tizanidine stimulates presynaptic α-2 adrenergic and imidazoline receptors decreasing norepinephrine release. Abrupt cessation can cause withdrawal. Clinical manifestations include tachycardia, hypertension, tremor, spasm and anxiety. Current treatment strategies include tapering oral tizanidine or substituting oral clonidine.
Case report: A 53-year-old man with a history of hypertension, diabetes, coronary artery disease, and chronic back pain presented with altered mental status, agitation, hypertensive emergency (BP 250/145 mmHg) and tachycardia. Diagnostic testing revealed kidney injury and a non-ST elevation myocardial infarction. The patient had been prescribed tizanidine for chronic back pain for 2 years and had recently run out with suspicion of misuse. Tizanidine withdrawal was diagnosed, and he improved with clonidine 0.1mg PO TID weaned over 5 days while hospitalized. Tizanidine was discontinued. One month later the patient was admitted for persistent hypertension, tachycardia, diaphoresis, and anxiety. α-2 agonist withdrawal was again diagnosed. He had been taking 30 mg tizanidine daily, obtained online. Substance use counseling was recommended, and a 0.3 mg clonidine patch was administered to improve compliance and provide gradual withdrawal treatment. The patch dose was decreased weekly (0.2 mg/day week 2, 0.1 mg/day week 3). All tizanidine was discontinued. After inpatient patch initiation, the adrenergic signs and symptoms improved. The patient had normal vitals at a follow-up appointment 3 days after discharge.
Discussion: Clonidine acts similarly to tizanidine and is available in both oral and transdermal formulations. Use of transdermal clonidine specifically may improve treatment compliance. Therapeutic transdermal clonidine concentrations are reached within 2–3 days after initiation. Utilizing a clonidine patch taper may offer a reasonable approach in patients with tizanidine withdrawal. Furthermore, α-2 agonist withdrawal must remain in the differential of patients exhibiting otherwise unexplained adrenergic signs and symptoms. Utilizing alternatives to opioid medications for pain management is critical in the ongoing opioid epidemic. However, these alternatives may also produce adverse effects, toxicity, and even withdrawal if not properly managed. Therefore, recognizing drug-induced toxidromes and withdrawal states remains critical.
Conclusions: We present a novel and effective treatment for tizanidine withdrawal involving a transdermal clonidine taper.

KEYWORDS Tizanidine withdrawal; clonidine taper
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112. Marchiafava-Bignami disease as a rare cause of toxic leukoencephalopathy in a 27-year-old patient

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Background: Marchiafava-Bignami disease (MBD) is a rare disorder characterized by demyelination and necrosis of the corpus callosum. The etiology is unclear but is attributed to direct alcohol-induced toxicity as well as B-complex vitamins deficiencies. Clinical features are variable and nonspecific, and can include dementia, altered mental status, spasticity, dysarthria, ataxia, gait abnormalities, and seizures. We report a case of the second youngest patient in the literature who developed MBD due to alcohol use disorder and gastric bypass with medication noncompliance, who was found to have an undetectable serum thiamine level.
Case report: A 27-year-old female with a history of alcohol use disorder and Roux-en-Y in 2018 presented to the emergency department complaining of stroke-like symptoms. She had chest pain, right facial droop, right arm weakness, and difficulty speaking just prior to presentation, but her deficits had resolved by the time she was evaluated in the ED. Her CTA head/neck were normal. Neurology was consulted and recommended further stroke workup including MRI and the patient was admitted. The patient's MRI showed abnormal T2 hyperintensity and diffusion restriction involving the splenium of the corpus callosum and bilateral frontoparietal lobes, consistent with toxic leukoencephalopathy. The patient had a similar episode of chest pain, right-sided weakness, and facial droop following her MRI. Medical toxicology was consulted for her abnormal MRI. During the patient interview, the patient reported daily alcohol use as well as noncompliance with her vitamin supplementation that was recommended after her Roux-en-Y surgery. Serum thiamine, folate, and B12 levels were recommended and sent. The patient was found to have normal serum folate and B12 levels; however, her serum thiamine level was undetectable. She had no other TIA-like symptoms during the rest of her hospital stay, and she was discharged to a rehabilitation facility with prescriptions for vitamin supplementation, repeat MRI, and neurology follow-up.
Discussion: MBD is most reported in patients with alcohol use disorder that puts them at risk for vitamin deficiencies, with a mean age of onset of 45. There are published cases of MBD as of 2001 according to one study, and only a handful of cases reported to the literature of patients in their 20s with suspected MBD based on radiographic findings. To our knowledge, this patient is the youngest patient reported in the literature to have MBD with a confirmed undetectable serum thiamine level. Diagnosis is difficult and because of the paucity of cases reported in the literature, there are no standard management guidelines. Most case reports show favorable response to treatment modalities used in Wernicke-Korsakoff syndrome.
Conclusions: Though typically a disease in older patients, young patients with significant risk factors can develop MBD. A high

index of suspicion, thorough medical and surgical history, and serum thiamine concentration can assist in diagnosis of MBD.

KEYWORDS Ethanol; toxic leukoencephalopathy; vitamin deficiency

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113. Nicotine toxicity from repeat use of nicotine pouches

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Background: Nicotine is an alkaloid derived from tobacco leaves and is the primary addictive ingredient in tobacco products. Tobacco products are typically consumed by smoking cigarettes which do not deliver high concentrations of nicotine, thus limiting acute toxicity in adults. Modern products, like e-cigarettes, contain concentrated liquid nicotine and are implicated in an increasing number of toxic exposures. Nicotine pouches have emerged as another novel way to administer concentrated nicotine and come as a white powder in flavoured, microfiber pouches placed between the cheek and gums to dissolve. This is the first case of acute nicotine toxicity through nicotine pouch use that we identified in the literature.
Case report: A 21-year-old male presented to the ED by ambulance with altered mental status after he was noted by his brother to be acting bizarrely. He was a non-smoker. His brother reported that the patient had used 15 extra strength nicotine pouches (10.9 mg/pouch) over the course of a 12-hour period as a study tool to prepare for next day exams. He also used 1 t (20 mg) of amphetamine/dextroamphetamine 24 hours prior to presentation. He initially presented somnolent and diaphoretic, producing non-sensical answers to questioning. His blood pressure was 184/99, heart rate 99, respiration rate 17, oxygen saturation 98% and temperature 36.3 °C. His pupils were mydriatic (7 mm) and reactive. He was tremulous, however there was no focal weakness, muscle fasciculations, or clonus. Electrocardiogram and a non-contrast computed tomography scan of the head were unremarkable. His bloodwork demonstrated an elevated creatinine (118 umol/L), for which he was treated with intravenous fluids (IVF) but was otherwise unremarkable. He was admitted for monitoring and supportive care, and over the next 12 hours continued to be confused, mildly agitated and hypertensive requiring IVF. 24 hours post-presentation he had returned to his baseline and was discharged home. Qualitative serum testing by LC-MS/MS detected amphetamine, nicotine, and cotinine (nicotine metabolite), negative for all other substances.
Discussion: Our patient was exposed to 163.5 mg of nicotine over a 12-hour period, which led to altered mental status and hypertension. While he did endorse taking 1 t of amphetamine/dextroamphetamine (confirmed in serum) it did not drive his presentation, given the prominent feature of confusion and inability to communicate with a lack of hyperthermia and tachycardia. With the declining sales of nicotine cigarettes, tobacco companies have marketed several novel nicotine delivery methods to increase uptake among a modern audience. Nicotine pouches are promoted among social media forums as study aids and safe alternatives to smoking. The packages lack clear warning labels, and upon discharge, our patient admitted he had not realized could be harmful, reinforcing the serious risk for inadvertent overdose.
Conclusions: Nicotine pouches are emerging as a novel way to use nicotine and due to their aggressive marketing and lack of warning labels, present a serious risk for inadvertent overdose and harm, especially among young adults. Healthcare professionals should be aware of this risk and ensure the public is cautioned appropriately.

KEYWORDS Nicotine; tobacco

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114. Double jeopardy: sequential seizures following serial naloxone administrations in a tramadol overdose

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Background: Tramadol is a synthetic opioid analgesic, which acts as a mu opioid receptor agonist and inhibits serotonin and norepinephrine reuptake. Tramadol has incompletely understood proconvulsant properties, but serotonergic activation, gamma-aminobutyric acid inhibition, and glutaminergic activation are likely contributory. Naloxone reverses respiratory depression caused by tramadol overdose; however, the use of naloxone in patients with tramadol overdose is controversial because of its possible role in potentiating or precipitating seizures.
Case report: An 18-year-old man without significant past medical history was found by his mother unresponsive and cyanotic near a bottle of tramadol 50 mg extended-release pills, of which approximately 50 were missing. At the time of emergency medical services' arrival, the patient had agonal respirations, miotic pupils, and did not respond to sternal rub. First responders ventilated the patient with a bag valve mask (BVM) and then administered 2 mg of intravenous (IV) naloxone. The patient immediately experienced a generalized tonic clonic seizure, which abated after administration of 2 mg IV lorazepam. Minutes later, he became apneic again and was given another 2 mg IV naloxone. He then experienced a second seizure, which terminated after he received 4 mg IV lorazepam. Upon arrival to the emergency department (ED), the patient was unresponsive with miotic pupils and intermittently apneic. His initial vital signs were: BP, 98/42 mm Hg; HR, 102 beats/min; RR, 20 breaths/minute; T, 98.1°Fahrenheit; O_2 Sat, 78–82% (on 15L/min O_2 via non-rebreather). He became combative when providers initiated BVM ventilation and required sedation with lorazepam and ketamine to facilitate pre-oxygenation prior to endotracheal intubation for airway protection. Laboratory studies drawn on arrival demonstrated a serum tramadol concentration of 2,000 ng/mL and *O*-desmethyl-tramadol (M1 metabolite) concentration of 300 ng/mL. He was admitted to the pediatric intensive care unit and had no further seizure activity throughout his hospital course. He was extubated on hospital day 2 and ultimately discharged home on hospital day 7 at his baseline mental status.
Discussion: Seizures occur in an estimated 15–35% of tramadol overdoses. The literature is divided on whether naloxone modifies the risk of seizure in patients with tramadol overdose. One randomized controlled trial demonstrated naloxone increases seizure risk, while several observational studies found no increased risk. We report a patient with an acute tramadol overdose who experienced two seizures, each of which occurred immediately following administration of naloxone. Following a single 100 mg oral dose of tramadol, expected peak plasma concentrations of tramadol and *O*-desmethyl-tramadol are 230–300 and 35–75 ng/mL, respectively. This patient's ingestion was

confirmed with significantly supratherapeutic tramadol and *O*-desmethyl-tramadol concentrations. While our case represents a single patient, the distinct temporal relationship between each of the patient's seizures and naloxone administration is no.
Conclusions: When administering naloxone to patients with tramadol overdose, providers should be aware of the possibility of precipitating seizures and be prepared to treat with benzodiazepines. Further research into the pharmacodynamic relationship between naloxone and tramadol is needed to elucidate whether naloxone increases seizure risk in tramadol overdose.

KEYWORDS Tramadol seizures; naloxone induced seizure tramadol overdose; tramadol overdose

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115. Heptatotoxicity associated with chronic tianeptine exposure

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Background: We report on a case of a 37-year-old male who developed acute hepatitis and delirium after taking an over-the-counter "natural supplement" primarily containing tianeptine and phenibut for anxiety and opioid use disorder.
Case report: He reports a history of opioid use disorder for which he had also been occasionally indulging in kratom but had most recently and consistently been taking 15 capsules of "SPAR Gold" daily for 5 months. Prior to his admission, he had been seen in surrounding emergency departments for bizarre behavior, diffuse shock like paresthesia, chest pressure, shortness of breath as well as right upper quadrant pain. On the penultimate visit to the emergency department, he had started developing elevations in his liver enzymes (ALT:546, AST:283) which prompted imaging including CT and ultrasound of the right upper quadrant. He was then discharged with outpatient GI follow-up. The next day he presented to a different emergency department with continued chest pain, shortness of breath as well as paranoid delusions. On this visit, he was found to have an ALT of 6931 and AST of 4911 at which point toxicology was consulted and N-Acetyl Cysteine (NAC) was started empirically. On bedside evaluation and after laboratory and literature review it was concluded that his paranoid delusions and agitation were likely related to phenibut withdrawal and his liver enzyme elevations were thought to be related to chronic tianeptine abuse. He was continued on NAC and provided further supportive care with improvement in his liver enzymes and mental status. Ultimately, he refused further drug counseling, and rehabilitation and left against medical advice three days later.
Discussion: Tianeptine is a tricyclic antidepressant not approved for use in the United States and is currently banned in Michigan, Minnesota, Alabama, Tennessee, Alabama, Indiana, Mississippi, and most recently Kentucky. It works as an atypical mu-opioid receptor agonist without significant kappa or lamba opioid effects. It is also thought to modulate glutamate receptors which may explain its antidepressant and anxiolytic effects. Literature has reported on its probable mechanism to produce microvesicular steatosis thought to be secondary to impaired mitochondrial beta-oxidation of fatty acids. Similar hepatotoxic effects were noted in humans with another atypical tricyclic, amineptine, which was approved in France for clinical depression in 1978 and subsequently suspended in 1999 for concerns over abuse. Tianeptine is still available for the treatment of major depressive disorder in France, other parts of Europe, Asia, and Latin America.

KEYWORDS Tianeptine; phenibut; hepatotoxicity

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116. Survival in persons receiving cardiopulmonary resuscitation in the field for suspected opioid overdose

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Background: Survival of out-of-hospital cardiac arrests (OHCA) remains low due to the complex and time-sensitive nature of emergency care in the prehospital setting. The overall survival to hospital discharge following all-cause OHCA has been previously studied and reported by the American Heart Association, Sudden Cardiac Arrest Foundation, Cardiac Arrest Registry to Enhance Survival, and others. Survival to hospital discharge from OHCA due to opioid overdose has not been studied. A statewide overdose response directive was established in 2019 in our state. It requires that all 150 emergency medical system (EMS) companies report suspected opioid overdoses to the regional poison center. This study aims to identify patients who received cardiopulmonary resuscitation (CPR) for suspected opioid overdoses and determine the overall survival to hospital discharge.
Methods: A retrospective cohort study of all suspected opioid overdose events reported to a regional poison center from 1 July 2019 to 31 December 2022 (3.5 years) was conducted. Inclusion criteria: suspected opioid overdose identified by EMS, received CPR (bystander or EMS-administered) in the field. Exclusion criteria: unable to follow up due to missing data. Demographic variables were collected including age, gender, and ethnicity. Each narrative was reviewed and data on CPR, naloxone administration, return of spontaneous circulation (ROSC), disposition following emergency department (ED) encounter, and final disposition following admission to hospital was collected.
Results: A total of 1272 cases were analyzed. Of these, 422 (33.2%) did not have ROSC and died in the field. Of the remaining 850 with ROSC, 19 (2.2%) refused transport to ED. Of the 831 patients with ROSC transported to the ED, 432 (52.0%) were discharged from ED, 248 (29.8%) were admitted to the hospital with the diagnosis of opioid overdose, 46 (5.5%) patients were diagnosed with other serious illnesses (STEMI, arrhythmia, etc.), 42 (5.1%) left against medical advice, and 31 (3.7%) died. Overall, survival to hospital discharge for all 1272 patients was 11.2% (143/1272). Survival for patients admitted to the ICU was 49.7% and survival for those admitted to medical floor was 100%. Only 4.0% of patients were lost to follow up.
Conclusions: In 2016, the Institute of Medicine reported that less than 6% of people who experience all-cause cardiac arrest outside the hospital survive to hospital discharge. In 2017, a multi-state public health initiative, HeartRescue, reported an 11.4% overall survival following OHCA from presumed cardiac etiology. In 2020, the Cardiac Arrest Registry to Enhance Survival (CARES) reported survival to hospital discharge after EMS-treated OHCA was 9%. Our study reported on 1272 patients who received bystander-CPR or EMS-CPR in the field for suspected opioid overdose. Of these, 65.3% (831) achieved ROSC and were transported to the ED. Overall survival to hospital discharge was 11.2% for all patients receiving CPR in the field for suspected opioid overdose. In the future, risk factors associated with survival will be identified.

KEYWORDS Opioid; arrest; survival

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117. A historical look at human exposures reported to the NPDS, 1985–2022

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Background: We took the occasion of the 40th anniversary of America's Poison Centers to consider exposure data from the early days to the present. Although National Poison Data System (NPDS) data are readily available online from 2000 to present, earlier data were created with different generic code standards and format and are not directly available via NPDS Enterprise Reports. Due to these differences, we expected to find apparent discontinuities between early and recent exposure data.
Methods: We examined all closed human single substance exposures from early (1985–1999) and recent (2000–2022) by year for the 68 major generic categories and 188 minor generic categories. Early data were retrieved by HTC Global Services. Although the Association Annual Report 1A includes 1983 and 1984 data, an electronic version for these data is not available. Therefore, these years were exclude. We calculated linear and quadratic change over time for more serious exposures (NPDS medical outcome = moderate, major or death), and morbidity index (MI = serious exposures ×1000/total exposures) for early, recent and combined data by major and minor category. All data management and statistical analyses were via SAS JMP ver 16.2.0 (SAS Institute).
Results: The data included 70,916,632 human exposures including 3,153,151 more serious exposures. Exposures per year (current /early) increased by 1.27 and serious exposures by 2.11. We excluded 3 major categories (exposure cases coded to major categories of Information Call, Narcotic Antagonists, and Weapons of Mass Destruction from the final analyses due to small numbers and suspected coding errors. Over the 38-year period, the greatest change-over-time increases in serious exposures were observed in the following major categories (increase in serious exposures/year): Analgesics (573), Sedative/hypnotics/antipsychotics (323), Antidepressants (303), and Stimulants/street drugs (263); minor categories were Miscellaneous Sedative/Hypnotics/Antipsychotics (329), Pharmaceutical and Illegal Opioid Preparations (243), Miscellaneous Unknown Drug (170), Sedating Antihistamines (166). The results were similar for early and current separate data regressions. 2 shows the MIs of the major categories with > 500,000 exposures. The top 5 major categories by MI were: Stimulants and Street Drugs (194), Antidepressants (158), Sedative/Hypnotics/Antipsychotics (149), Anticonvulsants (136). The top 5 minor categories by MI were: Snakes (535), Lithium Salts (315), Miscellaneous Anesthetics (314), Cannabinoids and Analogs (285), Tricyclic Antidepressants (TCA) (249).
Conclusions: Variability in change-over-time as judged by graphics failed to show inconsistencies at the transition (1999-2000). Morbidity ranking revealed the expected offender substance categories. We were surprised at the lack of discontinuity in the data between early and current exposure data. The remarkable consistency of these long-term data highlight NPDS' reproducible data trends and supports the investment of resources necessary to make these early data more accessible. The consistent trends over 38 years give impetus to the continuing education and prevention efforts of the Association and member centers. The historical dimension of NPDS data bookends the near real-time collection and supports both short-term and long-term data trend evaluation thus providing the infrastructure for detecting and reacting to emerging public health threats.

KEYWORDS Exposure cases; changes over time; morbidity index

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118. Evaluation of the effects of xylazine on fentanyl fatalities using post mortem data

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Background: Xylazine is a central alpha-adrenergic agonist used as a tranquilizer for large animals in veterinary medicine. Increasingly it has been found as an adulterant in illicit fentanyl produced by the various drug cartels. We reviewed the records of the Franklin County Coroner's Office, Columbus, Ohio for all fentanyl-associated fatalities for the presence of xylazine.
Methods: We retrospectively reviewed all fentanyl related fatalities with or without xylazine from 1 January 2019 to 31 March 2023. Analysis on post mortem blood was performed using LC/MS/MS for both fentanyl and xylazine quantitation. Mann–Whitney/Wilcoxon Two-Sample Test was used to evaluate differences between groups.
Results: There were a total of 3,039 fentanyl fatalities among which 148 (4.9%) had xylazine detected. There was a mean of 715 fentanyl fatalities per year with a peak of 807 in 2020. The portion of fentanyl fatalities with xylazine detected increased in linear fashion from 2.8% in 2019 to 7.2% in 2022 (R^2 = 0.97). A decline in annual fentanyl fatalities occurred after 2020 (R^2 = 0.89), while cases with xylazine detected continued to increase. Postmortem fentanyl concentrations were significantly higher ($P < 0.005$) in cases with xylazine detected than those without xylazine: quartiles with median fentanyl concentrations (ng/mL) were 7.9, 16.0 and 26.5 ng/mL in cases with xylazine detected and 5.6, 10.0, 18.0 ng/mL without xylazine, respectively. Post mortem xylazine concentrations in these decedents were (quartiles with median) 8.6, 18.5 and 42 ng/mL, with a range of 3.3–2,755 ng/mL. There was no significant change in postmortem fentanyl or xylazine concentrations over the 4 year study period. Post mortem concentration was not affected by age or gender. The mean and median age of fentanyl fatalities with xylazine detected was 42 and 43 years, respectively, range 19–78 years. Two-thirds (66%) were male. Seventy three percent were white, 24% were African American and 3% were other (biracial non-Hispanic).
Conclusions: There was an increasing percentage of fentanyl-related fatalities with xylazine detected from 2019 to 2022. These deaths occurred primarily in white, male, older adults. A similar but slightly greater annual increase in fentanyl fatalities with xylazine detected has been reported recently in Philadelphia. It is unclear why post mortem fentanyl concentrations were higher in fatalities with xylazine detected. This supports study findings from emergency department overdose patients which showed that xylazine adulteration was associated with less severe outcomes (coma and cardiac arrest). These findings led researchers to postulate that xylazine co-intoxication confers a protective effect, possibly due to decreased opioid dose or concomitant adulteration with other substances, such as novel psychoactives. In our large study set, patients with xylazine detected had significantly higher post-mortem fentanyl levels, therefore decreased total opioid dose in adulterated samples does not appear to account for this protective effect. More study is needed to determine whether these two trends are related and the reasons for this apparent protective effect.

KEYWORDS Xylazine; fentanyl; fatality

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119. An opioid by any other name. Detecting novel opioids on social media using linguistic features

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Background: Each year hundreds of new designer chemicals, including derivatives of fentanyl emerge. These novel drugs and their new names pose a unique challenge for ML/AI models, which are excellent at recognizing recurring patterns but slow to detecting emerging trends and changes in vocabulary. To detect use of novel substances earlier, there is a need to develop tools that can recognize emerging novel substances with limited prior data. Detecting novel substances earlier would prevent mortality by rapidly identifying outbreaks and helping to target resources. Prior studies suggest that, over the last decade, people increasingly refer to drugs online by variations of their chemical name rather than slang terms. Drug names have idiosyncratic spellings, which leads to our working hypothesis that novel psychoactive substances have unique spellings that identify them in online commentary.
Methods: To create a system that recognizes novel synthetic opioids based on spelling and determine its sensitivity and specificity, we identified all unique sequences of 3 letters or more (lexemes) in all substances approved by the Food and Drug Administration or listed on the Wikipedia pages for novel psychoactive substances. We acquired tweets mentioning opioids and compared the ability of lexemes to identify drug names to Med7, a natural language processing model for electronic health records that recognizes drug names.
Results: We identified 497 sequences of letters unique to drug names. We obtained 24,342,393 tweets (10,842,091 unique and in English) of which 6,281,542 explicitly mentioned at least one drug (3,278, 616 mentions of novel synthetic opioids and 3,002,926 of opioids). We manually annotated a random sample of 2,666 tweets. With human curation as the reference standard, our spelling rules-based approach had a sensitivity of 0.922 and specificity of 0.77 compared with 0.672 and 0.841 for Med7. For novel synthetic opioids, the sensitivity and specificity were 0.928 and 0.77 for our approach and 0.67 and 0.85 for Med7.
Conclusions: The spelling of drugs is as sensitive as Med7 in recognizing mentions of opioids from online comments, but less specific. Performance did not depend on whether tweets mentioned opioids or novel synthetic opioids. Models designed rationally from fundamental linguistic features may perform as well as more complex approaches.

KEYWORDS Social media; novel opioids; computational methods

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120. Characteristics of poisoning-associated rhabdomyolysis in various age groups

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Background: Poisoning-associated rhabdomyolysis is the breakdown of muscular tissue that may occur after exposure to many agents. Muscle damage may be caused by repeated muscular contraction, compression from prolonged sedation, or direct myotoxicity and the risks for each of these vary with age. Muscle damage may lead to elevations in serum myoglobin, creatine phosphokinase (CPK), metabolic acidosis, and renal failure. We sought to determine and compare the agents that are associated with, and the clinical characteristics of, toxicant-associated rhabdomyolysis in children, adolescents, adults, and those > 65 years.
Methods: We searched the ToxIC database for the 10-year period from 1/1/2012 to 12/31/2021. ToxIC is a database of cases that are prospectively entered into the registry after bedside consultation by a medical toxicologist. Agents that are primarily responsible for the subject's symptoms are determined by the medical toxicologist. Cases were included if they had a diagnosis of rhabdomyolysis (defined by ToxIC as CPK > 1000IU/L and had at least one agent listed as "primary agent" associated with the toxicity. Cases were excluded if there was no documented age. Pearson Chi-square test was used to test for association of dichotomous outcomes with the 19–35yo group as a comparator.
Results: There were 2450 cases of rhabdomyolysis that were related to poisoning over 10 years. 59 cases were excluded due to unknown age, leaving 2391 study cases. Subject ages ranged from 3mo to 89 yr. The majority of exposures were intentional in all age groups except < 7 yo. There were differences in primary agent in patients with rhabdomyolysis by age (1): children < 13 yo had a higher percentage of envenomation from rattlesnakes, hymenoptera, and recluse spiders; adolescents had a higher percentage of anticholinergics and serotonin toxicity as well as psychoactive substances. Subjects that are 19–50yo had high proportions of stimulants and those > 50 yo and had higher proportions of sedative/hypnotic drugs and opioids. Acute kidney injury (AKI) was present in all age groups, but was a higher percentage of cases in adults (> 19 yo) than children. Compared to adults aged 19–35 yo, the rate of AKI was lower in children < 7 yo (6.3 v. 26%, $P = 0.01$) and children 7–12 yo (8.0 v. 26%, $P = 0.045$). Mortality associated with rhabdomyolysis increased with age. Compared to adults aged 19-35 yo, mortality was higher in those aged 36–50 yo (6.2 v 3.5%, $P = 0.14$), aged 51–65 yo (6.3 v 3.5%, $P = 0.02$), and age 66–80 yo (9.6 v 3.5%, $P = 0.01$).
Conclusions: Poisoning-related rhabdomyolysis occurs in all age groups and there were no differences in associated agents between age groups.

KEYWORDS Rhabdomyolysis; renal failure; mortality

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121. Impact of minimum age requirement increase on teen nicotine-containing product exposures reported to NPDS (January 2015–December 2022)

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Background: E-cigarette utilization has increased over time and has lead to public health concern. In response to the increased use, particularly among teens, federal legislation was passed on 20 December 2019 to increase the minimum age requirement to purchase nicotine-containing products from 18 to 21 years of age. Research is needed to understand this legislation's effect on teen e-cigarette use and all nicotine-containing product exposures.
Methods: Nicotine-containing product exposure data were obtained from National Poison Data System (NPDS) from January

2015 through December 2022. Monthly exposures were analyzed by product type (traditional cigarettes, e-cigarettes, and other/unknown nicotine products), age group (teen: 13-20, adult: ≥21), medical outcome (clinically significant: moderate or worse), and period (pre: 01 January 2015 to 31 July 2019, post: 01 April 2020 to 31 December 2022). A transition period of 20 December 2019 through 31 March 2020 was excluded from the analysis. Exposures occurring between 01 August 2019 and 19 December 2019 were excluded from the analysis to control for a large spike observed in e-cigarette exposures potentially due to the e-cigarette or vaping use-associated lung injury concern and associated media during that time. Rate ratios were calculated to compare all and clinically significant monthly exposures between the pre- and post-periods.
Results: Nicotine-containing product exposures involving teens accounted for 29% of all exposures included in this analysis (n = 4,433/15,184). Overall, 54% of all teen exposures were e-cigarettes, 36% were other/unknown nicotine products, and 10% were traditional cigarettes. Rates of all teen exposures to e-cigarettes did not change between the pre- and post-periods; however, clinically significant e-cigarette exposures increased (pre: 4, post: 8; rate ratio [RR]: 1.89 (95% CI: 1.58, 2.26). Among teen exposures to other/unknown nicotine-containing products, all exposures significantly decreased from an average of 21 exposures per month in the pre-period to 14 exposures per month in the post-period (RR: 0.68 (95% CI: 0.61, 0.76), and clinically significant exposures decreased from 3 to 2 (RR: 0.74 (95% CI: 0.56, 0.96). All traditional cigarette exposures among teens also significantly decreased from 6 to 4 exposures per month (RR: 0.61 (95% CI: 0.49, 0.75). Among adults, all exposures to other/unknown nicotine-containing products increased (RR: 1.18 (95% CI: 1.11, 1.25) as did clinically significant e-cigarette exposures, though by a lesser degree compared to the increase observed among teens (pre: 4, post: 7; RR: 1.48 (95% CI: 1.23, 1.78).
Conclusions: Nicotine-containing product exposures reported to NPDS may have been impacted by the nationwide increase in minimum age required to purchase nicotine-containing products. Rates of all traditional cigarettes and other/unknown nicotine product exposures decreased significantly among teens. While the rates of all e-cigarette exposures were unchanged among both teens and adults, the rate of clinically significant exposures to e-cigarettes nearly doubled. Additional studies should be performed to understand why e-cigarette exposures were not affected by the legislation and to assess the public health impact of the policy.

KEYWORDS Nicotine; age legislation; NPDS

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122. Epidemiology of cnidarian stings reported as jellyfish stings to three statewide US poison centers

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Background: An estimate of 200,000 cnidarian stings occurs in our region's coastal waters annually. Although rarely fatal, these stings can cause severe local symptoms, and significant morbidity, especially in those unfamiliar with its basic management. As a popular destination location for visitors around the world, our region reports various cnidarian stings to our poison control centers (PCC) year-round, but no recent published data has been studied exclusively from our centers. Here, we report the epidemiology of cnidarian stings from our regions three PCCs.
Methods: A retrospective review of all calls to our state's three PCCs for cnidarian stings between 1 January 2013 through 31 December 2022 were obtained and analyzed from the Toxsentry© database. Data obtained included date and time of the exposure, age and gender of the exposed individual, species of cnidaria, exposure site, management site, route of exposure, medical outcome, clinical effects, and treatment. There were no exclusion criteria.
Results: A total of 816 reported cases of cnidarian stings were identified. 649 (79.5%) cases were recorded as jellyfish stings, 155 (19.0%) were as *Physalia physalis* stings, and 12 (1.5%) were recorded as "unknown". There were 433 (53.0%) female cases and 379 (47.0%) male cases. Stings occurred mostly in public areas (n = 507, 62.1%) or private residences (n = 288, 35.3%). Of those with a recorded age, 522 (72.4%) were under 30 years-old with 227 (43.5%) of those occurring in children less than 10 years-old. During the COVID-19 pandemic (2020–2022), 302 cases were reported compared to 166 cases in 2017–2019. An average of 68 cases were recorded per month, with cases peaking in March (n = 121, 14.8%). Dermal irritation occurred in 509 (62.3%) cases, puncture wounds in 442 (54.1%) cases, and erythema in 211 (25.8%) cases. Treatment mostly consisted of irrigation/dilution (n = 549, 67.2%), steroids (n = 140, 17.1%), or antihistamines (n = 91, 11.1%). 317 cases were followed up, with a majority causing only minor effect (n = 270, 85.1%). Of those not followed, all (n = 499) were deemed to have minor or no clinical effect. No fatalities were reported. 614 (75.2%) stings were managed on site (outside of a health care facility), 169 (20.7%) in the Emergency Department, and 33 (4.0%) were unknown. Of those that were evaluated at an Emergency Department, 118 (69.8%) were discharged, 30 (17.8%) were admitted, and 21 (12.4%) left against medical advice (AMA).
Conclusions: A large percentage of cnidarian stings were reported as true jellyfish stings. A majority of those occurred in school-aged children. These stings were slightly more common in females over males. Although cnidarian stings are reported year-round in our area, a slightly higher proportion was noticed during peak visitor months. The volume of calls was noted to increase during the COVID-19 pandemic. Cnidarian stings overwhelmingly caused local dermal symptoms, and most did not require evaluation at an emergency department. The number of cnidarian stings are likely underreported to our PCCs. PCCs play an important role in guiding callers through appropriate cnidarian sting management and can help prevent unnecessary emergency department evaluation.

KEYWORDS Cnidaria; envenomation; poison center

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123. A comparison of vitreous fluid and blood matrices in postmortem drug analysis

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Methods: Vitreous humor (VH) from one or both eyes was collected and analyzed using liquid chromatography–mass spectrometry (LC-MS) in 66 postmortem cases in southwestern and southcentral Pennsylvania over a period of 8 months. All specimens included in the study contained at least one of the following analytes: 6-acetylmorphine (6-AM), Morphine (MOR), Fentanyl (FENT), Norfentanyl (NORF), Cocaine (COC), and Benzoylecgonine (BZE). To determine the utility of vitreous fluid analysis compared to traditional whole blood analysis for these analytes, blood specimens were analyzed alongside vitreous specimens and compared.
Results: When VH was compared to whole blood there was no significant differences in the detection rates of fentanyl, BZE, and morphine. There were increased detection rates in both 6-AM

and cocaine. Additionally, 6-AM concentrations were increased in VH compared to whole blood.
Conclusions: This increased detection rate and concentration could prove to be a useful screening test when preforming toxicological analysis.

KEYWORDS Vitreous humor; liquid chromatography–mass spectrometry (LC-MS); 6-AM

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124. Battery ingestions by dogs reported to poison centers

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Background: Because of their common presence in the home, there is a risk that batteries may be ingested by dogs. If the battery becomes lodged in the dog's esophagus, injury may result through direct pressure against the surrounding tissues, leakage of the alkaline electrolyte from those types of batteries that contain such substances, and generation of external current that causes electrolysis of fluids in the surrounding tissues, producing hydroxide. The objective of this study was to describe battery ingestions by dogs reported to poison centers that primarily manage human exposures.
Methods: Cases were battery exposures (Generic codes 0077230, 0077231, 0077232, 0077233, 0265000, 0265230, 0265231, 0265232, 0265233, 0265234, 0265235, 0265236) reported to a large, statewide poison center network during 2000-2021 where the exposure route was ingestion, the patient species was animal, and the animal type was dog. The distribution of cases was determined for various factors.
Results: A total of 443 battery ingestions by dogs were identified. The type of battery was 376 (84.9%) pen/flashlight/dry cell battery, 54 (12.2%) disc battery, 9 (2.0%) other battery, and 4 (0.9%) unknown battery. There were 123 (27.8%) ingestions during December–February, 103 (23.3%) during March-May, 112 (25.3%) during June-August, and 105 (23.7%) during September–November. The ingestion occurred at the home of the dog's owner or caregiver in 320 (72.2%) cases, 1 (0.2%) at another residence, and 122 (27.5%) at an unknown location. The management site was 285 (64.3%) on site (outside of a healthcare facility), 150 (33.9%) at a healthcare facility or other location (possibly a veterinarian facility), and 8 (1.8%) at an unknown location. A clinical effect was reported in 77 (17.4%) of the cases. The most frequently reported clinical effects were vomiting (n = 32, 7.2%), oral irritation (n = 20, 4.5%), excess secretions (n = 9, 2.0%), drowsiness/lethargy (n = 7, 1.6%), and oral burns (n = 4, 0.9%). The ingestion was not serious (no effect, minor effect, moderate effect, not followed-judged nontoxic, not followed-minimal effects possible) in 298 (67.3%) cases, serious (moderate effect, major effect, unable to follow-potentially toxic) in 143 (32.3%), and unrelated to the ingestion in 2 (0.5%); no deaths were reported, although the poison center network generally does not follow animal exposures to determine final outcome. A treatment was documented in 211 (47.6%) of the cases. The most frequently reported treatments were dilute/irrigate/wash (n = 178, 40.2%) and food/snack (n = 28, 6.3%).
Conclusions: This study found that battery ingestions by dogs most often occur at the owner's own home. There was no apparent seasonal pattern to the ingestions. Although a greater proportion of cases did not result in serious outcomes, a significant number did have serious effects.

KEYWORDS Dogs; battery; disc battery

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125. Clinical impact of fomepizole as an adjunct therapy in massive acetaminophen overdose

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Background: N-acetylcysteine (NAC) therapy is considered the standard of care for acetaminophen (APAP) overdose (OD). Fomepizole use in massive APAP exposures is postulated to be a potential adjunct therapy with limited supportive data. Effectiveness has not been proven and fomepizole's indication, optimal timing and dosing is unknown. The study objective was to compare the timing of fomepizole initiation to peak AST and clinical outcomes after massive APAP overdose.
Methods: This study was an Institutional Review Board approved retrospective chart review of massive APAP ODs reported to the Poison Center from 1/1/2018 to 12/31/2022. Exposure calls in patients ages 0–100 with a massive APAP ingestion (level of $\geq$300 mcg/mL at any time OR multiplication product of $\geq$10,000 on initial lab evaluation) treated with NAC AND at least 1 dose of fomepizole met inclusion criteria. Patients with a toxic alcohol ingestion, known history of ethanol abuse, co-ingestion of hepatotoxic drugs, and patients not followed for at least 24 hours from fomepizole administration were excluded. Demographic, clinical, treatment data and National Poison Center Data System (NPDS) outcome codes were collected. Patients were placed into two groups: Group S (fomepizole started the same day as NAC) and Group D (fomepizole started $\geq$ 1 day after NAC). Basic descriptive and bivariate analysis were performed in SPSS Statistics v29.
Results: A total of 111 patients were screened and 41 met inclusion criteria (Group S = 22; Group D = 19). The average age was 42.5 ± 23.2 years, 31% (13) were males, four total deaths and one patient received a liver transplant. All but one patient in group S and all patients in group D were treated with an initial fomepizole dose of 15 mg/kg. The average number of additional fomepizole doses in Group S was 1.6 ± 0.51 and in Group D was 1.4 ± 0.54. Group S had significantly lower peak AST levels (P = 0.034) and total days of NAC therapy (P = 0.046) compared to Group D. Group S had fewer deaths/major outcome designations than Group D, but this was not significantly lower (P = 0.074). There was no difference between groups for ICU length of stay. Additionally, there was no difference between groups related to when NAC was initiated.
Conclusions: The use of fomepizole as an adjunct treatment is becoming more common, but there is a lack of data to indicate the optimal timing of initiation after massive APAP overdose. To our knowledge, this study is the largest reported retrospective review and the first to suggest differences in hepatotoxicity and treatment utilization based on timing of fomepizole therapy. We found initiating fomepizole the same day as NAC therapy in massive APAP OD was associated with significantly lower peak AST and less total days of NAC compared to delayed start. Based on this data, it may be beneficial to start fomepizole within 24 hours of NAC therapy initiation after massive APAP ingestions. Further study is needed to replicate and validate these preliminary findings.

KEYWORDS Fomepizole; acetaminophen

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126. Characterizing fomepizole use in acetaminophen deaths reported to US poison centers

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Background: N-acetylcysteine (NAC) continues to be the mainstay of therapy to prevent and treat hepatotoxicity in acetaminophen overdoses, but there has been a rise in treatment failures secondary to massive acetaminophen ingestions. A novel strategy that has gained popularity is utilizing fomepizole to decrease N-acetyl-para-benzoquinone imine production. This therapy has promising preclinical data, but there continues to be limited published data especially in the cases of fatalities.
Methods: Fatality narratives and case information for years 2010-2021 were obtained from the National Poison Data System (NPDS) in which fomepizole was coded as performed or recommended and performed. Cases with ingestions of a toxic alcohol, substances that did not include acetaminophen or if the cause of death could not be determined were excluded. Each abstract was reviewed by one author, and 10% of these were randomly sampled and analyzed by a second author to confirm whether inclusion or exclusion was appropriate. Three categories were created to distinguish the severity of hepatotoxicity at the time of fomepizole administration: no hepatotoxicity, hepatotoxicity (aspartate aminotransferase [AST] or alanine aminotransferase [ALT] $>$ 1,000) or acute liver failure (international normalized ratio [INR] $>$ 1.5, elevated transaminases, encephalopathy). The presence of renal injury, if renal function was documented, was also assessed surrounding the time that fomepizole was given. Descriptive statistics are reported.
Results: A total of 214 fatality cases of the 1,316 retrieved met inclusion criteria for fomepizole use in acetaminophen poisoning. Of these, 141 cases were suitable to differentiate between the three aforementioned categories. The most frequent time of fomepizole administration was during acute liver failure with 78% (110/141) of the cases falling within this category. This was followed by 15.6% (22/141) of the cases having no hepatotoxicity, and 6.4% (9/141) having hepatotoxicity when fomepizole was given. Renal injury was noted in 86.3% (113/131) of the fatalities. Fomepizole use in these patients sharply trended up in 2020, with 2021 containing the largest number of cases compared to the previous years. Initiating this intervention earlier in a patient's course without hepatotoxicity present also increased in 2021.
Conclusions: Acetaminophen poisonings continue to be a major problem, especially in the setting of massive ingestions refractory to standard treatments. Case reports and case series have described good outcomes with the use of fomepizole as an adjunctive therapy in these situations. Fomepizole is increasingly being used in patients with established liver failure after acetaminophen overdoses. The timing of fomepizole administration in relation to liver and/or renal injury may affect its effectiveness and should be a point of subsequent research.

KEYWORDS Fomepizole; acetaminophen

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127. Increase in acetaminophen overdoses and severity in teens during the COVID pandemic: results from the US National Poison Database System 2017–2022

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Background: Recent research indicates that the COVID-19 pandemic resulted in increased mental health disorders and depressive symptoms among adolescents. Poor outcomes have been associated with adolescent age, female gender, and neurodiversity. According to the most recent Youth Risk Behavior Survey published (2019), suicide is the second leading cause of death among high school-aged children. This observed trend builds on previous National Poison Data System (NPDS) data that shows there has been a significant increase in attempts using self-poisonings since 2011, with an associated increase the severity of outcomes. Over the counter analgesics such as acetaminophen are common overdose agents and as a group are associated with the largest number of serious medical outcomes. In this retrospective observational case series, we evaluated the NPDS from 2017 to 2022 and compared rates of acetaminophen overdose and outcomes, in the three years preceding the pandemic years (2017–2019) against the three years during the COVID-19 pandemic (2020–2022).
Methods: We performed a retrospective review of the NPDS 1 January 2017 – 31 December 2022 for ingestions coded as intentional suspected suicide with the generic NPDS codes for acetaminophen products overdose for the age range 13–19 years of age. Further details on outcome, interventions, and demographic details were obtained. Chi-squared tests were used to evaluate for statistical significance in changes for the age groups 13–19 years of age during the time periods 2017–2019 vs. 2020–2022.
Results: In the study period, there is an increase in suicidal acetaminophen overdoses, those receiving NAC, and those requiring critical care admission. There was a significant increase in the number of acetaminophen overdoses requiring admission – 16,033 in 2020–2022 compared to 10,277 in 2017–2019 ($P <$ 0.0001). There was a significant increase in the number of acetaminophen overdoses requiring ICU level care ($P <$ 0.0001); however, there was not a significant increase in those directly admitted to psychiatry from the ED. The number of patients requiring n-acetyl cysteine increased significantly from 18,987 to 27,474 ($P <$ 0.00001). Demographically, there was a significant increase in the number of female acetaminophen overdoses ($P <$ 0.0001).
Conclusions: Increasing US teen suicide is a public health emergency. The increase in acetaminophen as a method of attempted suicide is concerning due to the ease of obtaining acetaminophen and the morbidity and mortality associated with overdose. Data from the UK have demonstrated that limiting acetaminophen package size and utilization of 16 and 32,500 mg tab blister packs have been successful interventions. Limitations of this study are that the NPDS is a voluntary database and may underreport cases, the coding of NPDS may misrepresent cases, and cases may be lost to follow up. Future studies include continuing to trend acetaminophen overdoses amongst teens over time to assess if they return pre-pandemic baselines.

KEYWORDS Acetaminophen; teen suicide; COVID pandemic

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128. Massive vs. submassive acetaminophen exposures and hepatotoxicity in adolescents

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Background: The need for treatment with N-acetylcysteine (NAC) in acute acetaminophen ingestion has long been determined by use of the Rumack-Matthew nomogram, which stratifies risk of acetaminophen-induced hepatotoxicity based on serum concentrations. Adolescents and adults are treated with the same NAC regimens despite a growing recognition of differences in the way each group experiences poisoning and hepatotoxicity. Pediatric massive acetaminophen overdose data in particular is notably thin. Therefore, we sought to compare adolescent massive and submassive acetaminophen overdoses, including exposure demographics, rates of hepatotoxicity despite treatment with NAC, and outcomes.
Methods: This was a retrospective cohort study of acute, intentional, single-substance acetaminophen ingestion cases in patients aged 10–19 years old and reported to NPDS from 1 January 2009, to 31 December 2018. If amount was reported in dosage units (e.g., tablets or capsules), we converted it to a numerical amount using an assumed strength of 325 mg per unit. Cases were excluded if the amount ingested was unknown or nontoxic ($<$ 5 g), appeared to be miscoded or highly improbable ($>$ 150 g or any amount coded in mCg or kg), or NAC was not administered. The remaining cases were then stratified into massive ($\geq$30 g) and submassive (5–29 g) ingestions for comparison. Patient demographics, clinical effects, and medical outcome were analyzed. The primary outcome was the incidence of hepatotoxicity (AST or ALT $>$ 1000 units/L) in each group. Secondary outcomes included NAC route of administration, indirect markers of end-organ dysfunction (PT/INR, serum creatinine, acidosis, ammonia, confusion, and hypoglycemia), and rate of adverse drug reactions.
Results: A total of 13,025 cases were analyzed (massive n = 1267). The mean ingested acetaminophen doses were 45.6 g (0.75 g/kg) and 11.8 g (0.2 g/kg) in the massive and submassive groups, respectively. Massive overdose was associated with a significantly higher incidence of hepatotoxicity (8.8 vs. 4.8%; $P < 0.001$), PT/INR prolongation (8.6 vs 4.8%; $P < 0.001$), elevated serum creatinine (1 vs. 0%; $P = 0.008$), acidosis (2.4 vs. 0.7%; $P <$ 0.001), and confusion (1 vs. 0%; $P < 0.001$). Hypoglycemia was rare (n = 2, both in submassive group), and hyperammonemia was not reported in either group. There were no differences between groups in age, weight, use of activated charcoal, formulation of NAC administered (~84% intravenous), or rate of ADRs (~4%).
Conclusions: Adolescents who acutely ingest $\geq$30 g of acetaminophen are at nearly twofold higher risk of developing hepatotoxicity compared to those who ingest 5–29 g, even when controlling for NAC administration. Consideration of current treatment strategies and whether they remain adequate in pediatric massive acetaminophen overdose is warranted. This study also emphasizes the need for a more comprehensive understanding of massive acetaminophen overdose as well as the importance of including pediatric data in all toxicology research.

KEYWORDS Acetaminophen; hepatotoxicity; adolescent

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129. Evaluation of laboratory utilization among clinicians in acetaminophen overdose

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Background: In acetaminophen overdose without signs of hepatoxicity, general recommendations are to check liver transaminases (LFTs), acetaminophen level, and coagulation studies upon initial assessment and just prior to the conclusion of N-acetyl cysteine (NAC) 21-hour infusion protocol (2 sets). The continuation of infusion depends on the elevation of LFTs or the continued presence of acetaminophen at the end of the NAC protocol. Despite these recommendations, many clinicians continue to trend these levels with multiple sets of labs, during the initial NAC protocol. The primary aim was to evaluate if multiple lab evaluations, during the NAC protocol, changed the management or patient outcomes.
Methods: A retrospective chart review from 2010 to 2021 of adult and pediatric patients presenting to a tertiary care hospital for acetaminophen overdose was completed. Inclusion criteria consisted of overdoses requiring NAC without initial evidence of hepatoxicity (AST or ALT $>$ 1000 U/L) to evaluate the number of laboratory occurrences during the NAC protocol. Secondary outcomes evaluated were patient disposition, development of hepatoxicity, and extension of NAC infusion occurred.
Results: Out of 321 patients identified, 191 charts were excluded, and 130 met the inclusion criteria. Overall, the average (mean) number of sets of labs drawn was 5, with a range of 1–22 sets, during the entirety of NAC infusion. Seventy-three cases, that never developed hepatoxicity and only received 21 hours of NAC, had greater than 2 sets of labs, with an average of 4 sets and a range of 1–8 sets. Thirty cases required NAC beyond the 21-hour protocol. Two patients required transfer to a liver transplant facility, 128 were discharged, and no deaths occurred. Ten patients developed hepatoxicity, but all incurred an elevation of LFTs from baseline on laboratory evaluation on labs drawn at the recommended time, just prior to the conclusion of the 21-hour NAC protocol. Using Fisher's Exact test, there was a significant association between following recommended lab protocol (2 sets) and change in management ($P < 0.01$). Specifically, cases following recommended lab protocol are less likely to have a change in management (extension of NAC protocol), compared to those that did not follow protocol.
Conclusions: There is variability among clinicians in laboratory utilization in acetaminophen overdose. Of patients developing hepatoxicity, all had an elevation of LFTs on lab work at the recommended time, just prior to the scheduled conclusion of the initial NAC protocol. Streamlining the administration of NAC and providing a standard order set for laboratory evaluation for acetaminophen overdose may decrease costs and save the patient from unnecessary phlebotomy.

KEYWORDS Acetaminophen; laboratory utilization; N-acetylcysteine

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130. High-risk acetaminophen overdose outcomes after treatment with standard dose vs. increased dose N-acetylcysteine

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Background: Prompt N-acetylcysteine (NAC) treatment at standard doses is almost universally effective in preventing hepatotoxicity after acetaminophen (APAP) overdose. However, hepatotoxicity may occur despite early NAC treatment with ingestions leading to APAP concentrations above 300 mcg/mL at 4 hours. Prior studies evaluating increased dose NAC to treat high-risk APAP ingestions have shown mixed results.
Methods: Records from a single poison center were reviewed from 2017 to 2022. Cases of acute ingestion (over < 1 hr) of any acetaminophen product treated with IV NAC were screened. Inclusion criteria were an [APAP] plotting above the "300 mcg/ml" line on the Rumack-Matthew nomogram. Cases were excluded if data were incomplete, time of ingestion was unknown, NAC was started after 24h from ingestion, NAC therapy was interrupted, or NAC treatment was incomplete or used non-standardized dosing (e.g., combination of standard and increased dose NAC at different times). Case demographics, laboratory results, NAC dosing (standard vs increased), other treatments, and outcomes were abstracted. Hepatotoxicity was defined as an AST or ALT > 1000 U/L and acute liver failure as hepatotoxicity and an INR > 2. APAP ratio was defined as the APAP concentration divided by the corresponding concentration at the "150" line on the nomogram.
Results: 345 Cases met initial inclusion criteria. 155 were excluded and 190 cases met all criteria for analysis. Median age was 18 years (IQR 15–27) with 73% female. Reason for exposure was suicide attempt in 98%. APAP ratio was 2–3 in 128, 3–4 in 29, and > 4 in 33 patients. 46% were treated within 8 h of ingestion. 56% received standard dose NAC while 44% received increased dose NAC. Two patients received fomepizole, both in the high-dose NAC group. No patient received hemodialysis. Among patients treated within 8 h, 0/31 (0%) of standard dose NAC and 1/56 (1.54%) of high-dose NAC patients developed hepatotoxicity. Among patients treated > 8 h from ingestion, 7/46 (13.2%) of standard dose and 18/31 (36.7%) of high-dose NAC developed hepatotoxicity (OR 3.82 95% CI 1.43–10.21) and liver failure occurred in 5/48 (9.4%) treated with standard dose NAC and 11/38 (22.45%) treated with high-dose NAC (OR 2.78 95% CI 0.89–8.69). Rate of hepatotoxicity increased with increasing APAP ratio: 2–3 (7%), 3–4 (13.8%), and > 4 (38.2%). No patient died or received a liver transplant.
Conclusions: In this cohort of patients with high-risk APAP ingestions, hepatotoxicity was rare in all patients treated with NAC within 8 h of ingestion regardless of NAC dose or APAP ratio. Unexpectedly, treatment with increased dose NAC was associated with increased odds of hepatoxicity in those treated after 8 h. There was no difference in rates of liver failure between NAC dose regimens. Hepatotoxicity occurred most often in patients treated > 8 h from ingestion and with higher APAP ratios. As hepatotoxicity is well known to occur with delays in NAC treatment, larger studies, particularly with patients with APAP ratios > 3 and NAC treatment within 8 h, are needed to determine if high-dose NAC is beneficial in preventing hepatotoxicity in high-risk APAP overdoses.

KEYWORDS Acetaminophen; N-acetylcysteine; overdose

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131. Comparison of low-risk and high-risk acetaminophen ingestions using the standard prescott protocol of intravenous N-acetylcysteine

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Background: N-acetylcysteine (NAC) is the antidote to detoxify acetaminophen (APAP) intoxications and is most commonly administered as a continuous IV infusion. Acute APAP intoxications are treated with the standard Prescott NAC protocol (300 mg/kg IV as three separate infusions over 21 hours) if the appropriately drawn serum APAP concentrations [APAP] are above the 150 mcg/mL-treatment line on the Rumack-Matthew nomogram. Recent data and clinical guidelines have suggested that the third infusion of the Prescott Protocol should be doubled (200 mg/kg over 16 hours) if [APAP] is above the 300 mcg/mL treatment line. The purpose of this project is to compare the rate of hepatotoxicity, defined as maximum AST > 1000, post-APAP intoxication using the standard NAC Prescott Protocol dosing strategy for "low" and "high" risk cases using our poison center (PC) historical data. High risk cases are defined as [APAP] greater than the "300-line" using the Rumack-Matthew nomogram.
Methods: This is a retrospective chart study of single-substance acetaminophen ingestions from a PC. Our PC's electronic database (Toxicall®) was queried for single-substance acute APAP ingestions treated with IV NAC from 1 April 2015 to 31 December 2017. These dates were chosen because at the start of 2018, our PC began recommending doubling of the 16-hour 100 mg/kg NAC infusion. Patients were included if they had documented time of ingestion as well as [APAP] and had recorded transaminases (AST/ALT). The primary outcome was comparing the rate of cases with maximum AST above 1000 for high-risk and low-risk cases. Descriptive statistics were used for analysis.
Results: A total of 476 single-ingredient APAP cases were identified that received IV NAC and had documented times of ingestion, 311 of which met all inclusion criteria with 79 (25.4%) patients meeting high-risk criteria. Median ingested amount was 20 g ($n = 186$, IQR 12.6–30). Most patients were female (75.6%); median age was 18 years (IQR 15–24, Range 0.8–95). Intentional suspected suicide was the reason for exposure in 94.2% of cases. No patients died. Hepatotoxicity was more common (11.4%) in high-risk patients (i.e., above the 300-line) treated with standard Prescott Protocol NAC than in lower risk patients (4.3%; i.e., those between the 150 and 300-lines; $P = 0.02$). Major effects were more common in high-risk patients (10.1%) than in low-risk patients (3.4%; $P = 0.02$), as were moderate effects, 17.7 versus 9.9% ($P < 0.05$), respectively. The maximum AST was higher (median 25, IQR 17–68) in high-risk cases compared to low-risk cases (median 18, IQR 14-29, $P = 0.000$, $z = -4.121$). Additional IV NAC after the initial standard Prescott Protocol was administered in 44.3% of high-risk cases compared to 11.6% of low-risk cases.
Conclusions: With the standard Prescott protocol dosing of IV NAC recommended by our PC, we found a higher incidence of major and moderate effects, a larger proportion of maximum AST > 1000 as well as an increase in the requirement of additional IV NAC treatment in high-risk cases. Future comparisons to groups that received double-dose NAC should be investigated.

KEYWORDS Acetaminophen; N-acetylcysteine; NAC

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132. N-acetylcysteine dosing in a patient with acetaminophen-induced acute liver failure undergoing plasmapheresis: an emerging challenge

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Background: Plasmapheresis (PLEX) is increasingly utilized as a salvage therapy in patients with acute liver failure, including those after acetaminophen (APAP) overdose. Very limited data exist on its effect on N-acetylcysteine (NAC) clearance, which brings additional challenges to managing NAC dosing.
Case report: 18 year-old female history of anxiety and depression presents 18 hours after intentional acetaminophen ingestion ~35 g. found to have APAP 187 mcg/mL, AST/ALT 176/170 U/L, INR 1.34. High dose NAC and fomepizole initiated. Later that day, she developed worsening transaminitis 1029/1009 U/L, hypothermia, severe acidosis pH 6.9, bicarb 8 mmol/L, lactate 10 mmol/L, ammonia 68 umol/L. She received fluid resuscitation and bicarbonate infusion and was transferred to a liver transplant center. On day 2 post-ingestion, she developed fulminant liver failure with shock, grade III hepatic encephalopathy (ammonia 544 umol/L), coagulopathy (INR > 10), and oliguric AKI requiring CVVHD. The patient was deemed not a transplant candidate due to psychosocial risk. She was started on plasma exchange (~3L of plasma were removed and replaced with ~3L of FFP on each daily session) for three days to improve transplant-free survival. Empirically she was given 75 mg/kg NAC re-bolus after each PLEX session in addition to continuing NAC infusion at 12.5 mg/kg/h. On post-ingestion day 3, the patient reached peak AST/ALT 9360/8380 U/L. On day 6, the patient's LFT, acidosis and encephalopathy all significantly improved. On day 8, she was weaned off pressors & CVVHD, transitioned to iHD for an additional week until renal recovery occurred. Her hospital course was complicated by mild pancreatitis and RLL PNA but eventually transferred to inpatient psychiatry on day 20. Her liver biopsy 2 months after ingestion revealed regenerative nodules in the background of parenchymal collapse suggestive of post-submassive necrosis and extensive cholestasis which are expected to continue to resolve. Ascites and non-bleeding esophageal varices both resolved within 3 months and she continued to do well outpatient.
Discussion: While the pharmacokinetics of NAC in renal replacement therapy has been well studied, little is known about the change in NAC clearance with PLEX. Recent evidence suggests that PLEX may increase transplant-free survival in patients with acute liver failure and it is increasingly utilized. Based on known pharmacokinetics of NAC including protein-binding of 66–87% and each of patient's PLEX session removed 4L of plasma, we postulated that each PLEX session removes about three times more NAC compared to a standard 4-hour HD session, and empirically administered 75 mg/kg NAC bolus after each PLEX session. Our patient ended up having a good outcome. A major limitation of the study is the lack of pre-and-post PLEX NAC level.
Conclusions: Plasmaphresis as an emerging supportive therapy for acute liver failure brings additional challenges to N-acetylcysteine doing. Additional pharmacokinetic study of N-acetylcysteine during plasmaphresis is needed.

KEYWORDS N-acetylcysteine; plasmaphresis; acetaminophen

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133. Frequency and types of errors involved in the use of a modified one-bag 3% intravenous N-acetylcysteine protocol for acetaminophen overdose

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Background: Acetaminophen overdose is a leading cause of acute liver failure in developing countries. N-acetylcysteine (NAC) is a highly effective antidote for acetaminophen hepatotoxicity; however, errors in NAC administration can be associated with morbidity and rarely death. Due to a known high rate of errors with the standard 3-bag IV NAC protocol, in 2019, our regional Poison Centre changed to a modified one-bag 3% IV NAC protocol. Since there is little data regarding the rate of errors using this protocol, this study was undertaken to determine the frequency and types of errors associated with this one-bag 3% IV NAC protocol.
Methods: Data were gathered via retrospective chart review of Poison Centre cases identified as receiving IV NAC for acetaminophen overdose between 1 August and 30 September 2022. 220 total charts were identified, and 188 were deemed eligible based on inclusion and exclusion criteria. Additionally, cases identified with known NAC overdose errors with the new protocol between 2019 and 2023 were reviewed to identify a threshold dose for adverse effects from NAC overdose.
Results: The total error rate was 25%, consisting of dosing errors found in 11.7% of charts, stopping errors 9.0%, initiation errors 3.7%, and interruptions in therapy in 3.2%. Dosing errors were the most common type of error (44.4%), with overdoses occurring three-times more than underdoses. Clinical outcomes were compared between charts with and without errors. Severe outcomes in cases with known NAC overdoses were rare over the 4 year period, however, included confusion, seizure, cerebral edema, hemolysis, ventricular tachycardia, and one death.
Conclusions: The rate of errors identified with this one-bag 3% IV NAC protocol is lower than reported for the 21-hour 3-bag IV NAC protocol, but remains high due to dosing errors. Although severe outcomes are rare, IV NAC overdose can be fatal. Further evaluation into the factors contributing to error and enhanced education for medical providers is needed to minimize administration errors.

KEYWORDS N-acetylcysteine; acetaminophen; error

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134. Pediatric intravenous acetaminophen overdoses reported in the Toxicology Investigators Consortium (ToxIC) Registry

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Background: Despite recent case reports of pediatric intravenous (IV) acetaminophen (APAP) overdoses, there remains no clear

consensus on the assessment and management of these patients. Since IV acetaminophen is available in a 100 mL vial of 10 mg/mL solution, there is a risk of dosing error when a child receives the entire 1000 mg from a single vial. Some have suggested empiric treatment with N-acetylcysteine (NAC) in pediatric patients who receive an IV APAP dose greater than 60 mg/kg, whereas others (including the manufacturer) recommend obtaining an APAP concentration ([APAP]) at 4 hours (or as soon as possible after 4 hours) and subsequently treating with NAC per the Rumack-Matthew nomogram. In this case series, we analyzed recent pediatric IV APAP overdose cases submitted to the Toxicology Investigator's Consortium (ToxIC) registry to study their key features and treatment by medical toxicologists.

Case series: We queried the ToxIC registry for pediatric IV APAP overdoses cases from 1 January 2017 to 31 December 2022. Five cases met these criteria. The median age was 13 months (range from 2 weeks to 4 years), and four patients were under two years of age. Additionally, we had specific APAP doses for four patients. Three patients were treated with NAC. One patient received 1000 mg (78 mg/kg) of APAP – this patient had a 4-hour [APAP] of 21 mcg/mL and an AST of 61 IU/L. The patient received NAC after repeat AST was 86 IU/L (highest observed) with a normal ALT four hours later. Another patient received 1000 mg APAP (unknown mg/kg) with no reported [APAP] nor elevations in AST or ALT. One patient received NAC following an unknown dose of APAP with AST reported as "greater than 1000 IU/L" but no reported ALT elevation. Two patients with APAP doses of 20 mg/kg and 60 mg/kg did not receive NAC and had no reported transaminase elevations. All patients survived to hospital discharge.

Discussion: We question the necessity of NAC in the three patients who received it. In this case series, all who received NAC were below the treatment threshold on the Rumack-Matthew nomogram or did not have an [APAP] measurement available at the time of treatment with NAC. Only one patient had a reported AST above 1000 IU/L, but the absence of concomitant ALT elevation suggests that this was unlikely due to APAP toxicity. At least two patients received the entire 1000 mg vial of APAP (10 mg/mL). This likely reflects confusion with the intended dose of 10 mg/kg. Among pediatric medication errors, ten-fold errors remain notoriously common. Each 10 mL vial contains a 10 mg/kg dose for a 100 kg adult. Reformulation in smaller volume or lower concentration may prevent future pediatric IV APAP overdoses.

Conclusions: Treatment of pediatric IV acetaminophen overdoses by medical toxicologists in this case series varied substantially. Empiric treatment with NAC is likely unnecessary unless the [APAP] exceeds the treatment line.

KEYWORDS Acetaminophen; pediatrics

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135. Increased acetylcysteine dosing in early, acute massive acetaminophen ingestion has minimal impact on patient outcomes

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Background: Recent literature suggests standard intravenous (IV) N-acetylcysteine (NAC) dosing inadequately prevents hepatotoxicity in massive acetaminophen (APAP) overdose, even with timely initiation. Thus, for such cases it has been recommended to provide increased NAC dosing—two- to four-times the standard 16-hour NAC infusion rate—to sufficiently neutralize APAP's toxic metabolite.

Methods: This is a single poison center retrospective study of patients with acute, massive APAP overdose (APAP concentration $\geq$300 mcg/mL at 4 hours post-ingestion) treated with IV NAC between 1 January 2017, and 31 December 2022. Single-substance ingestion cases having initial APAP concentration(s) collected within 8 hours post-ingestion were included. Non-acute ingestions, cases with unknown exposure time, and patients with baseline aspartate aminotransferase (AST)/alanine aminotransferase (ALT) levels $>$ 100 U/L were excluded. Extracted data included demographics, exposure details, lab values, clinical effects, therapies, and medical outcome. Four-hour APAP concentrations were back extrapolated via pharmacokinetic calculation for cases in which a concentration was obtained 4-8 hours post-ingestion. A four-hour half-life was assumed. The primary objective was to determine the impact of increased NAC dosing on incidence of hepatotoxicity (AST/ALT $>$ 1000 U/L) in an early presenting, massive APAP overdose population.

Results: A total of 85 cases met study criteria for evaluation, 24 of which were treated with increased NAC dosing (range: 9.375–15 mg/kg/hour 16-hour infusions). Four-hour APAP concentrations were back extrapolated in 69 (81%) cases. The median four-hour concentration was 418.2 mcg/mL (IQR 338.2–440.4 mcg/mL), and the average time to NAC initiation (n = 75) was 6.8 (±2.26 SD) hours post-ingestion. There was no difference in the incidence of hepatotoxicity between standard versus increased dosing. When adjusted for time to NAC initiation, four-hour APAP concentration, and age, there was no difference in number of serious outcomes or number of repeat 16-hour NAC infusions. Three cases developed hepatotoxicity (four-hour APAP concentrations: 336.6, 347, 545.6 mcg/mL); all were treated with standard NAC dosing.

Conclusions: In this study of patients presenting with early massive APAP overdose, increased NAC dosing did not have a statistically significant impact on development of hepatotoxicity. Additionally, there was no difference in duration of NAC therapy (number of repeat 16-hour infusions) between treatment groups. However, consistent with previous reports, a small proportion of patients in this study developed hepatotoxicity despite timely, standard NAC treatment (3/61, 4.9%). While not statistically significant, the clinical significance of this finding is appreciable. Limitations most notably include small sample size as well as disproportionate treatment groups, the large percentage of extrapolated four-hour levels, and variability in poison center chart details. Larger, prospective studies are needed to further describe the utility of increased NAC dosing for massive APAP overdose.

KEYWORDS Massive acetaminophen overdose; increased acetylcysteine dosing; hepatotoxicity

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136. Distinguishing repeated supra-therapeutic (RST) and acute acetaminophen exposures using a decision tree algorithm: a pilot study based on the National Poison Data System

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Background: This study aimed to compare clinical and laboratory characteristics of supra-therapeutic (RST) and acute acetaminophen exposures using a predictive decision tree (DT) algorithm.
Methods: We conducted a retrospective cohort study using the National Poison Data System (NPDS). All patients with RST acetaminophen exposure ($n = 4{,}522$) between January 2012 and December 2017 were included. Additionally, 4,522 randomly selected acute acetaminophen ingestion cases were included. After that, the DT machine learning algorithm was applied to differentiate acute acetaminophen exposure from supratherapeutic exposures.
Results: The DT model had accuracy, precision, recall, and F1-scores of 0.75, respectively. The DT model produced in this study was 29 nodes in size, with 17 leaves and four levels. Age was the most relevant variable in predicting the type of acetaminophen exposure, whether RST or acute. Serum aminotransferase concentrations, abdominal pain, drowsiness/lethargy, and nausea/vomiting were the other most important factors distinguishing between RST and acute acetaminophen exposure.
Conclusions: DT models can potentially aid in distinguishing between acute and RSTI of acetaminophen. Further validation is needed to assess the clinical utility of this model.

KEYWORDS Repeated supra-therapeutic ingestion; acute acetaminophen poisoning; decision tree

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137. Consensus-based recommendations for the out-of-hospital management of acetaminophen poisoning in the United States and Canada

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Background: Acetaminophen overdose is the leading cause of acute liver injury and acute liver failure in the United States (US) and Canada, despite effective antidotal treatment with acetylcysteine and aggressive supportive care. This underscores the importance of quick and accurate triage in the out-of-hospital (OOH) setting. Consensus guidelines for the OOH management of acetaminophen overdose were published in 2006. In response to expanding knowledge, the NAC-GAP consensus panel developed updated OOH patient management guidelines.
Methods: Information regarding the OOH management of acetaminophen overdose was obtained from regional poison centers (RPCs), medical toxicology fellowships, commercial vendors, medical literature, and professional organizations such as America's Poison Centers (APC), the American Academy of Clinical Toxicology (AACT), American College of Medical Toxicology (ACMT), and the Canadian Association for Poison Centres and Clinical Toxicology (CAPCCT). A panel of experts was chosen by APC, AACT, ACMT, and CAPCCT. A modified Delphi consensus methodology was utilized to present statements regarding each element of OOH patient management to panel members, who considered relevant literature and current guidelines in voting *agree*, *disagree*, or *strongly disagree* for each statement. Consensus was defined as 75% of the panel voting *agree* with none voting *strongly disagree*. Statements that did not reach consensus were iteratively revised based on panel discussions and re-voted on until consensus could be reached.
Results: The panel developed a comprehensive guideline for the OOH management of acetaminophen overdose for use by providers in the US and Canada. The main objective of the guideline is to provide a standard framework for RPCs to determine when to refer patients with suspected acetaminophen overdose to the emergency department (ED). This guideline encompasses acute and repeated supratherapeutic ingestion (RSTI) patterns, with acute ingestion defined as a presentation between 4 and 24 hours after acetaminophen ingestion. After determining the reliability and accuracy of the history available, patients with an unreliable history should be referred to the ED regardless of reported dose or intent. All patients reporting intentional self-harm or malicious intent, or those with symptoms of acetaminophen poisoning (i.e., repeated vomiting, right upper quadrant abdominal tenderness, or mental status changes), should be referred to the ED. For patients with a reliable history and without self-harm or malicious intent, the decision to refer is based on reported ingestion amount. Patients with an acute ingestion of $>$ 200 mg/kg are referred to the ED. RSTI ingestions of $>$ 200 mg/kg over 24 hours, OR $>$ 150 mg/kg/24 hours over the preceding 48 hours, OR $>$ 100 mg/kg/24 hours over more than 48 hours, are referred to the ED. Providers are recommended to seek poison center or clinical toxicology guidance for complicated scenarios.
Conclusions: An expert multidisciplinary group reviewed the literature and clinical practices and developed consensus guidelines for the OOH management of acetaminophen overdose. Next steps should include assessment of implementation and utility of the guidelines in real-world settings. Future work to improve patient outcomes should include refining techniques for accurate history-taking in poisoned patients and streamlining the ED referral triage process.

KEYWORDS Treatment guidelines; acetaminophen overdose; out-of-hospital

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138. Acetaminophen-induced renal failure requiring CRRT in an adolescent

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Background: Acetaminophen is an over-the-counter medication frequently used by adolescents in overdose. While there is a large body of literature describing acetaminophen-related hepatic injury, our understanding of extrahepatic effects, like nephrotoxicity, is very limited. There are reports describing adolescents developing acetaminophen-related renal toxicity due to acute tubular necrosis in the literature but very few of these patients ultimately required renal replacement therapy (RRT). We report a case of an adolescent whose renal failure progressed after clinical improvement of her hepatic injury necessitating RRT.
Case report: A 14-year-old female presented to the Emergency Department (ED) for abdominal pain, nausea, and vomiting. On arrival, she was hemodynamically s. A CBC was normal, however additional laboratory testing revealed a serum bicarbonate level of 17 mmol/L, creatinine 1.63 mg/dL, total bilirubin 1.1 mg/dL,

AST 428 U/L, ALT 318 U/L, and INR of 1.5. Urine drug screening was negative; salicylate and ethanol levels were undetectable. Initial acetaminophen level was 85.5 ug/mL. An EKG obtained shortly after arrival demonstrated sinus rhythm with normal intervals. The patient ultimately admitted taking 10,000 mg of acetaminophen several hours prior to ED arrival. N-acetylcysteine (NAC) was started, and she was subsequently transferred to a tertiary care facility. She developed hepatic failure with ALT/AST levels peaking at > 5000 U/L/ > 1000 U/L on hospital day (HD) 2. On HD 3 her INR peaked at 9.4 and ammonia at 156 umol/L. She continued to receive NAC and was given 3 doses of 10 mg vitamin K on HD 3. Her coagulopathy and hyperammonemia improved over 24 hours. However, she subsequently became anuric and developed acute renal failure. Her creatinine peaked at 8.76 on HD 6 and CVVHD was started at that time. A neutrophil gelatinase-associated lipocalin (NGAL) was noted to be 639 ng/mL on HD 7 and peaked at 747 ng/mL on HD 8. CVVHD was discontinued on HD 9 and her creatinine improved to 1.19 mg/dL on HD 19. She was discharged to a psychiatric facility for further management. An extensive environmental history and detailed list of all medications in the home, vitamins, and supplements was obtained and no other etiology of the patient's renal failure was identified. Medications in the home included, dextromethorphan, guaifenesin, phenylephrine, cetirizine, aspirin, albuterol, fluticasone, topiramate, and apple cider vinegar gummies.

Discussion: Acetaminophen-related nephrotoxicity occurs in 1% of the adult population and 8.9% of 12–18 year olds with severe overdose. In previously published reports of acetaminophen-induced renal failure, renal replacement is rarely indicated. The pathophysiology behind acetaminophen-induced nephrotoxicity has not been fully elucidated and the relationship with acetaminophen dosage and nephrotoxicity is unknown. Existing literature suggests NAC doesn't prevent nephrotoxicity, and there are no large scale studies evaluating the benefit of NAC once nephrotoxicity develops.

Conclusions: Nephrotoxicity is a rare but serious complication of acetaminophen overdose. Further research evaluating the pathophysiology of and impact of NAC once nephrotoxicity develops is needed.

KEYWORDS Acetaminophen; renal failure; pediatric

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139. Treatment of methemoglobinemia due to acetaminophen toxicosis with or without N-acetylcysteine in cats: 18 cases (2002–2022)

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Background: Acetaminophen (APAP) is an analgesic and antipyretic. Acetaminophen exposures represent a common call to both human and animal poison control centers. Both humans and cats can develop centrilobular liver necrosis as a result of acetaminophen toxicosis, though it is rare in cats. N-acetylcysteine (NAC) is commonly used as an antidote for APAP overdose-induced hepatotoxicity in humans and cats by ensuring adequate glutathione levels in the liver and, when sulfation and glucuronidation pathways have been overwhelmed, providing alternative conjugation for the toxic metabolite N-acetyl-p-benzoquinone imine (NAPQI). In cats, the most prominent feature of acetaminophen overdosages is methemoglobinemia. Methemoglobinemia is theorized to develop in cats due to the deacetylation of acetaminophen to para-aminophenol (PAP). In rodents, PAP undergoes n-acetylation and is excreted in the bile. Cats lack the enzymes to effectively catalyze this reaction. N-acetyltransferase 1 is functional but very slow and N-acetyltransferase 2 is absent. Therefore, PAP accumulates and can reduce hemoglobin to methemoglobin. Additionally, cats are more likely to develop methemoglobinemia as they have six reactive sulfhydryl groups on their red blood cells, while humans only have two. Treatment of methemoglobinemia in cats exposed to acetaminophen consists of NAC, supplemental oxygen, and supportive care.

Methods: The AnTox™ poison control database was queried for acetaminophen cases between 1 January 2002 and 31 December 2022. Cases were limited to cat exposures to acetaminophen only (no other exposures or agents with multiple active ingredients) with a known outcome, complete medical record, and clinical signs assessed as high or medium likelihood of being related to the acetaminophen exposure.

Results: 18 unique cases were identified that fit the selection criteria. 7/18 (38.9%) of the patients died or were euthanized due to poor prognosis. 11/18 (61.1%) of patients made a full recovery. 7/7 of the non-survivors and 10/11 (90.9%) of the survivors developed methemoglobinemia. 11/11 (100%) of the survivors received NAC, while 4/7 (57.1%) of non-survivors received NAC. One non-survivor received NAC for 24 hours instead of the recommended 72 hours. The methemoglobinemia reportedly resolved with the administration of NAC but recurred after the discontinuation of NAC. The dosage of APAP ingested was higher in the non-survivor group (160.3 mg/kg) compared to the survivor group (130.2 mg/kg). The average dosage is higher for the non-survivor group; however, patients in both groups were at high risk for the development of methemoglobinemia, so that does not appear to be a significant confounding factor. Administration of NAC appears to be associated with positive outcomes for the cases. NAC is a glutathione precursor and in cats has been effective at reducing methemoglobin formed by increased PAP concentrations back to hemoglobin.

Conclusions: Methemoglobinemia is a very common complication to acetaminophen toxicosis in cats due to their inability to efficiently metabolize and excrete PAP and exacerbated by their inability to glucuronidate acetaminophen. All cats exposed to acetaminophen should be monitored for methemoglobinemia. NAC administration is key to the successful management of acetaminophen intoxication in cats.

KEYWORDS Acetaminophen; cat; N-acetylcysteine

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140. Poster titles at NACCT 2013–2022: is NACCT experiencing a pun-demic?

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Background: Puns have become commonplace at the American Academy of Clinical Toxicology. Webinars, continuing education, oral presentations, and posters appear to be increasingly using clever titles to garner intrigue. Has it always been this way, or are clinical toxicology puns an abstract fashion trend? This project sought to determine whether so-called "punny" titles are a growing practice among abstracts accepted at the North American Congress of Clinical Toxicology (NACCT) over the past ten years.

Methods: A punny title was defined *a priori* as one that contains any form of deliberate wordplay. Wordplay was identified as one or more of the following: homophones (ex. "You've got a NAC

for this"), rhymes (ex. "All Set Without Chemet: Treating Lead Toxicity during a Succimer Shortage"), alliteration (ex. "Pain Pump Predicament"), double entendres (ex. "A Relaxing Trend: Muscle Relaxant Exposures Reported to NPDS"), idioms (ex. "Biting the Bullet: A Case of Lead Ingestion"), or hyperbole (ex. "CNS Explosion: A Case of C4 Ingestion"). NACCT abstracts published in Clinical Toxicology between 2013 and 2022 were reviewed for punny titles and entered into a database in duplicate by three data abstractors. Titles unanimously considered punny were accepted. Discrepancies were resolved by an independent adjudicator. All four pun-dits were practicing clinical and medical toxicologists. Descriptive statistics were calculated and Chi-Square tests were utilized to determine *P*-values.
Results: Of all published NACCT abstracts between 2013 and 2023 ($n = 3{,}000$), 260 (8.7%) had punny titles. 2022 was the punniest year (39 of 312, 12.5%) whereas 2014 had the fewest wordplay titles (18 of 290, 6.2%) ($P < 0.01$). A nonsignificant trend towards increasing punniness was observed in the most recent five years compared to the previous five years, with 147 of 1529 (9.6%) containing puns in 2018–2023 compared to 113 of 1471 (7.7%) in 2013–2017 ($P = 0.06$). A trendline for all ten years showed a weak correlation with $R^2 = 0.42$. Puns were reviewed *post-hoc* for originality to determine whether any joke became recycled over the ten years studied. No pun in ten did.
Conclusions: This study cohort was limited to published abstracts. In a given year, members of the NACCT abstract review committee may have influenced the number of punny titles accepted based on their pun appreciation. Future studies should compare accepted titles to all submitted titles to determine whether use of puns influences the rate of abstract acceptance. Wordplay plays a significant role in abstract titles at NACCT, though rate of punniness varies from year to year. At a conference where the dose makes the poison, a little bit of toxic humor can go a long way in generating a "pun" of laughter.

KEYWORDS NACCT; puns

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141. Use of location data targeting to grow awareness of the poison help line in low utilizers

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Background: Our Poison Center provides emergency and informational call center services for poisonings in a US Territory. In 2021, nearly .75% of our home state callers used the Poison Help line while less than 0.02% of the territory callers took advantage of the service. Additionally, in our state, nearly 70% of the calls originated from the home and nearly 25% originated from health care workers. This pattern was reversed for calls from the territory. While there are multiple possible reasons to explain the low utilization of the Poison Help line by territory residents, lack of awareness of the service was considered a major contributing factor. Media consumption on the US territory is different than in traditional US markets, which makes growing awareness by traditional marketing avenues difficult. Our objective was to improve awareness of the Poison Help line in the territory. A low-cost digital advertising campaign (nearly $3,000) was implemented, sending a Poison Help virtual contact file (vCards) to smartphones through geotargeting and geofencing technology.
Methods: In August of 2022, we contracted with a digital marketing company to target Poison Center advertising to specific Facebook and website users in the territory based on smartphone user location and demographics. Geofencing was used to target users located in the territory and geotargeting was used to identify women $\geq$ 18 years of age caring for children/grandchildren. This demographic population was targeted based on previous research showing females make the majority of household medical decisions. The advertising campaign period was from August to October 2022. The advertising contained a link to the USVI Poison Control website where users could then download a Poison Help line vCard directly to their smart phone contacts. Additionally, the advertising contained cookies which facilitated tracking of users as they navigated to various websites. The advertising on these websites were then re-targeted to prioritize Poison Center messaging. The campaign was augmented with traditional radio advertising promoting the Poison Center and the Poison Help line. The advertisements impressions and "Click through rates" were collected. A click through is counted every time a user clicks the ad and is linked to additional content. The national average click through rate is 0.06%.
Results: The campaign on the user's Facebook pages had 649,365 impressions with a click through rate of 0.55%. The website advertising generated an additional 60,484 impressions with a click through rate of 0.18%. The campaign generated 12,000 user visits to the Poison Center territory website. We also served 1,875 radio ads across 5 stations during the campaign period.
Conclusions: We describe a non-traditional approach to poison center advertisement that led to a click through rate better than the national average. While the data is based only on a 3-month campaign without comparison data, our results are promising. Further investigation on the impacts of geo-targeting and geofencing as part of poison center advertising should be conducted.

KEYWORDS Media; advertising; targeting

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142. Incidence of seizure activity on electroencephalogram in patients presenting with toxic ingestion

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Background: Seizure is a common reported effect of toxicologic exposures. Standard medical management of seizure often involves electroencephalogram (EEG) monitoring. As the majority of toxicologic seizures are described as self-limited and clinically evident, the utility of EEG in these cases is not clear. Appropriate use of diagnostics not only influences patient care, but has large financial implications, as many patients require transfer for specialized monitoring. We hypothesized that patients presenting with toxic ingestions or exposures have a low incidence of seizure on EEG. Therefore, the purpose of this study was to characterize patients that had epileptiform discharges on EEG after a toxicologic presentation.
Methods: We performed a retrospective chart review at an urban teaching hospital from 1 June 2016 through 31 December 2022. Patients $>$ / $=$ 18 years presenting after toxicologic exposure were identified by International Classification of Diseases, tenth revision codes (T35–65, G92.8, G92.9, G93.4, E950–E952, E958–E959) in conjunction with toxicology consult. We extracted demographics, information regarding initial presentation, and data from hospitalization including level of care, laboratory results, procedures, medications administered, and ultimate disposition. We defined findings of interest on EEG as epileptiform discharges consistent with seizure activity. We performed a descriptive statistical analysis, including further characterization of patients with EEG findings.
Results: We identified 809 patients and 100 (12%) underwent EEG. Patients with EEG had an increased length of stay (LOS)

compared to those who did not undergo EEG (median 166 hours [IQR:82.5–298.5] versus 59 hours [IQR:33.8–108.3], $P < 0.01$). Further, these patients had a higher admission rate (99 versus 90%, $P < 0.01$). Eight percent of patients with EEG had epileptiform discharges. Patients with concern for seizure on EEG had an increased LOS compared to patients without findings of interest on EEG (median 676.5 hours [IQR:145.74–954.5] vs. 164.5 hours [IQR:78.5–261.25], $P = 0.18$). Of the eight patients with findings of seizure activity on EEG, the most common seizure type was myoclonic jerking ($n = 3$), followed by generalized tonic clonic ($n = 2$) and nonconvulsive status epilepticus ($n = 2$). Five of the eight patients had clinically apparent seizures. Only two of these eight patients had reported seizures directly prior to admission. All eight patients were admitted to intensive care units received neurology consultation. Five patients had a lumbar puncture, four of which were unremarkable; the final patient had positive N-Methyl-D-Aspartate antibodies. Six of these patients survived to discharge; five of whom were discharged on anti-epileptic drugs (AEDs).

Conclusions: EEG use was high. Among cases receiving EEG monitoring, clinically non-apparent seizures were identified in 3%, suggesting EEG is seldom critical. There is little current data to support the need for AEDs following toxicologic-seizures, however nearly all surviving patients with epileptiform discharges on EEG received AED prescription at discharge. Limitations include our sample size and data from only a single-institution. Future research could include a cost analysis and eventual development of scoring criteria to determine the need for EEG.

KEYWORDS Electroencephalogram; seizure

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143. Analysis of changing pediatric case volume reported to America's Poison Centers

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Background: Pediatric cases reported to US poison centers from both the home and healthcare settings for children aged five and under have been decreasing for over a decade. This study seeks to characterize national poisoning trends for children ages 5 years and younger with regard to the most common substance exposures and medical outcomes of all the cases utilizing the National Poison Data System (NPDS) which is a voluntary reporting system from phone-based reports to America's Poison Centers.

Methods: The NPDS was queried to identify all single or multi-substance exposures in children 5 years old and younger for the ten-year period 2013–2022. Data extracted and analyzed included substance categories, level of care, medical outcomes, and disposition.

Results: Pediatric exposures reported in NPDS decreased by 223,811 (21%) from 2013 to 2022, with the top 11 substances making up 69% of the decrease in cases. The majority of the case volume loss was in children 1 and 2 years of age (76% of the total decrease). The top 5 substance categories with the largest decrease over the study period were topical preparations (47%), cosmetics/personal care products (46%), foreign bodies/toys/miscellaneous (24%), analgesics (22%), and cleaning substances (22%). Cases that were managed on-site decreased by (22%), while calls from a healthcare facility experienced a similar decrease (20%) as well. There was a 14% decrease in admissions to the hospital. Over the last decade, the number of cases reported to poison control centers for children under five years old has declined by 21%. The cases reported from home and HCF had similar declines. The long term decrease in pediatric cases reported in NPDS may be multi-factorial and may be attributed to public education on harmful substances, better safety regulations, and increasing access to non-telephone based information sources including the internet. From a regulatory standpoint, the availability of childproof caps, safety latches, and other safety measures has been instrumental in reducing the number of exposures. As parents and caregivers become more educated on the risks and hazards associated with certain substances, they may be more likely to take appropriate preventative measures to create a poison proof home. In the event of an exposure in the home, the use of smartphones that can facilitate internet search based answers for common non-toxic and minimally toxic exposures and preventing the need to call a poison center or go to the emergency department.

Conclusions: Phone-based reports in NPDS on pediatric poison exposures have decreased by 21% from 2013 to 2022. The most common substances account for almost 70% of the volume loss and most are considered non to minimally toxic in the amounts common in exploratory exposures in children ages 0–5 years of age. Poison centers should continue to provide poison prevention education to decrease exposures, but should also look to provide information to the public in non-traditional ways that do not utilize the phone.

KEYWORDS Pediatric; case volume

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144. Characterization of toxicity and outcomes secondary to lemborexant ingestions reported to the National Poison Data System, 2020 to 2022

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Background: Lemborexant is a novel dual orexin receptor antagonist approved by the United States (US) Food and Drug Administration in 2019 for adult insomnia. It selectively blocks orexin-A and orexin-B neuropeptide binding to OX1R and OX2R, respectively, in the lateral hypothalamus. Receptor antagonism inhibits the signaling pathway promoting wakefulness and arousal, resulting in decreased wakefulness and increased sleep. This study characterizes the toxicity and outcomes associated with lemborexant ingestions reported to the US National Poison Data System (NPDS).

Methods: This retrospective observational study evaluated NPDS data of lemborexant ingestions reported to US poison centers from 1 January 2020 to 31 December 2022. The NPDS was queried for cases including the drug lemborexant at any dose. Only cases of single substance exposure to lemborexant were included. Cases of polysubstance exposure were excluded.

Results: The total number of ingestions reported was 74; 39 (52.7%) ingestions reported at least one adverse reaction. Reason for exposure included unintentional general ($n = 30$, 40.5%), therapeutic errors ($n = 21$, 28.4%), suspected suicide ($n = 12$, 16.2%), intentional misuse ($n = 5$, 6.8%), adverse reactions ($n = 3$, 5.4%), intentional unknown ($n = 1$, 1.4%), unintentional environmental ($n = 1$, 1.4%), and unknown ($n = 1$, 1.4%). Demographics included 48 (64.9%) females and 26 (35.1%) males (age range, 1 to 81 years; mean 28.3 years). Dosages ranged from 5 to 250 mg (mean 32.2 mg). The most common symptom reported was mild CNS depression ($n = 21$, 28.4%), followed by moderate CNS depression ($n = 7$, 9.5%), tachycardia ($n = 5$, 6.8%), agitation ($n = 4$, 5.4%), confusion (n = 2, 2.7%), headache ($n = 3$, 4.1%), and hypertension ($n = 4$, 5.4%). The remaining

symptoms coded as related to lemborexant are each reported in 1.3% of ingestions (abdominal pain, bradycardia, hallucinations/delusions, miosis, muscle rigidity, mydriasis, nausea, other - miscellaneous, other - neurological, respiratory depression, tremor). Thirty-three ingestions (44.6%) were managed on-site (non-healthcare facility), one (1.4%) required admission to the critical care unit, seven (9.5%) were admitted to the noncritical care unit, four (5.4%) were admitted to a psychiatry, four (5.4%) were lost to follow-up, four (5.4%) refused referral, and 21 (28.4%) were treated/evaluated and released from hospital care. Treatments most commonly included dilution, intravenous (IV) fluids, food/snack, and oxygen. Uncommonly reported treatments included benzodiazepines, multiple dose activated charcoal, single dose activated charcoal, flumazenil, fresh air, IV N-acetylcysteine, naloxone, other emetic, and potassium.
Conclusions: Our results provide insight into the clinical presentation of patients following lemborexant ingestions reported to US poison centers. The majority of ingestions reported at least one adverse event potentially requiring medical support or observation, and 1 in 10 ingestions reported moderate CNS depression. Further research is warranted on this relatively new agent to better understand the risks associated with pediatric exposure and intentional supratherapeutic exposure in adult patients. A conservative approach to management should be considered.

KEYWORDS Lemborexant; orexin antagonist; NPDS data

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145. Unique case of serotonin toxicity in a poor CYP2D6 metabolizer

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Background: Serotonin toxicity is caused by an excess of serotonin in the central nervous system leading to neuromuscular, autonomic, and/or mental status changes. Onset is typically 6–8 hours after initiation, dose increase or excessive ingestion of serotonergic medications. Dextromethorphan is a cough suppressant metabolized by CYP2D6 with some serotonin reuptake inhibition. We present a case of poor CYP2D6 metabolism of dextromethorphan leading to serotonin toxicity.
Case report: A 10-year-old male presented to the emergency department with altered mental status (AMS). His initial vital signs were temperature 103 °F, heart rate 133 beats per minute, respiratory rate 28 breaths per minute, and blood pressure 123/86 mmHg. His physical exam demonstrated hyperreflexia, myoclonus, and incomprehensible speech. Parents reported 4 days of mild cough and congestion for which he received 2 age-appropriate doses of dextromethorphan hydrobromide syrup – one given 3 days prior to arrival and one at dinner the night before admission. Past medical history was significant for attention deficit disorder on dexmethylphenidate with a dose increase 1 month prior. The patient was intubated for airway protection. Work up was negative for infectious or intracranial causes of altered mental status, including a negative lumbar puncture. Standard 6 drug urine toxicology panel was negative. He remained intubated requiring midazolam, propofol, and dexmedetomidine infusions for 3 days secondary to continued agitation, tachycardia, hyperthermia, and inducible, non-sustained clonus before being extubated. Pharmacogenomic testing was ordered due to unclear etiology of serotonin toxicity and concern for future medication adverse effects. The pertinent enzyme results were CYP2D6 *4/*5 indicating a poor metabolizer with 0.00 functional activity score.
Discussion: Dextromethorphan acts on the medulla oblongata in the central nervous system (CNS) to suppress cough and inhibits serotonin reuptake in the synapses. This patient presented with classic symptoms of serotonin toxicity (AMS, hyperthermia, tachycardia, hyperreflexia, and clonus) and the appropriate timing in relation to the last dose of dextromethorphan (~ 6 hours). Additionally, he had a recent dexmethylphenidate dose increase. Dexmethylphenidate, a CNS stimulant, inhibits dopamine and norepinephrine reuptake on the presynaptic neurons with some serotonin reuptake inhibition. Due to unclear cause of presentation and history of receiving appropriate medications and dosing, pharmacogenomic testing was pursued; specifically screening for CYP2D6 activity, which was found to be decreased in this patient. Patients with decreased or no CYP2D6 activity are unable to metabolize medications like dextromethorphan via normal pathways, resulting in accumulation of parent drug and symptoms of toxicity that can mimic an overdose. In this case, standard dosing of dextromethorphan in combination with chronic dexmethylphenidate therapy resulted in severe serotonin toxicity.
Conclusions: CYP2D6 poor metabolizers on serotonergic medications are at increased risk of experiencing serotonin toxicity due to lack of functional enzyme activity. There should be consideration for pharmacogenomic testing when there is no clear explanation or history of overdose or overuse of a medication. Pharmacogenomics testing for patients on chronic serotonergic medications, allow patients and healthcare providers to make more informed decisions regarding future medications.

KEYWORDS CYP2D6; dextromethorphan

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146. Water beads .... size matters?

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Background: Superabsorbent polymer beads, a popular child toy, have been associated with risk of intestinal obstruction after ingestion; although some brands have been recalled, many remain on the market. Small children are at particular risk for obstruction, due to their small bowel size (diameter of 2.5–3 cm). Best management recommendations, including brand- and size-specific data and dilutional fluids to prevent expansion, are limited. Our primary aim was to measure pre-and post-submersion diameter of various purchasable brands. Our secondary aim was to evaluate clumping or fracturing behavior. Based on previous literature, we hypothesized that no single bead would achieve diameter greater than 3 cm.
Methods: Four brands of water beads (labelled brand 1–4, including "small", "medium", and "large" sizes of brand 4) were evaluated in 8 different solutions (bottled water, infant formula, skim milk, apple juice, carbonated water, sports drink, Triple Sec (15% ethanol *v/v*) and 5% vinegar. Of note, brand 1 came pre-expanded. Three beads from each brand were placed in 59mL of study solution. In total, there were 48 combinations of beads and liquid. Diameter was measured pre-submersion and hourly for 8 total hours. Other findings, such as clumping or bursting, were also noted at each interval.
Results: Mean expansion of all beads in bottled water at 8 hours was 349% (range 76–523%). The "large" size bead from brand 4 expanded 460% in water, resulting in the largest final bead size, averaging 31.8 mm at the 7-hour mark. Vinegar was the fluid with the lowest post-expansion change (mean diameter change ratio vs. water 0.26, range −0.57 to +0.67) while water was the solution with greatest expansion across all brands and sizes.

Brand 1 (pre-expanded) decreased in size in vinegar, carbonated water, and juice. Clumping was observed in all non-water solutions, but was consistently observed in juice, sports drink, and vinegar. Milk (mean 0.45, range 0.01–0.74) and formula (mean 0.60, range 0.21–0.96) showed no clumping in brands 1–4, but showed clumping in the "medium" and "large" size of brand 4.
Conclusions: We noted that there is a low possibility of single beads achieving diameter of 3 cm across all brands. Exceptions to this included "large" size of brand 4 (pre-submersion diameter 6.0 mm) which achieved 3 cm diameter at 7 hours and was still expanding at the 8-hour mark. Healthcare professionals should be aware of these findings when advising on indications for referral to healthcare facility. While fluids with higher osmolarity, such as juice or sports drink, were generally associated with smaller size compared to water, the percent difference was not consistent among brands. We did, however, observe increased chance of clumping and adherence to container walls in these sugary solutions among all brands and sizes. Although milk and formula are attractive options given relatively low percent expansion compared to water, no single solution gave a favorable combination of low percentage expansion and complete lack of clumping across all bead sizes. Limitations include in vitro nature and lack of simulation of gastric acid and no measurements past 8 hours.

KEYWORDS Water beads; obstruction; pediatrics

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147. Cases involving abortifacients called to US poison centers in the post Roe era

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Background: Unsafe use of abortifacients is a cause of morbidity and mortality worldwide and is more common in countries with limited access to methods for pregnancy prevention and termination. A 2022 United States (US) Supreme Court ruling (Dobbs V. Jackson Women's Health Organization) held that the US constitution does not confer a right to abortion and in the process made abortion illegal in several US states. Understanding evolving trends in abortifacient exposures can guide interventions to mitigate the negative public health impact of limited safe abortion access. The purpose of this study was to compare the number of calls involving abortifacients to US poison centers before and after the Supreme Court ruling in June 2022.
Methods: The National Poison Data System (NPDS) was queried for information and human exposure cases from 6/1/2021 to 12/31/2022 that involved the following known abortifacients: abrin, *Acanthospermum hispidum,* aristolochic acid, a-momarcharin, *Cajanus cajan*, *Lagenaria breviflora*, oil of savin, castor/ricin, rue/chalepensis, misoprostol, mifepristone, furanocoumarins, yuanhuacine, pulegone, *Moringa oleifera*, podophyllin, devil's claw, trichosanthin, *Caulophyllum thalictroides*, *Cimicifuga racemosa*, quinine, ergotamines. Methotrexate was excluded from analysis due to its multiple indications. Data extracted included patient demographics, clinical effects and medical outcome. Data analysis on exposure cases was limited to females of reproductive potential (age 12–50). The mean number of calls per month to US poison centers before and after June 2022 was compared using a student's t test. This study was exempt by our institutional IRB.
Results: Of all exposure calls, 155 (75%) involved female patients, whose mean age was 39 years. Minors (age $<$ 18) comprised 13% ($n = 19$) of exposure cases, of whom 89% were female ($n = 17$). No exposure cases were under 12 years old. After excluding all males and non-reproductive age women, 108 exposure cases were included in the final analysis. There were 109 information calls. There was no statistical difference between the mean number of cases per month before and after June 2022 with information cases (3.2 and 2.1, $P < 0.23$) or exposure cases (5.4 and 6.4, $P < 0.5$). Six exposure cases involved known pregnant patients (misoprostol $n = 2$, *Cimicifuga racemosa* $n = 1$, castor oil $n = 3$). The majority of exposure cases resulted in no clinical effects ($n = 100$, 93%). Only one exposure case, involving *Caulophyllum thalictroides* reported a major clinical effect of CNS depression. No deaths were reported.
Conclusions: Female patients of reproductive age make up the majority of cases called to US poison centers involving abortifacients. There was no change in monthly call rate for abortifacients after the June 2022 Supreme Court ruling. This study was limited by a low number of cases and the inability to determine intent of use. Evolving trends in abortifacient exposures as state laws are enacted and changed may not have been captured by the limited time frame evaluated.

KEYWORDS Abortifacients

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148. Outcomes of ingested superabsorbent polymers ("water beads"): a single poison center study

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Background: Superabsorbent polymers (SAPs) are cross-linked hydrophilic polymers that retain and expand several times their dry size on contact with water used for a variety of applications. There has been rising use of SAPs marketed as "water bead" toys for young children with a reciprocal rise of exploratory ingestions reported to local poison control centers. There is growing concern regarding potential danger from ingestion, including bowel obstruction. Isolated cases of bowel obstruction have been reported however, estimates of incidence are unknown. We summarize outcomes of SAP ingestions reported to a single poison center.
Methods: This was a retrospective cohort study conducted by chart review of electronic records to our poison center from 1 January 2002 to 25 April 2023. A Toxicall® search was performed for human exposures to sixty verbatim terms such as "water bead," "expanding beads," "polymer water beads," as specific AAPCC codes do not currently exist. Single acute ingestions of superabsorbent polymer(s) were included. Patients of all ages and suspected ingestions were also included. Outcome measures included development of symptoms, imaging, interventions, disposition, and final outcome.
Results: There were 256 cases, 39 were excluded, and 217 were analyzed. 182 (84%) cases were in children less than 6 years of age with 110 (51%) males. Final outcomes included 118 (54.4%) patients with no clinical effect and 9 (4.1%) with minor effects. There were two cases coded as moderate effect due to vomiting. Of the 14 imaging studies, none demonstrated acute abnormalities. Furthermore, there were no cases of intestinal obstruction, need for procedures, or admission. The majority of patients (83.4%) were monitored at home, with the remainder seen in clinic or discharged from the ED. Follow-up calls were attempted up to a week from ingestion, answered in 53% of cases, with an average of 45 hours of follow-up time.
Conclusions: Limitations included inconsistent follow-up and specialist in poison information documentation, unwitnessed

ingestions, unknown sizes of beads ingested, and inter-rater reliability was not assessed. Based on these data, there were no severe or fatal outcomes from SAP ingestions. There were no documented cases of bowel obstruction, operative intervention, or hospital admission. The overall outcome from water bead ingestions appears to be favorable.

KEYWORDS Superabsorbent polymer; water bead; obstruction

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149. Delayed, severe paroxysmal muscle cramping after Chilean Rose Tarantula (*Grammostola rosea*) envenoming

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Background: Known for its generally docile nature (and low cost), the Chilean rose tarantula (*Grammostola rosea*) is one of the most commonly kept exotic pets. In the US from 2020 to 2021, more than 600,000 *Grammostola* were commercially traded. Despite this, there is a paucity of medical literature describing *G. rosea* envenoming in humans.
Case report: A 42-year-old healthy woman was bitten on her forearm by a *Grammostola rosea* while attending a party and viewing an exotic pet collection. The patient reported the tarantula bit her forearm for approximately 30 seconds (corroborated by a witness), during which she described feeling venom being injected into her skin. She noted immediate local pain, similar in character and severity to a wasp sting that responded to ice and ibuprofen. Day 1 post-bite, extremely painful paroxysmal muscle cramping developed in her feet and lower legs initially lasting 15–20 minutes, recurring every few hours, for which she presented to the local emergency department (ED). Laboratory workup revealed normal electrolytes and creatinine kinase concentrations. The poison center was consulted, recommended supportive care, and she was discharged with diazepam and cephalexin. Post-bite day 2 she had progressively worse cramping extending to the feet, legs, and hips. She returned to the ED and was admitted for 3 days for pain control, diphenhydramine, diazepam, prednisone, cefpodoxime, and baclofen; however, spasms persisted. Intermittent cramping increased in duration, frequency, and intensity for two weeks and spread to her hands, forearms, abdomen, and lower face. Symptoms spontaneously improved, resolving at 6 weeks. None of the pharmacologic therapies employed were subjectively effective.
Discussion: Multiple sequelae from tarantula bites have been described in literature, including mechanical injuries and hypersensitivity reactions from both venom and urticating hairs. Reports of severe muscle cramping, particularly from Old World tarantulas (e.g., *Heteroscodra maculate*) have been published; however, the mechanism is not well described, nor has it been previously reported with *G. rosea*. Tarantula venoms across all species are mixtures of salts, nucleotides (e.g., ATP), amino acids, neurotransmitters, polyamines, peptides, proteins, and enzymes and are known to cause skeletal muscle necrosis in mice. *G. rosea* venom analysis suggest the venom may contain low-voltage activated calcium channel Cav3.1 and sodium channels Nav1.3 and Nav1.7; related tarantula toxins may inhibit activation of voltage-activated potassium (Kv) channels via interaction with voltage-sensing domains. *G. rosea* venom was shown to be quickly lethal to mice. Case reports of human tarantula bites from other species suggest cramping is a direct effect from the venom rather than sequelae of electrolyte abnormalities. Despite this, calcium, magnesium as well as diazepam and dantrolene are all suggested therapies, but have largely shown poor results. Complete recovery is expected, though it may be delayed for weeks as in our patient case.
Conclusions: Delayed regional and systemic paroxysmal muscle cramping may result from an envenoming bite by *Grammostola rosea*. Poison Centers and toxicologists should counsel patients accordingly and relate that these apparent venom-induced symptoms may last for several weeks but are self-resolving with time.

KEYWORDS Tarantula; Grammostola rosea; envenomation

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150. Trends in physostigmine usage and impact of drug shortage in patients with anticholinergic toxicity: a 10-year retrospective study

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Background: Historically, physostigmine has been used as an antidote for anticholinergic neurotoxicity that is refractory to benzodiazepines. Usage of this antidote has been variable over the years based on literature, familiarity and preference of different poison control centers. In 2019 and 2022, physostigmine experienced a shortage. Previously, physostigmine usage has been explored along with trends and safety parameters; however, not in the context of drug shortages and assessing differences in outcomes. Therefore, the purpose of this study was to assess national trends in physostigmine usage over time and assess differences in clinical outcomes surrounding times of shortage.
Methods: This was a retrospective analysis of the National Poison Data System (NPDS) for all hospitalized cases from 01/01/2013 to 12/31/2022 that involved a single substance exposure with an anticholinergic drug (including antihistamines, over-the-counter agents, sleep aids); anticholinergic plants; atypical antipsychotics; and phenothiazines. Data points obtained from NPDS included: date, age, gender, clinical effects, therapies, medical outcome, and product code name. A linear regression was used to analyze the trends in physostigmine usage over the last decade. Odds ratio was calculated for composite outcomes (death or major effect) between physostigmine and non-physostigmine groups. Additionally, a paired student *t*-test was used to examine differences in composite outcomes between times of shortage and no shortage in both groups.
Results: NPDS data indicated that annual physostigmine usage has increased in the last decade by 24%; however, physostigmine usage increased by 122% between 2013 and 2020. When comparing periods of physostigmine shortage (June–November of the years 2019 and 2022) and no shortage (June–November of the years 2020 and 2021), there was no statistically significant difference in composite outcomes in the non-physostigmine group ($P > 0.05$). Patients that were administered physostigmine had presentations consistent with more severe toxicity (delirium, seizures and intubation).
Conclusions: There is no longer a US supplier of physostigmine, and little financial impetus exists for pharmaceutical companies to produce physostigmine as it was used in 1% of anticholinergic toxicity cases in the last decade. Although physostigmine offers potential benefits, alternative management strategies for

anticholinergic toxicity should be developed. This data suggests patients can be safely managed without physostigmine as there was little impact on composite outcomes during times of shortage.

KEYWORDS Physostigmine; Poison Control Center; anticholinergic syndrome

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151. Safety and efficacy of sugammadex use outside of the operating room

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Background: Sugammadex is a modified gamma cyclodextrin that forms a complex with the neuromuscular blocking agents (NMBA) rocuronium or vecuronium. This results in the reversal of neuromuscular blockade induced by rocuronium or vecuronium. The role of sugammadex is not well defined in the literature outside of the operating room setting. This study aims to describe the safety and efficacy of sugammadex use outside the operating room for the reversal of non-depolarizing neuromuscular blocking agents.
Methods: This was a single-center, retrospective cohort study conducted in patients that received sugammadex outside of the operating room at an academic medical center between 14 June 2016 and 14 November 2022. The primary outcome was efficacy of sugammadex use for NMBA reversal based on descriptive documentation of clinical status. Secondary outcomes included adverse reactions associated with sugammadex use, documentation of contraceptive counseling in patients with child-bearing ability, and cost of sugammadex use when compared to the neostigmine-anticholinergic combination.
Results: A total of 14,383 patients received sugammadex at this institution during the study period. Of those patients, 41 (0.3%) received sugammadex outside of the operating room setting for a non-surgical indication and were included in the study. Sugammadex was administered for NMBA reversal post-magnetic resonance imaging or bronchoscopy ($n = 21$), neurologic exam ($n = 18$), or bedside extracorporeal membrane oxygenation cannulation ($n = 1$). Thirty-nine patients received rocuronium with median dose of 1.1 mg/kg (IQR, 0.6–1.3 mg/kg). The median sugammadex dose administered was 3.6 mg/kg (IQR, 2.2–4.0 mg/kg). Two patients (5%) never received a non-depolarizing NMBA and only eight patients (20%) had a train of four documented prior to NMBA reversal. Thirty-nine patients (95%) had documentation that their neurologic function was appropriate following sugammadex administration. Three patients (7%) had documentation of oral contraceptive use and only one patient had documentation of counseling on the use of an alternative method of contraception for seven days following sugammadex administration. No adverse reactions to sugammadex were reported.
Conclusions: A limited amount of literature exists for the use of sugammadex outside of the surgical setting. This study found that the use of sugammadex was overall rare and well tolerated.

KEYWORDS Sugammadex; reversal; paralytic

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152. Spectrophotometric analysis of purple urine secondary to methylene blue and hydroxocobalamin co-administration

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Background: The development of purple urine after methylene blue (methylthioninium chloride) and hydroxocobalamin co-administration is a rare clinical entity that has not been fully elucidated. In this study, we identify the cause of purple urine secondary to methylene blue and hydroxocobalamin co-administration by utilizing color chromatography and spectrophotometric analysis.
Case report: A 47-year-old male presented to the emergency department with hypotension, cyanosis, and depressed mental status. Initial vital signs were heart rate 125 beats/minute, blood pressure 75/56 mm Hg, respiratory rate 20 breaths/minute, and oxygen saturation 82% that did not increase with supplemental oxygen. The patient was noted to have profound peripheral and central cyanosis, as well as chocolate colored arterial blood. He was intubated for airway protection and accidentally treated with 5g hydroxocobalamin without clinical improvement. Initial co-oximetry was no for a methemoglobin level of 66% and PaO_2 202 mmHg. Medical toxicology was consulted and the patient received 2 mg/kg methylene blue with rapid clinical improvement. His hemodynamics normalized and cyanosis resolved within 1 hour, at which point the repeat methemoglobin level was 22% and he was extubated. He endorsed accidentally ingesting "poppers" containing isobutyl nitrite thinking it was a shot of alcohol. The patient's urine developed an initial red hue following hydroxocobalamin administration that transitioned to a deep purple following methylene blue administration. Urinalysis performed at that time demonstrated violet color, negative leukocyte esterase, 2+ nitrite, negative bacteria, and trace blood. The patient denied dysuria or urinary complaints, and left on hospital day two via self-directed discharge. On phone follow up one month later, he was doing well and stated the purple discoloration of his urine persisted for one week post-discharge.
Discussion: *Urine Color Chromatography* - Color chromatography was performed by placing 3 mL of the patient's urine directly onto absorbent filter paper. After five minutes clear separation of distinct red and blue phases was observed. This finding supports the hypothesis that the purple color is a result of two separate compounds and prompted definitive testing with a scanning spectrophotometer. *Urine Spectrophotometry* - Urine spectrophotometry was performed utilizing the NanoDrop One/One C UV-Vis Spectrophotometer (Thermo Fisher Scientific). 0.01% hydroxocobalamin (Sigma-Aldrich, USA) and 0.01% methylene blue (Biopharm, USA) standard solutions were analyzed separately to establish their absorption spectrum (a). The methylene blue and hydroxocobalamin standard solutions were then mixed and the absorbance spectrum of the mixture was obtained and compared to the absorbance spectrum of a 4% solution of the patient's urine (b). Overlap between the methylene blue/hydroxocobalamin absorbance spectrum and the patient's purple urine absorbance spectrum was nearly perfect.
Conclusions: Purple urine secondary to methylene blue and hydroxocobalamin co-administration is due to combined urinary excretion of methylene blue (blue) and hydroxocobalamin (red), and not a novel purple metabolite. We anticipate that this is going to be an increasingly common clinical entity as the roles

of both hydroxocobalamin and methylene blue expand from toxicologic antidotes to adjunct therapies for vasoplegia, poor cardiac output, and sepsis.

KEYWORDS Methylene blue; hydroxocobalamin; purple urine

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153. Cosmetic product adverse events reported to the center for food safety and applied nutrition adverse event reporting system

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Background: The United States (US) Center for Food Safety and Applied Nutrition (CFAN) Adverse Event Reporting System (CAERS) is a national database that contains reports of food, dietary supplement, and cosmetic product adverse events and product complaints submitted to the US Food and Drug Administration (FDA). Healthcare professionals (e.g., physicians, pharmacists, nurses), consumers (e.g., patients, family members, lawyers), and manufacturers submit reports to CAERS. The reports are generally voluntary, although manufacturers are required to send reports of serious adverse events they receive from healthcare professionals and consumers to the FDA. Adverse events are coded to terms in the Medical Dictionary for Regulatory Activities (MedDRA), a validated, internationally standardized medical terminology. The adverse events include minor to major medical events as well as complaints about taste, color, defective packaging, and other non-medical issues. The objective of this study was to characterize cosmetics product adverse events reported to CAERS.
Methods: Cases were adverse events with a Product code of 53 (Cosmetics) reported to CAERS with a report created date of 2004–2021. Cases with "Exemption 4" in the Product field were excluded because it was unclear what these cases represented. The distribution of cases was determined for various factors.
Results: A total of 12,044 cosmetic product adverse events were reported, representing 9.7% of the 124,617 total adverse events reported during 2004-2021. The annual number of reports was 333 in 2004, decreasing to 124 in 2007 then increasing once more to 2,207 in 2016 before decreasing once more to 769 in 2021. The distribution by patient's age was 279 (2.3%) 0–5 years, 245 (2.0%) 6–12 years, 330 (2.7%) 13–19 years, 1,742 (14.5%) 20–29 years, 2,246 (18.6%) 30–39 years, 1,791 (14.9%) 40–49 years, 1,605 (13.3%) 50–59 years, 845 (7.0%) 60–69 years, 245 (2.0%) 70–79 years, 70 (0.6%) 80+ years, and 2,646 (22.0%) unknown age; 10,452 (86.8%) of the patients were female, 1,071 (8.9%) male, and 521 (4.3%) unknown sex. The medical outcomes (a record can have more than 1) were 5,749 (47.7%) other outcome, 3,602 (29.9%) other serious or important medical event, 2,690 (22.3%) visited a health care provider, 593 (4.9%) visited emergency room, 530 (4.4%) disability, 365 (3.0%) hospitalization, 227 (1.9%) life threatening, 196 (1.6%) required intervention, 104 (0.9%) other serious outcome, 26 (0.2%) death, and 10 (0.1%) congenital anomaly. The most commonly reported MedDRA terms (a case can have more than 1) were 4,881 (40.5%) alopecia, 2,688 (22.3%) pruritus, 1,552 (12.9%) rash, 1,483 (12.3%) burning sensation, 1,300 (10.8%) trichorrhexis, 1,231 (10.2%) erythema, 1,119 (9.3%) hair texture abnormal, and 1,082 (9.0%) hypersensitivity.
Conclusions: Persons age 20–59 years accounted for 78.6% of the cosmetic product adverse events, and the majority of persons were female. The most frequently reported outcome was other outcome followed by other serious or important medical event and visited a health care provider. The most frequently used MedDRA terms were alopecia, pruritus, rash, and burning sensation. A limitation of the CAERS database is that it does not separate cosmetics products into more specific subgroups.

KEYWORDS Cosmetic; adverse; CAERS

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154. Variability among adult and pediatric hospital calls to a medical toxicology consultation service

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Background: Medical toxicologists (MTs) are subspecialist physicians trained to care for patients with acute and chronic poisonings as well as toxic exposures in a wide array of practice settings. Interest in training in medical toxicology appears to be increasing. While some data on volumes, logistics, reimbursement, and billing exist, to our knowledge there are no studies examining seasonal and day-to-day variability in consultations for a medical toxicology consultation service (MTCS). We sought to identify and describe trends in consultation volumes to our well-established bedside MTCS, with particular attention to differences between adult and pediatric consultation patterns.
Methods: We prospectively collected initial consult requests placed to our MTCS service covering five area hospitals (four adult and one pediatric) over a six-month period, including dates, times, consulting hospital, and ward (emergency department, floor, or ICU). We excluded consults that did not include all this information or that were requests for other assistance besides an initial bedside consultation.
Results: Between July 2022 and January 2023, we received 233 initial consultations. 87 (37%) were from the pediatric hospital. Most consultations were placed from the emergency department (66%). September and October were our highest consultation months by volume, driven primarily by a surge in pediatric hospital consultations. In general, adult consultations tended to occur during business hours while pediatric consultation requests were more often placed in the late evening. There did not appear to be any trend based on day of the week.
Conclusions: This small, exploratory study of a mature MTCS covering five area hospitals suggests both seasonal and hourly variation in consultation volumes. Most consultations were placed from the emergency department. Consults on pediatric patients tended to arrive in the evening, which tracks with overall patient flow at pediatric EDs. Overall variation in volume was more pronounced in our pediatric population, and the changes in overall volume appeared to be driven by surges in consults on pediatric patients. Additional studies should seek to investigate these trends on a broader scale.

KEYWORDS Medical toxicology consultation service; consult variability

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155. Evaluation of large-scale, interactive simulation in poison management & drug abuse course

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Background: High-fidelity simulation has been used by numerous medical schools and residency programs to help learners

apply the skills necessary to manage toxicologic emergencies. Operationalizing a high-fidelity simulation for large class sizes comes with many challenges. Our pharmacy school traditionally limits the use of high-fidelity simulation to clinical electives with capped enrollment or skills labs with multiple, small sections. Thus, the use of high-fidelity simulation has been limited in our Poison Management & Drug Abuse course, a required third-year PharmD course with high enrollment. Course instructors designed a high-fidelity simulation for a large classroom setting as a pilot for future semesters. The purpose of this study was to evaluate the effectiveness of large-scale high-fidelity simulation on pharmacy student aptitude and perceived confidence in the identification and management of toxicologic emergencies.

Methods: Students voluntarily participated in this large-scale simulation on the last scheduled class day of this required, 15-week course limited to third-year professional PharmD students. During the simulation, students were asked to identify toxidromes and make treatment recommendations at critical decision points in an unknown overdose case using interactive polling software. Students were asked to complete an identical, 10-item, anonymous, internet-based questionnaire before and after the simulation. Questions were divided into 3 sections: demographics, assessment of knowledge, and self-perceived confidence in assessing an overdose patient. Students were asked to rate their level of confidence on a scale of 0 (not confident at all) to 3 (extremely confident). Only fully complete questionnaires were included for comparison between groups.

Results: One hundred fifty-seven students participated in the simulation. Of the students who participated, 110 (70%) fully completed the pre-simulation questionnaire and 130 (83%) fully completed the post-simulation questionnaire. Only one student in both groups had prior poison center experience and the majority had taken 1 clinical elective (70 pre vs. 73% post) in the PharmD curriculum. The mean score on the 5-question toxidrome recognition portion of the questionnaire was 2.69 (SD = 1.30) before the simulation and 3.61 (SD = 1.21) after the simulation. Prior to the simulation, the majority of students ranked their level of confidence at or below a 1 when assessing the patient's level of instability (75%), gathering relevant history (58%), identifying the toxidrome (80%) and selecting gastrointestinal decontamination (74%). After the simulation, students ranked their level of confidence at or above a 2 in all categories except toxidrome recognition: assessing the patient's level of instability (51%), gathering relevant history (61%), identifying the toxidrome (49%) and selecting gastrointestinal decontamination (57%).

Conclusions: This large-scale high-fidelity simulation improved pharmacy students' ability to recognize toxidromes and feel confident in doing so. Incorporating large-scale, high-fidelity simulation into courses with large class enrollment may aid in educating healthcare professional students in the principles to managing toxicological emergencies.

KEYWORDS Simulation; pharmacy; education

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156. Midodrine exposure: findings from a 21-year NPDS review

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Background: Midodrine is the only FDA-approved drug to treat orthostatic hypotension in the United States. It is an alpha-1 adrenergic agonist that causes peripheral vasoconstriction, leading to hypertension and bradycardia in overdose. This study characterizes single-substance exposures to midodrine reported to the National Poison Data System (NPDS) from 2000 to 2021, including overall trends in midodrine exposures, the types of exposures (intentional versus unintentional), demographics, and medical outcomes.

Methods: Data were obtained from the National Poison Data System (NPDS), a surveillance system that collects data from all poison centers across the United States. Cases were single-substance exposures to midodrine reported to NPDS from 2000 to 2021.

Results: There were 1432 exposures reported to NPDS from 2000 to 2021. Exposures have increased over time, with 3–4 exposures per year from 2000 to 2003 to 166 in 2021. 52.5% of exposures were managed at home. Intentional ingestions accounted for 50% of reported exposures of patients aged 13–19 years. The most common effects were hypertension (211, 14.7%), bradycardia (142, 9.9%), headache (50, 3.5%), lethargy (40, 2.8%), dizziness (37, 2.6%), and chest pain (25, 1.8%). One patient had dysrhythmias. Of therapies provided, 115 (8.0%) had IV fluids given, 38 (2.7%) were given antihypertensives, 18 (1.3%) were given supplemental oxygen, 15 (1.1%) were administered atropine, and 5 (0.4%) were intubated. In patients aged 60+ years, 81% of reported exposures were due to therapeutic error. Of the two exposures with significant clinical effects that had a scenario reported, one was an iatrogenic error, and one was a wrong medication taken/given. In terms of medical outcomes, 126 patients (9.3%) had minor clinical effects, 267 patients (19.7%) had moderate clinical effects, 8 patients (0.59%) had major clinical effects. 401 patients (29.6%) were not followed.

Conclusions: Midodrine exposures reported to NPDS have increased significantly over time . Though a large percentage of exposures were managed at home, specific exposure scenarios, such as double dose scenarios and taking the medication too soon after an initial dose, can result in adverse clinical effects. Despite most exposures resulting in anywhere from no clinical effect to moderate clinical effects, midodrine is still capable of producing significant clinical effects and can require major treatment interventions, including intubation. An improved understanding of midodrine exposures and their associated medical outcomes can help guide clinical decision-making, such as poison center triage.

KEYWORDS Midodrine; NPDS

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157. The effects of the COVID-19 pandemic on reported cases involving ethanol-based hand sanitizer exposures to an animal poison control center

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Background: Ethanol-based hand sanitizer sales increased by 600% in 2020. A concurrent increase in hand sanitizer toxicoses has also been noted by human poison centers; however, data on the impact that the pandemic has had in dog and cat cases has not yet been reported. Ethanol toxicosis causes similar signs of intoxication in dogs and cats as humans, most commonly depression, ataxia, and lethargy. Gastrointestinal upset can also be seen, and severe toxicosis can result in seizures and coma. Treatment is symptomatic and supportive. The current study categorizes the number of calls and types of calls that were made to an animal poison control center involving ethanol-based hand sanitizer before and after the start of the COVID-19 pandemic.

Case series: The database was queried for all cases involving ethanol-based hand sanitizer from 01/01/2018 to 2/28/2020 resulting in 152 unique cases. Searching the database from 03/

01/2020 to 12/31/2021 yielded 519 unique cases. The increase in cases was noted to be consistent until the end of the monitoring period. Both pre- and post- pandemic cases predominantly involved canine patients and oral exposures. The most common exposure event was that the hand sanitizer bottle was chewed, and the product was ingested. The second most common exposure circumstance was that hand sanitizer was spilled from the bottle and licked off the surface it was spilled on. Interestingly, for pre-pandemic the third most common exposure involved the pet licking human hands that had hand sanitizer applied, while post pandemic was the pet licking themselves after humans had applied hand sanitizer to the pet.
Discussion: From 1/1/2018 to 2/28/2020, there were an average of 5.8 cases per month involving exposure to ethanol-based hand sanitizers. However, from 3/1/2020 to 12/31/2021, the average increased to 23.6 cases per month, which represents a 306.9% increase in cases involving ethanol-based hand sanitizers. This increase was sharply noted with 5 cases in February 2020 and 21 cases in March 2020. Given that the circumstances of exposure remained fairly consistent in the pre and post pandemic cases, it is reasonable to assume that the increase in cases is likely due to the increased opportunity for exposure, given an increased presence of ethanol-based hand sanitizers in the home environment. Exposures appear to be stable at these increased numbers, which may represent a new normal for animal ethanol-based hand sanitizer exposures.
Conclusions: Ethanol based hand sanitizer cases reported to an animal poison center between 2018 and 2022 were analyzed to give pre- and post-pandemic data. After the start of the COVID-19 pandemic, the percentage of calls involving ethanol-based hand sanitizers increased over 300%. However, while the overall numbers increased, the exposure trends appeared to be overall fairly similar. For both the pre- and post- pandemic datasets, cases involving canine patients were the most common, and accidental oral exposure was the most frequent type of exposure event noted.

KEYWORDS COVID; ethanol; animal

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158. Neural networks models for predicting medical outcomes of acute salicylate poisoning

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Background: Neural networks have demonstrated promise in predicting medical outcomes. This study aimed to evaluate the performance of a neural network model in predicting outcomes secondary to acute salicylate poisoning.
Methods: We extracted single-substance cases reported to the National Poison Data System (NPDS) from 1 January 2014, through 31 December 2018, involving acute salicylate exposures. A deep neural network (DNN), using the application programming interface Keras, was applied for multi-class classification tasks.
Results: The Keras DNN had an overall accuracy and F1 score of 98, 96.7, and 96.5%, for training, validation, and testing groups, respectively, in predicting medical outcomes. The outcomes were classified as either serious outcomes (moderate or major effect or death) or minor outcomes defined by NPDS coding criteria. Our results showed that acidosis, coagulopathy (except for PT or INR prolongation), and age were the primary contributing features in the accurate prediction of acute salicylate poisoning outcomes.
Conclusions: The accuracy of the Keras model for predicting medical outcomes associated with acute salicylate poisoning was 96%. The model could predict serious and minor outcomes with high sensitivity (> 96%). This model has the potential to be a useful clinical tool in helping to predict outcomes and inform the management of acute salicylate poisoning warranting further scrutiny and validation.

KEYWORDS salicylate poisoning; deep neural networks; National Poison Data System

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159. Ethephon poisoning: clinical characteristics and outcomes

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Background: Ethephon (2chloroethylphosphonic acid) is one of the most commonly used plant growth regulators used to promote fruit ripening, abscission, flower induction, and other responses. Current data on ethephon poisoning in humans are very limited. This study describes clinical characteristics and outcomes of patients exposed to products containing-ethephon.
Methods: We performed a retrospective cohort study by analyzing data from the Poison Center database for 8 years (2013–2020).
Results: There were 252 patients included in the study. Most (65.9%) patients were males and had ingested ethephon accidentally (83.3%). The median age was 32 years (range, 11 months–86 years). Almost all (98.4%) had oral exposure. The median amount of ingestion was 25 milliliters. The median time from exposure to hospital visit was 60 minutes. Clinical presentations included gastrointestinal (GI) symptoms (55.6%), local effect (irritation) (36.1%), neurologic symptoms (9.1%) and respiratory symptoms (1.6%). At presentation, most had normal vital signs and were conscious. Fifty-four patients (21.4%) had no obvious clinical effects at presentation. Most patients had normal laboratory tests at presentation, although some had acute kidney injury (AKI) (2 patients) and high anion gap metabolic acidosis (1 patient). One hundred and eight patients (42.9%%) were admitted to hospitals, with a median length of stay of 0.7 day. Most patients received only supportive treatment and fully recovered. Seven and six patients received inotropic drugs and were intubated with ventilator support, respectively. Most had no and minor effects. Three patients died. Two deaths ingested accidentally. All had underlying diseases and developed AKI and pneumonia during hospitalization. We compared the clinical characteristics at presentation of patients who had no-minor effects (244 patients) and moderate-severe effects including deaths (8 patients) The amount of ingestion, neurological symptoms, drowsiness, salivation, Glasgow coma scale (GCS) < 15 showed significant differences. No significant differences were found in age, sex, local effects, GI symptoms, respiratory symptoms, fever, hypotension.
Conclusions: Products containing Ethephon or Ethephon caused only mild effects in most patients, but systemic effects occurred in some. The mortality from this poisoning was very low,

however, deaths occurred in patients with accidental ingestion. Supportive care and proper management of complications should be the main treatment for this poisoning. The amount ingested and neurological symptoms including depressed consciousness and low GCS at presentation were associated with moderate to severe outcomes including deaths.

KEYWORDS 2-Chloroethylphosphonic acid; plant growth regulators; deaths

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160. An osmol gap performance gap: a laboratory survey

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Background: Despite national guidelines, many hospitals are unable to determine toxic alcohol concentrations in a clinically meaningful timeframe. In lieu of an available gold standard, clinicians must use surrogate markers such as the osmol gap. Following toxic alcohol ingestion, the osmotically active parent compound contributes to a difference in measured osmolality when compared to a calculated osmolarity determined by the measured serum chemistries. Our poison center was recently consulted on a patient with a reported ethylene glycol exposure who had two reported osmol gaps of less than – 10 mOsm/kg. This called the diagnosis of toxic alcohol ingestion into question. Investigation revealed that the serum osmolality was merely calculated and when the sample was measured with an osmometer there was a clinically significant osmol gap. In light of this sentinel event, a survey of hospital laboratories in our poison center catchment area was performed.
Methods: We attempted to survey 81 hospitals. A four-question survey was administered via telephone, consisting of the following questions: Is your hospital laboratory able to directly test for toxic alcohols such as methanol and ethylene glycol? If your hospital is unable to directly test for toxic alcohols, how long does it take to get the results back? By what method does your hospital test for serum osmolality? If your hospital directly measures serum osmolality, is there ever a scenario in which a calculated osmolality may be reported instead?
Results: Of the 81 laboratories surveyed, only 38 responded. Of the responding hospitals, 0 (0%) were able to directly test for toxic alcohols and provide bedside clinicians with results in a clinically meaningful timeframe. Thirty-eight (100%) were reliant on outside laboratories, with a reported average time to result of 2.3 days. Of these 38 surrogate-dependent hospitals, 1 (2.6%) reported calculating osmolality based on chemistries as opposed to direct measurement via freezing point depression (35 (92.1%)) or boiling point elevation (0 (0%)). Two hospitals (5.3%) were reliant on outside laboratories for osmolality measurement as a "send-out" test. Two hospitals that have the capability to directly measure osmolality did have scenarios in which a calculated value would be reported instead. This policy was reported to have changed during our survey.
Conclusions: Based on the limited results of this survey, there is no hospital in our poison center's catchment area that can directly test for toxic alcohols. This widespread suboptimal dependence on osmolality is further hampered by reliance on outside laboratories (5.3%) and scenarios in which osmolality is simply calculated instead of measured (7.9%), invalidating its usage for toxic alcohol assessment. In conclusion, over 10% of hospitals in our catchment area could have significant trouble assessing for toxic alcohol ingestion in their patient population. Toxicologists should be aware of their local laboratory capabilities and deficiencies as it can directly impede patient care.

KEYWORDS Osmol gap; toxic alcohols; laboratory error

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161. The interval before the storm: veno-arterial extracorporeal membrane oxygenation initiation for confirmed severe bupropion cardiotoxicity

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Background: Bupropion is a norepinephrine/dopamine reuptake inhibitor used to treat major depression. Overdoses result in tachycardia, hypertension, agitation, and seizures. Cardiotoxicity due to conduction impairment, impaired inotropy, and malignant dysrhythmias can be fatal.
Case report: A 32-year-old transgender man with human immunodeficiency virus, major depression, and substance use disorder presented to the emergency department after a suicidal ingestion of bupropion three hours prior. A self-terminating seizure occurred prior to arrival. Upon presentation, his vital signs were notable for tachycardia (109 beats/minute). A generalized tonic-clonic seizure occurred 20 minutes later. An electrocardiogram (ECG) revealed: heart rate, 125 beats/min; QRS duration, 110 ms; and QTc interval (Rautaharju), 544 ms. These data and another seizure prompted our recommendation for transfer to our veno-arterial extracorporeal membrane oxygenation (VA-ECMO) capable hospital. He was intubated for airway protection several hours after arrival to our hospital. One-hour post-intubation, he developed shock requiring increasing vasopressor and inotropic support over the next seven hours. The ECG demonstrated QRS duration of 162 ms and QTc interval of $>$ 750 ms. A bedside echocardiogram demonstrated a globally hypokinetic myocardium with a reduced ejection fraction (20–25%). We initiated VA-ECMO approximately 24 hours post-ingestion. The patient had fixed and dilated pupils for which an emergent head computed tomography scan was obtained, revealing no evidence of herniation. Eight hours after ECMO initiation, he developed ventricular tachycardia, which was treated with two electrical cardioversions and intravenous lidocaine by bolus and infusion. After this clinical nadir, he steadily improved, and ECMO was discontinued approximately 72 hours after ingestion. The patient was extubated three days later and was neurologically normal. Serum bupropion and hydroxybupropion concentrations were $>$ 1000 and $>$ 3000 mcg/L at presentation, $>$ 1000 and $>$ 3000 mcg/L 3 hours after ECMO initiation, 137 and $>$ 3000 mcg/L at ECMO decannulation, and 16 and 1798 mcg/L at extubation.
Discussion: The lack of an effective antidote for bupropion overdose risks fatal cardiovascular collapse. To our knowledge, this is

a unique case of bupropion toxicity confirmed by serum concentrations for whom ECMO was initiated prior to cardiac arrest. We believe the hemodynamic support provided during treatment of malignant dysrhythmias contributed to his good outcome. Similarities to other cases included initial seizures, early severe cardiotoxicity, and apparent brain death. Bupropion kinetics are described as first-order; our data are consistent with this. Dilutions for concentrations above assay limits are ongoing to allow for further kinetic characterization. The ability to prognosticate the severity of patients with bupropion overdose is difficult. For this patient, our recommendation to transfer to an ECMO center was based on recurrent seizures and QRS/QTc widening. The initiation of ECMO was informed by widening ECG intervals that corresponded with a deteriorating hemodynamic status, echocardiography, and multidisciplinary discussions.
Conclusions: The use of VA-ECMO can be lifesaving in severe bupropion poisoning. While specific ECG thresholds or at-risk bupropion concentrations to initiate VA-ECMO await further study, progressive ECG interval widening or shock should prompt ECMO consultation prior to cardiovascular collapse.

KEYWORDS Bupropion; ECMO; electrocardiogram

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162. Minding the gap: a case of misleading osmol gaps

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Background: Despite national guidelines, many hospitals are unable to determine toxic alcohol concentrations in a clinically meaningful timeframe. In lieu of an available gold standard, clinicians must use surrogate markers such as the osmol gap. Following toxic alcohol ingestion, the osmotically active parent compound contributes to a difference in measured osmolality when compared to a calculated osmolarity determined by the measured serum chemistries. As the alcohol is oxidized to acidic metabolites, the osmol gap decreases while the metabolites contribute to an increasing anion gap acidosis.
Case report: Our poison center was consulted on a sixteen-year-old girl who presented after a reported intentional ingestion of antifreeze. A bottle containing 50% ethylene glycol was found under her bed. Her physical examination was unremarkable. Her laboratory studies were notable for a normal creatinine, an anion gap of 10 mEq/L, a negative ethanol concentration, and an osmol gap of −10.6 mOsm/kg. Her laboratory studies were repeated one hour later and revealed an identical osmolar gap of −10.6 mOsm/kg. Given the stable negative osmol gap in this patient, the diagnosis of toxic alcohol ingestion was called into question. The disconnect between history and laboratory findings in combination with the suspiciously stable osmol gap resulted in a call to the hospital laboratory. It was revealed that the serum osmolality was reported as measured but in truth was merely calculated. When directly measured using an osmometer, the patient's osmol gap was 16.4 mOsm/kg. She was treated appropriately with fomepizole, her osmol gap normalized, and she never developed an acidosis or kidney injury. Her care was ultimately transferred to psychiatry. Her ethylene glycol concentration resulted three days later at 80.8 mg/dL (13.0 mmol/L), which if unrecognized could have led to kidney injury and further morbidity.
Discussion: This case helps demonstrate the need for rapid, direct measurements of toxic alcohols, and highlights one of many problems with osmol gaps. In this case, the suspiciously stable osmol gap arose from a simple difference in algebraic equations for osmolarity.
Conclusions: In the context of a disconnect between history and laboratory findings along with identical osmol gaps, the clinician should ensure that osmolality is directly measured as opposed to calculated. Until the standard of rapidly obtaining toxic alcohol concentrations is broadly implemented, we recommend that policies and procedures be put in place to minimize errors associated with determination of the osmol gap.

KEYWORDS Ethylene glycol; osmol gap; toxic alcohols

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163. Glow product ingestions by dogs reported to poison centers

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Background: Glow (chemiluminescent) products, such as glow jewelry and glow sticks, provide heatless chemical luminescence in a variety of colors. The active ingredients in many of these products are anthracene and oxalates synthesized with dibutyl phthalate. Although generally considered non-toxic, information on glow product ingestions by dogs is limited. The objective of this study was to describe glow product ingestions by dogs reported to poison centers that primarily manage human exposures.
Methods: Cases were glow product exposures (Generic code 0201027) reported to a large, statewide poison center network during 2000–2021 where the exposure route was ingestion, the patient species was animal, and the animal type was dog. The distribution of cases was determined for various factors.
Results: A total of 169 glow product ingestions by dogs were identified. There were 32 (18.9%) ingestions during December–February, 28 (16.6%) during March–May, 48 (28.4%) during June–August, and 61 (36.1%) during September-November. The months with the highest number of ingestions were November (n = 25, 14.8%), October (n = 24, 14.2%), and July (n = 23, 13.6%). The ingestion occurred at the home of the dog's owner or caregiver in 126 (74.6%) cases, 1 (0.6%) at another residence, 1 (0.6%) in a public area, and 41 (24.3%) at an unknown location. The management site was 145 (85.8%) on site (outside of a healthcare facility), 23 (13.6%) at an unspecified other location (possibly a veterinarian facility), and 1 (0.6%) at an unknown location. A clinical effect was reported in 37 (21.9%) of the cases. The most frequently reported clinical effects were oral irritation (n = 17, 10.1%), vomiting (n = 6, 3.6%), dermal irritation/pain (n = 3, 1.8%), and diarrhea (n = 2, 1.2%). Clinical effects reported in single cases included agitation, blood in the rectum, drowsiness/lethargy, dyspnea, excess secretions, hematemesis, nausea, and tremor. The ingestion was not serious (no effect, minor effect, not followed-judged nontoxic, not followed-minimal effects possible) in 148 (87.6%) cases, serious (moderate effect, major effect, unable to follow-potentially toxic) in 20 (11.8%), and unrelated to the ingestion in 1 (0.6%); no deaths were reported, although the poison center network generally does not follow animal exposures to determine final outcome. A treatment was documented in 114 (67.5%) of the cases. The reported treatments were dilute/irrigate/wash (n = 106, 62.7%), food/snack (n = 14, 8.3%), other emetic (n = 1, 0.6%), and unspecified other (n = 4, 2.4%).
Conclusions: This study found that glow product ingestions by dogs were more often reported during the months of July, October, and November. Human exposures to glow products have been reported to cluster around the Independence Day (July 4) and Halloween (October 31) holidays. Most of the ingestions occur at the owner's own home. The majority of cases did not result in serious outcomes and were treated on site.

KEYWORDS Dogs; glow products; poison center

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164. Characterization of benazepril ingestions reported to a regional poison center network

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Background: Benazepril is an angiotensin-converting enzyme (ACE) inhibitor commonly prescribed for high blood pressure, heart failure, or kidney disease in both pets and humans. ACE inhibitors decrease blood pressure by decreasing vascular resistance, with little-to-no change in heart rate, volume, or cardiac output. Common adverse effects of ACE inhibitors include hypotension, hyperkalemia, dry cough, and impaired renal function. Many medical resources, such as Poisindex®, report dose ranges associated with toxicity for use by Specialists in Poison Information (SPIs) when triaging incoming calls for emergency department referral. However, no such dose range has been established for the ACE inhibitor benazepril. This review aimed to describe the clinical effects associated with benazepril ingestion and determine the dose range associated with toxicity.
Methods: This was a retrospective quality improvement chart review of benazepril ingestions reported to a statewide Poison Center network from January 2015 to December 2022. Cases were included if an exact or estimated dose of benazepril ingested was reported and had documentation of a known or expected outcome. Information about the patient's age, gender, weight, additional substances ingested, milligram dose, the certainty of ingested dose, location of medical management, and outcome were collected. The data were analyzed using descriptive statistics to evaluate trends.
Results: 124 cases of benazepril ingestions occurred within the study period, 98 of which were reported with a known outcome and quantified dose ingested to be included in this review. Four (4.1%) cases were noted to have minor effects, 48 (49%) cases had no effects, and 6 (6.1%) cases were judged as a nontoxic exposure (clinical effects not expected). Forty (41%) cases were not followed due to minimal clinical effects possible (no more than minor effect). There were no reports of moderate or major outcomes or death. Most cases (84, 85.7%) were safely followed at the patient's own residence, 8 (8.2%) at a hospital location, and 6 (6.1%) at another location. Six cases were multi-drug exposures, two of which were reported to have minor effects. The mean dose ingested was 58.66 mg (range: 2.5–800 mg) and the median dose ingested was 25 mg. Thirty-five cases included the patient's weight, for which the average dose ingested was 1.13 mg/kg (range: 0.06–4 mg/kg) and the median dose ingested was 0.97 mg/kg. The mean dose ingested in the 4 cases with a known outcome of minor effects was 100 mg or 2.08 mg/kg. The most common adverse effect reported was dizziness/vertigo (4 cases). Headache, vomiting, mild CNS depression, tachycardia, and agitation were also reported.
Conclusions: Per this review, cases of benazepril ingestion up to 4 mg/kg were typically benign, with most cases able to be safely followed at the patient's own residence without medical intervention. Patient-specific risk factors and comorbidities should be evaluated when triaging the care of a patient reporting an overdose, such as age, weight, severity of initial symptoms, intention of ingestion, and concomitant substances ingested.

KEYWORDS Benazepril; ACE Inhibitor

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165. The epidemiology of patients with acute toxicity admitted to the intensive care unit by the toxicology team at a tertiary care centre in the UAE from April 2015 to April 2022: a retrospective observational study

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Background: Acute Poisoning is an important cause of ICU admission. The specific patterns of poisoning vary between different countries and age groups. Patients with acute poisoning requiring ICU admission are at the end of the toxicity spectrum. Managing such patients in the ICU requires extensive resource utilization and is associated with high morbidity and mortality rates.
Methods: This study is a Retrospective Observational Study that will describe all the cases aged 13 years and older of acute poisoning admitted to the ICU of a Tertiary Care Centre in the UAE. It will look at patients' characteristics, history, duration of hospitalization, and the management approaches used during their hospital stay. Statistical Package for Social Sciences (SPSS) will be used for analysis to compare the variables and describe the ICU-toxicology population.
Results: The study identified 194 ICU cases of acute poisoning, 14 of which died in the ICU. The type of poisoning with the highest incidence was Sedative – Hypnotics (21.4%), followed by Caustics and Corrosives (16.6%). The highest number of deaths was by Caustics and Corrosives (30.8% of mortalities). 72.2% of patients used mainly supportive therapy without the requirement of any antidotes or specific therapy. ICU mortality was significantly higher in patients who needed inotropic support ($P = 0.01$); those with a previous history of psychiatric illness and admission ($P = 0.008$ and $P = 0.029$, respectively). The need for decontamination and specific therapy was also significant ($P = 0.005$ and $P = 0.016$, respectively). The Indication for Computed Tomography and its findings are also significant ($P = 0.000$ and $P = 0.054$, respectively). All other parameters studied were insignificant.
Conclusions: The study described all the acute poisoning cases in the ICU of a Tertiary Care Center in the UAE. The leading types of poisoning cases requiring intensive care unit admission were sedative-hypnotics, caustics, and corrosives, and the outcome was significantly affected by the need for inotropic support. This study can serve as the first step towards establishing a poisoning registry in the UAE, and it can help with recognizing patterns of acute poisoning which will help with devising preventative measures.

KEYWORDS ICU admission; toxicology; overdose

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166. Intersex people remain invisible to the poison center's documentation

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Background: Some people only believe in the gender binary classification. This classification only recognizes two distinct and opposite forms of gender, masculine and feminine. This train of

thought excludes intersex people. Research has documented that as many as 5%, of the U. S. population is born with different sexual development (DSD, intersex). Intersex people are born with sex characteristics that do not fit the typical binary male and female phenotypes and genotype. These characteristics include chromosome patterns, gonads, and/or genitals. The objective of this research is to determine if intersex people who attempted or committed suicide by overdose are documented as intersex by the poison control centers.
Methods: We conducted a retrospective data review of 11% of the 55 poison centers in the United States from 2012 to 2022 and determine if there is a statistical representation of intersex people attempting or committing suicide by overdose compared to their cisgender counterparts. Cisgender is the term used to describe the person's gender identity and the gender is documented by the person completing the chart; the Toxicall®'s chart's options include male, female and unknown.
Results: The total number of people who attempted or committed suicide by overdose cases that were documented by the 11% of the poison centers under review from 2012 to 2022 was 232,818. The number of documented intersex cases from the same sample was zero. Intersex is not included in Toxicall® 's gender drop down options and it was never included in the chart's written section.
Conclusions: Theoretically, of the 232,818 people that was documented by the poison centers as attempting or committed suicide by overdose, 11,641 should have been intersex people, yet none were documented. The tool used to document the person's gender identity should be upgraded to be inclusive. Data collection by the poison center should be accurate and representative of the population. Accurate data will help research, social services, and medical personnel provide optimal healthcare for those in need.

KEYWORDS Intersex; gender; documentation

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167. When tox isn't tox: characterization of non-toxicologic causes of death reported to a regional poison center from 2018–2022

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Background: The Regional Poison Center (RPC) provides consultation to almost 3 million people who reside within 14 of the 15 counties in the state. From 2018 to 2022 the RPC consulted on 91,517 human exposures, of which 150 resulted in fatality. While most of the deaths were found to be related to the toxicologic substance(s) of concern, an undetermined number of them were coded to be "probably not responsible," "clearly not responsible," or "unknown" if related, as defined by the National Poison Data System (NPDS) using the Relative Contribution to Fatality (RCF) guidance system. This review was undertaken to gain an understanding of the conditions associated with consultations to the RPC that result in fatalities not clearly stemming from toxicologic exposure.
Methods: This was a retrospective descriptive review of death reports submitted by the RPC to the NPDS for 2018–2022. The reports were separated into RCF categories 1–3, where the toxin was related to the fatality, and categories 4–6, where this was less clear. Cases with RCF of 4–6 were evaluated for circumstances surrounding the death, toxin of concern, and cause of death.
Results: From 2018 to 2022 the number of consultations that resulted in fatality averaged 30 deaths per year, and approximately 25% of these deaths were found to have an RCF of 4–6. The circumstances prompting consultation for these cases involved patients where there was an unclear cause for a new medical condition. Fifty-one percent of the consultations originated from patients found down and unresponsive. Other new medical conditions, such as intractable nausea and vomiting, weakness, dizziness, seizures, and heart failure, accounted for 49%. A measurable drug concentration was the cause for 16% of these consultations, and use of an herbal supplement precipitated 8% of these cases. There was overlap between these groups. The toxin of concern largely centered around prescription medications, such as prescription pain medications (43%). Drugs of abuse were involved in 41% of these deaths. Over-the-counter medications, primarily acetaminophen, were implicated in 19%, as was "unknown substance." Herbal supplements and "other chemicals" accounted for 8 and 5%, respectively. One case was associated with possible snakebite. Overlap between prescription pain medications and drugs of abuse occurred in 77% of these cases. An autopsy was obtained for 19% of these deaths. Cause of death in 43% of these reports was found to be undetermined. The rest were attributed to medical causes.
Conclusions: Fatality reports with an RCF of 4–6 are challenging to evaluate. Concern for a toxicologic source or contribution to the death generates the poison center consultation. Perhaps by obtaining more information from the patients' family and friends, first responders' evaluation of the scene, and with increased involvement by the Medical Examiner, more pieces to these mystery cases can help clarify what role the toxin may have played in the death. Ultimately this could help provide closure to the patients' families.

KEYWORDS Relative contribution to fatality; death reports; uncertain cause of death

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168. Antidepressants and anxiolytics: a 7-year positivity overview in clinical case submissions

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Background: Antidepressants and anxiolytics are medications that are prescribed to control many mood disorders, including anxiety, depression, obsessive-compulsive disorder, and psychosis. These substances are classified by their drug structure and/or mechanism of action, and based on the needs of the individual, dosing regimens are tailored by the prescriber. Commonly prescribed classes of these substances include selective serotonin reuptake inhibitors (SSRIs), serotonin-norepinephrine reuptake inhibitors (SNRIs) and benzodiazepines (BZDs). Recent studies have noted an increase in prescriptions for antidepressants and anti-anxiety medications through prescription data and self-reported use.
Methods: In this study clinical blood and serum casework submitted to NMS Labs from 2016-2022 were evaluated for frequently prescribed SSRIs (fluoxetine, citalopram, vilazodone, paroxetine, and sertraline), SNRIs (atomoxetine, venlafaxine, and duloxetine), and BZDs to evaluate data trends. Testing was either performed as a directed analysis or as a screen with subsequent confirmation analysis; testing was determined by the submitting

agency. Demographics, including age and sex, were also monitored to determine if any drug trends were observed.
Results: The SSRI's citalopram and fluoxetine showed a marked increase in prevalence, 270 and 210% increase, respectively. Conversely, paroxetine and sertraline showed minor decreases in positivity, while vilazodone remained relatively constant. All three SNRIs included in this study decreased during the monitored period. Overall, benzodiazepines remained relatively constant across this seven-year time frame, with approximately 1300 positive findings in 2016 and 1000 in 2022. Alprazolam and diazepam showed a decrease in positivity, 64 and 68%, respectively, while lorazepam and midazolam showed little change.
Conclusions: While recent literature does note an increase in non-specific antidepressant use, that trend was not observed in this study for all drug classes. It is likely this is a limitation of the casework submitted to NMS as testing performed is specific to the client's needs as well as how previous data was collected (self-reported and prescription records). Increases were only noted for two of the SSRIs monitored (fluoxetine and citalopram) while other analytes showed minimal changes or decreases (SNRIs and BZDs). Differences in trend observations can be hypothesized to originate from differences in positivity measurements (by clinical analyte positives versus prescriptions) or by clinical clients requiring testing be performed at NMS Labs. To obtain another perspective on prevalence, postmortem (PM) population positivity could also be explored. By exploring this avenue of testing and comparing the results of PM and clinical results, the theory of submitting clients affecting positivity could be evaluated. Future work comparing trends of current clinical data with future PM positivity results would allow for a more comprehensive picture of total positivity to be established.

KEYWORDS Antidepressants; anxiolytics; prescription trends

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169. Pre-hospital administration of Crotalidae immune F(ab')2 for North American pit viper envenomation

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Background: Treatment for symptomatic pit viper envenomation in North America consists primarily of antivenom administration with either crotalidae immune F(ab')$_2$ (equine) or crotalidae polyvalent immune Fab (ovine). Either therapy is typically initiated after presentation to and evaluation by emergency department providers. We report on the administration of crotalidae immune F(ab')$_2$ (equine) for symptomatic North American pit viper envenomation in a rural pre-hospital setting.
Case report: A 77-year-old man was hiking with his wife when he was bitten by a rattlesnake above his hiking boot. His wife called 911 and ground transport was dispatched. Ground emergency medical services (EMS) contacted air medical transport services while en route to the scene, having been previously informed of a hospital-based program in our state which was now providing crotalidae immune F(ab')$_2$ to the helicopter service. EMS reached the patient approximately 45 minutes after envenomation. Physical exam revealed two puncture marks on the patient's left lower extremity, just superior to the lateral malleolus with swelling noted to the mid-calf region. Air medical transport arrived and assessed the patient 75 minutes after envenomation. Pursuant to an approved algorithm for the initial treatment of rattlesnake envenomation, the decision was made to administer a 10-vial dose of crotalidae immune F(ab')$_2$ 83 minutes after the bite. No infusion-related adverse events occurred. On arrival to an outside hospital ED, the patient was awake and alert, with stable vital signs. Swelling was again noted which extended from the dorsum of the foot up to the mid-calf region, crossing the ankle. Initial labs were as follows: hemoglobin 12.3 g/dL, platelets 444,000/μL, fibrinogen 286 mg/dL, and prothrombin time 11.5 sec. The patient was later transferred to our hospital, arriving to the ICU 12 hours after envenomation. Upon arrival, he described some evolving ecchymosis on his foot but felt that his swelling was improving. The patient was treated with antiemetics and analgesics but required no further doses of crotalidae immune F(ab')$_2$. Two repeat sets of laboratory studies for venom-related coagulopathy remained within normal limits. At follow up three days after discharge (five days after envenomation), the patient reported improvement in his pain with near complete return to baseline function. His repeat labs showed no signs of delayed coagulopathy: hemoglobin 12.1 g/dL, platelets 423,000/μL, fibrinogen 366 mg/dL, and prothrombin time 10.1 sec.
Discussion: Crotalidae immune F(ab')$_2$ is indicated for symptomatic envenomation by North American pit vipers. Antivenom administration can reverse the hemotoxic, neurotoxic, and systemic toxicity but can only halt the local cytotoxic effects. The forward deployment of pit viper antivenom to first responders in under-resourced locations can lead to earlier drug administration with the goal of optimizing outcomes in envenomated patients.
Conclusions: This case demonstrates the safe administration of crotalidae immune F(ab')2 in a pre-hospital setting and the potential for investigation into whether earlier administration of antivenom minimizes the extent and severity of North American rattlesnake envenomations.

KEYWORDS Rattlesnake; pre-hospital; antivenom

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170. Eye-popping spider bite: viscerocutaneous *Loxosceles* envenomation with orbital compartment syndrome

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Background: *Loxosceles* is a spider genus comprising 13 US species popularly known as brown recluses. The venom is a complex cytotoxic protein mixture. Envenomation can cause necrotic skin lesions and rare systemic effects that occur within 24–48 hours following the bite, leading to widespread hemolysis, coagulopathy, and even death.
Case report: A 44-year-old male with no past medical history presented 24 hours after being bitten by what he stated was a brown recluse spider just superior to the right eyebrow. Eight hours later he noted facial pain, swelling, and progressive vision loss that worsened throughout the day. In the ED, vital signs were HR 129 bpm, BP 108/67 mmHg, R 18 breaths/min, T 36.8 °C, and SpO_2 91%. He had facial ecchymosis with angioedema. The right eye had marked proptosis and severe periorbital edema. The patient rapidly decompensated with hypoxia, hypotension, and worsening angioedema. During intubation, tracheal deviation was noted and attributed to severe edema of the neck. Stomach contents revealed upper gastrointestinal bleeding. Lateral canthotomy with cantholysis was performed for ocular compartment syndrome with subsequent clinical improvement. Laboratories showed 53% bands, thrombocytopenia, high anion gap metabolic acidosis, multiorgan failure (MOF), rhabdomyolysis, and disseminated intravascular coagulopathy (DIC). The patient

continued to deteriorate, and the ICU contacted the poison center, who recommended supportive care including steroids, blood products, and even plasmapheresis. Continuous Renal Replacement Therapy (CRRT) was considered but not performed. The patient died 37 hours after the bite.
Discussion: This is a case of death secondary to probable systemic loxoscelism in an adult with respiratory failure, orbital compartment syndrome, and DIC with hemorrhage and MOF. Proposed venom pathophysiology, especially hematogenous and tissue spread, involves phospholipases D, metalloproteases and hyaluronidases. Metalloproteases and hyaluronidases allow for spread through tissues and eventually access the systemic vascular system. Phospholipases D promotes cell membrane destabilization, and contributes to red blood cell lysis, renal epithelial damage, and eventual end organ damage. Case reports have described secondary warm autoimmune hemolytic anemia, which may be due to IgG- and complement-mediated intravascular and extravascular processes. The mainstay of treatment is aggressive supportive care, as antivenom is not available in the US. Initial treatment includes blood transfusion and corticosteroids; rituximab is second line; and patients may require splenectomy and intravenous immunoglobulin (IVIG). Vaccines trials are underway and antivenom is used in Brazil, Argentina, Peru, and Mexico but requires swift diagnosis. To aid in diagnosis of local *Loxosceles* envenomation, the "NOT RECLUSE" mnemonic may be applied, and prospective diagnostic performance of the mnemonic is one of many future research opportunities.
Conclusions: Acute care clinicians should be prepared to use common and rare ED procedures in complex envenomation emergencies. Further research on pathophysiology and treatments, such as antivenom, immunotherapy, and vaccines, is needed to improve outcomes. Improved access to emergency care and treatments in underserved areas, and ability to transport to definitive, higher levels of care may also help improve outcomes, however more research is needed.

KEYWORDS Spider; envenomation; canthotomy

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171. Along came a spider: brown recluse spider bites reported to the NPDS from 2002 to 2022

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Background: The Brown Recluse Spider (*Loxosceles reclusa*) is a geographically limited arachnid whose envenomation can result in significant local symptoms, including necrosis and, potentially, life threatening systemic toxicity. However, published medical literature is primarily limited to single center case reports and series. We sought to examine the national trends, clinical characteristics, and treatment of brown recluse spider bites and envenomations reported to the National Poison Data System (NPDS) from 2002 to 2022.
Methods: The NPDS was queried for all brown recluse spider bites and envenomations reported between 1 January 2002 to 31 December 2022. Cases which were followed to a known outcome were included for analysis. All data in the NPDS data set was analyzed using IBM SPSS Statistics for Mac, Version 25.0 (Armonk, NY, USA).
Results: 13750 cases were reported, 78.4% (n = 10787) were adult and 21.5% (n = 2963) were pediatric cases. The average age for adults was 40.3 years (SD 15.0) and 8.7 years (SD 5.8) for pediatric cases. A majority (54.4%, n = 5867) of adult cases involved females while males predominated (51.5%, n = 1527) in the pediatric cases. Cases declined significantly over the study period. The most cases were reported in 2004 (n = 1326) and the least in 2021 (n = 284). Texas had the most reported total cases (n = 1571) and adult cases (n = 1179), but Missouri had the most pediatric cases (n = 412). The top five reporting states (TX, MO, TN, OK, AL) were in the brown recluse endemic region but every state reported at least one bite and several, such as Nevada (n = 382) and New York (n = 206), reported hundreds of cases. The month with the most reported cases was June for both adults (n = 1516) and pediatrics (n = 467). 54% (n = 5831) of adult and 54% (n = 1602) of pediatric cases were managed at a health care facility. However, 15.8% (n = 467) of pediatric cases were admitted to a health care facility, including 5.7% (n = 168) to a critical care unit, versus 6.3% (n = 679) and 1.3% (n = 140), respectively, for adult cases. Dermal effects were the 3 most common clinical effects reported in both groups. Necrosis was more commonly seen in adult cases (17.9%, n = 1931) than in pediatric cases (11.8%, n = 350). Hemolysis was documented in 4% (n = 120) of pediatric cases and in less than 1% (n = 82) of adult cases. Antibiotics were commonly used in both groups (38% of adult, 36.2% of pediatric cases) while steroids were used in 9.7% (n = 288) of pediatric case and 7.9% (n = 848) of adult cases. Moderate or major clinical outcomes were documented in 48.7% (n = 5250) of adult cases versus 40.4% (n =1196) of pediatric cases. Six deaths were reported, 4 adult and 2 pediatric cases.
Conclusions: Brown recluse spider bites and envenomations reported to the NPDS declined over the study period. Cases predominated in endemic areas but the significant number of cases from non-endemic regions may offer education opportunities for PCC staff. Dermal effects were most common but significant clinical outcomes were reported in more than 45% of cases. Though rare, deaths were reported.

KEYWORDS Brown recluse; spider; NPDS

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172. Do widows weave wicked webs? Black widow bites reported to the NPDS from 2002 to 2022

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Background: *Latrodectus* is a broadly distributed genus of spiders, which includes 5 species in North America. They are commonly referred to as widow spiders, with the black widow being most notorious. Black widow envenomations are reported to cause such significant toxicity that an antivenom is approved for treatment. However, literature regarding black widow envenomations remains limited primarily to isolated case reports or series. We sought to investigate national trends, clinical characteristics, and treatment of black widow bites and envenomations reported to the National Poison Data System (NPDS) from 2002 to 2022.
Methods: The NPDS was queried for all black widow spider bites and envenomations reported between 1 January 2002 to 31 December 2022. Cases which were followed to a known outcome were included for analysis. All data in the NPDS data set was

analyzed using IBM SPSS Statistics for Mac, Version 25.0 (Armonk, NY, USA).
Results: 20052 cases were reported: 76.9% (n = 15425) adult and 23.1% (n = 4627) pediatric cases. The average age was 40.1 years (SD 14.4) for adult and 8.7 years (SD 5.8) for pediatric cases. Males predominated in adult (56.8%, n = 8766) and pediatric (59.9%%, n = 2770) cases. Cases declined over the study period, with the most reported in 2002 (n = 1298) and the least in 2021 (n = 575). California had the most overall (n = 3163), adult (n = 2384), and pediatric cases (n = 779). Every state except North Dakota and Washington reported at least one case during the study period. The most cases were reported in September for both adult (n = 2222) and pediatric (n = 708) cases. 61.4% (n = 9466) of adult and 64.6% (n = 2991) of pediatric cases were managed at a health care facility, of which 14.3% (n = 2215) of adult and 18.9% (n = 873) of pediatric cases were admitted. 5.3% (n = 244) of pediatric cases were admitted to critical care unit compared to 3.5% (n = 539) of adult cases. Dermal effects were the 3 most common clinical effects reported in both groups, Abdominal pain was reported in 10.5% (n = 1626) of adult and 11.9% (n = 549) of pediatric cases. Benzodiazepines were used in 22.8% (n = 3533) of adult and 20.2% (n = 937) of pediatric cases but opioids were used in only 3.7% (n = 569) of adult and 2.5% (n = 119) of pediatric cases. Calcium was given in 2.6% (n = 395) of adult and 1.8% (n = 85) of pediatric cases. Antivenom was used in less than 1% of both adult and pediatric cases, however, 85.9% (n = 122) of all antivenom was given since 2018. Moderate or major clinical outcomes were documented in 36.1% (n = 5579) of adult cases versus 30% (n = 1390) of pediatric cases. No deaths were reported during the study period
Conclusions: Black widow spider bites and envenomations reported to the NPDS declined over the study period. Clinical effects were typically dermal though systemic effects such as abdominal pain and hypertension were reported. Benzodiazepines were commonly given while antivenom therapy was rarely administered. Though they have a lethal reputation, no death from a black widow bite or envenomation was reported in this study.

KEYWORDS Black widow; Latrodectus; spider

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173. Big spider, big problems? Tarantula exposures reported to the NPDS from 2002 to 2022

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Background: Tarantulas are a group of large, hairy spiders with worldwide distribution, including the United States. The large size of these spiders has given them a dangerous reputation in lay press. Interactions with tarantulas can result in envenomation and, uniquely, exposures to the urticating hairs or bristles. Medical literature regarding exposures to tarantulas in the United States is limited and restricted to primarily case reports. We sought to investigate the national trends, clinical characteristics and treatment of tarantula exposures reported to the National Poison Data System (NPDS) from 2002 to 2022.
Methods: The NPDS was queried for all tarantula bites and envenomations between 1 January 2002 to 31 December 2022. Cases which were followed to a known outcome were included for analysis. All data in the NPDS data set was analyzed using IBM SPSS Statistics for Mac, Version 25.0 (Armonk, NY, USA).
Results: 759 Cases were reported, 63.2% (n = 480) were adult and 36.7%% (n = 273) were pediatric cases. The average adult age was 37.3 years (SD 14.9) and 9.4 years (SD 4.9) for pediatric cases. A majority of the cases involved male patients for both adults (58.3%, n = 280) and pediatrics (62.2%, n = 170). The highest number of cases were reported in 2002 (n = 118) and the fewest in 2017 (n = 8). Texas had the most reported overall cases (n = 101) and pediatric cases (n = 37), but Arizona had the most adult cases (n = 64). Cases were reported from every state except Hawaii, Maine, Rhode Island, and North Dakota. The most cases were reported in the month of September (n = 101). 45% (n = 216) of adult and 33.7% (n = 92) of pediatric cases were managed at a health care facility. 3.1% (n = 15) of adult and 2.9% (n = 8) of pediatric cases were admitted to a health care facility. Only 2 adult cases and 1 pediatric case were admitted to a critical care unit. Dermal effects were the 4 most common clinical effects reported in both groups. Eye effects were reported in 3.7% (n = 18) of adult cases and 5.5% (n = 15) of pediatric cases. Local wound cleaning was the most common intervention in both groups, 56.7% (n = 272) in adult and 66.3% (n = 181) in pediatric cases. Moderate or major clinical outcomes were documented in 16.2% (n = 78) of adult cases versus 9.9% (n = 27) of pediatric cases. No deaths were reported.
Conclusions: Tarantula exposures were rarely reported to the NPDS. When they were, dermal effects predominated while ocular effects were rare. Basic wound care was most commonly performed and significant morbidity or mortality was lacking.

KEYWORDS Tarantula; spider; NPDS

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174. Ranolazine exposures reported to the NPDS

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Background: Ranolazine is a piperazine derivative which was approved in 2006 as a treatment for chronic stable angina. Its mechanism of action is believed to include inhibition of late inward sodium channels and may also inhibit rapid delayed rectified potassium channels at higher doses. Published medical literature concerning exposures to ranolazine is limited though several deaths have been reported. We sought to describe the characteristics of ranolazine ingestions reported to the NPDS.
Methods: This was a cross sectional study consisting of NPDS data collection utilizing quantitative data for the period of 1/1/2006 to 12/31/2022 to identify all single agent human exposures to ranolazine followed to a known outcome. All data entered into NPDS was collected and analyzed using Microsoft Excel (Microsoft Corp., Redmond, Washington, 2010).
Results: 650 Cases were identified. 348 Cases (53.54%) were female. 501 cases (77.1%) involved adult patients. The average age of adult patients was 68 years (SD 14.3) and 3 years (SD 4) for pediatric patients. The top three reasons for exposure were unintentional-therapeutic error (425, 65.38%), unintentional-general (146, 22.46%) and intentional-suspected suicide (36, 5.54%). The highest number of cases were reported in 2015 (n = 72). Forty-six cases were reported in 2022. No clinical effect was reported in 407 cases (62.6%). All unintentional pediatric exposures resulted in no clinical effect. Moderate or major medical outcomes were reported in 95 cases (14.6%), 4 of these were intentional pediatric cases. Eighty-five cases (13.1%) were admitted to the hospital including 49 cases which were admitted to critical care unit. Hypotension was reported in 20 cases,

bradycardia in 16 cases, and QT prolongation in 9 cases. Asystole occurred in 4 cases. Intubation was performed in 12 cases and vasopressors were used in 10 cases. ECMO was reported in 1 case. There were 2 deaths reported, both adults with one case being an intentional-suspected suicide and other documented as an adverse drug reaction.
Conclusions: Single agent ranolazine exposures reported to NPDS were uncommon and most commonly due to unintentional therapeutic errors. Unintentional pediatric exposures were associated with no clinical effect. However, intentional or adult ranolazine exposures were associated with significant clinical effects, sometimes requiring critical care interventions. Deaths, though rare, were reported.

KEYWORDS Ranolazine; NPDS; unintentional exposures

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175. Neurological effects on adolescents exposed to horse conch

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Background: Brevetoxins are polyether toxins produced by dinoflagellate *Karenia brevis* and cause sodium channel-mediated depolarization resulting in a stimulatory nervous effect. Brevetoxins can be associated with "Red Tide," which contaminates bivalve shellfish, including scallops, clams, mussels, and oysters. It also contaminates water, aerosols, or foams near the shore. These toxins can be found in the Gulf of Mexico, the United States Southeastern and mid-Atlantic coasts, and New Zealand.
Case series: Two children, ages 10- and 14-year-old females, were brought to the emergency department for gastrointestinal upset and paresthesias after eating the horse conch. Emergency medical services reported persistent vomiting during transport and the appearance of sea snails within the emesis, and a foul pungent odor. The 10-year-old child experienced nausea, vomiting, tachycardia, tachypnea, whispering when attempting to speak, muscle rigidity described as lockjaw and clenching of the hands, and paresthesias of extremities. She had labs within normal limits, except for an elevated lactate of 4 mmol/L. The 14-year-old child experienced mild symptoms of nausea, vomiting, and paresthesias of the hands. Her labs were unremarkable. Both children were treated with antiemetics, diphenhydramine, multiple doses of lorazepam, and normal saline. After a few hours, symptoms resolved, and the children were medically cleared. It was later discovered that the family harvested suspected horse conch at a local beach, and all family members who consumed it developed symptoms.
Discussion: The potential sources of exposure include horse conch (*Triplofusus giganteus*), lightning whelk (*Busycon sinistrum*), crown conch (*Melongena corona*), fighting conch (*Strombus alatus*), true tulip (*Fasciolaria tulipa*), and banded tulip (*Fasciolaria lilium*). The suspected *Triphlofusus giganteus* is traditionally considered edible. However, given recent findings of brevetoxin being found in gastropods after red tide events, clinicians should be aware of this relationship between the two. These patients were exposed to horse conch during a high red tide event with concentrations of *Kerenia brevis* greater than 1,000,000 cells/liter in the area. This amount of *Kerenia brevis* may cause effects plus water discoloration. Symptoms from ingesting seafood contaminated with brevetoxin can include perioral paresthesia, which may spread. Gastrointestinal symptoms are also quite apparent. Vertigo, "hot and cold temperature reversal," ataxia, and muscle twitching may manifest. Seizures may occur. Gastrointestinal and neurological symptoms tend to occur at approximately the same time. Poisoned seafood looks and tastes the same as uncontaminated food, but cooking will not destroy the toxin. Most reported exposures to red tide are related to inhalation of sea spray containing the brevetoxin organisms. Symptoms are usually associated with the respiratory system, such as nasal irritation, bronchospasm, dyspnea, cough, and rhinorrhea.
Conclusions: This case series provides evidence that more research is needed to uncover potential poisoning from exposure to ingested harvested seafoods during high red tide events. Furthermore, rapid assessment and treatment for neurological symptoms were shown to be effective in preventing severe outcomes.

KEYWORDS Brevetoxins; neurological; adolescents

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176. A very hungry toddler who ate a caterpillar!

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Background: *Lepidoptera* poisoning is a very rare presentation to emergency departments. Symptoms range from local skin dermatitis (erucism) to systemic symptoms known as lepidopterism. Our case describes a pediatric patient who presents with drooling and sore throat after ingestion of a caterpillar. *Lepidoptera*: A Greek name, meaning scaly winged, is an order of insects. Caterpillars are the larvae of butterflies and moths belonging to *Lepidoptera*. In the US, most caterpillars are harmless, but several types are venomous, the latter can cause variable symptoms in humans upon exposure. Symptoms range from local skin dermatitis (erucism) to systemic symptoms (lepidopterism) including headache, nausea, or severe allergic symptoms. While the puss caterpillar (*Megalopyge opercularis*) is the most common cause of erucism in the United States, the White flannel moth caterpillar (*Norape ovina*), which is more prevalent in Virginia, has been reported to cause erucism. The exact chemical composition of the toxin is not known, but it contains hyaluronidase, peptides, phospholipase A, and a histamine-releasing substance.
Case report: 14 months old previously healthy female presents to the emergency department with drooling and refusal to eat. The toddler's parent reported that a few hours prior to the presentation, the patient chewed on a black hairy caterpillar before she spit it out. The patient was asymptomatic initially but then started drooling, crying, and refusing to eat. In the emergency department: the patient's vital signs were BP 125/89, Pulse 147, Temp 97.7 °F (36.5 °C) (Temporal), Resp 25, SpO_2 100%. She was drooling, breathing comfortably, with no stridor. Multiple tiny filaments/hairs were embedded in the tongue, lingual mucosal, buccal mucosa, left tonsil, soft palate, and uvula. No fluctuance. Imaging was done in the form of a soft tissue neck x-ray which was normal. The patient was transferred to the operating room under ENT service, where extensive black caterpillar hairs were found, embedded in the mucosal tissue. These were carefully removed. Direct laryngoscopy was then performed to evaluate the posterior oropharynx and glossopharyngeal region. The patient's symptoms improved and was discharged home.
Discussion: The differential diagnosis of a pediatric patient presenting with drooling includes but is not limited to, foreign body ingestion, infectious etiologies, and accidental exposure to toxins. Caterpillar ingestion is an uncommon presentation to the ER. Upon ingestion of the caterpillar, and because of the local reaction to the toxin excreted from the spines, inflammation of the oral cavity may develop which can manifest as erythema, swelling, and burning of the mucous membranes. This can explain our patient's symptoms. Although our patient did not have signs of upper airway obstruction, it remained a big concern. Airway

management in a controlled environment room with anesthesia and ENT specialists' presence was the safest option for our patient. The treatment for caterpillar exposure involves decontamination by removing the hairs/spines and symptomatic management with analgesics, antihistamines, and steroids.
Conclusions: Caterpillar ingestion is a very rare presentation to the ER. Our case description outlines the presentation and management of caterpillar ingestion in a pediatric patient.

KEYWORDS Lepidoptera poisoning; caterpillar; pediatric

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177. Dexmedetomidine: a potential homicidal medicine?

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Background: Dexmedetomidine, a sedative used in human medicine and veterinary practice, can cause overdose-related effects such as over-sedation, bradycardia, and hypotension. A study in 2019 reported its detection in drug-facilitated sexual assault cases.
Case report: A 61-year-old female with a history of hypertension and hyperlipidemia was admitted to the emergency department (ED) due to altered mental status, bradycardia, and hypothermia. These symptoms occurred after having lunch with her son and his friend. The son also experienced similar symptoms. They were found unconscious at home by a relative after approximately 7 hours and were taken to the ED. Upon arrival, body temperature was 34 °C and heart rate was 48 beats/min. She had pinpoint pupils and a Glasgow Coma Scale score of E3V5M6. Naloxone and flumazenil were administered but had no effect. A urine benzodiazepine (BZD) test was negative. Pralidoxime and atropine were given suspecting organophosphate/carbamate insecticide poisoning, although cholinergic toxidrome was not observed. The patient's consciousness improved on day 2, but she remained drowsy. She was transferred to Taipei Veterans General Hospital for suspected homicidal poisoning. At the ED, her pupil size was normal, and an ECG showed sinus bradycardia. Laboratory tests, including serum digoxin concentration and cholinesterase levels, were normal. Urine toxicological tests by using Q-TOF and LC-MS/MS revealed the presence of dexmedetomidine and scopolamine. Her condition gradually improved, and she was discharged on day 4.
Discussion: The clinical effects of dexmedetomidine poisoning primarily involve central nervous system (CNS) depression. Numerous medications, such as BZD, psychiatric drugs, and gamma-hydroxybutyrate (GHB), can cause similar CNS depression. Due to the patient's negative BZD screen, the possibility of BZD overdose was unlikely. As for GHB exposure, because her initial urine sample was not available, it was not possible to completely exclude the possibility of GHB exposure. The patient was found to have dexmedetomidine and scopolamine in her urine. Among them, scopolamine has previously been reported to be used for recreational purpose in Taiwan and may induce central anticholinergic effects and coma. However, the lack of peripheral anticholinergic toxidrome makes the diagnosis of overt scopolamine poisoning unlikely. Dexmedetomidine poisoning is rarely reported in Taiwan, and the diagnosis without appropriate toxicological tests is difficult. Only two other cases of dexmedetomidine detection were previously reported in our toxicology laboratory, both associated with drug-facilitated sexual assaults.
Conclusions: Homicidal dexmedetomidine poisoning is highly suspected in this unusual case. Due to the rarity of dexmedetomidine poisoning, diagnosis is challenging without appropriate toxicological tests. Emergency physicians and clinical toxicologists should consider dexmedetomidine poisoning as a possibility when encountering patients with CNS depression, bradycardia and miosis in the ED.

KEYWORDS Dexmedetomidine; homicidal medicine; scopolamine

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178. Expanding access to ECMO for poisoned patients: remote cannulation before transfer to ECMO center

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Background: The use of extracorporeal membrane oxygenation (ECMO) for poison-induced shock has steadily increased in recent years, however geographic disparities exist, with rural areas having limited ECMO access. Though ECMO is typically utilized at specialty centers, it is feasible to cannulate for ECMO at a referring hospital and then transport the patient on ECMO support to the receiving specialty center. This strategy could increase ECMO access for severely poisoned patients, but is poorly described in the toxicology literature. As such, the purpose of this study was to determine the percentage of poisoned patients treated with ECMO cared for by a single regional Poison Center (PC) that were cannulated at a referring hospital and then transferred to an ECMO center.
Methods: Cases were identified by querying our PC's electronic patient database (Toxicall®) for the therapy code "ECMO" was "performed, whether or not recommended," from 2000 to 2023. The study PC serves 3 US States encompassing > 230,000 square miles containing 5 major ECMO centers, 4 of which are clustered in one metropolitan area, 2 of which serve exclusively children. Data was abstracted by a trained abstractor for the following information: reported substance/poison exposure, location of ECMO cannulation, whether transfer to an ECMO center occurred, distance of patient travel, complications relating to ECMO cannulation and during patient transfer, concomitant therapies, clinical effects, and patient outcomes including mortality. Descriptive statistics were used for analysis.
Results: From 2000 to 2023, 73 patients had ECMO performed for poisoning with veno-arterial (VA-ECMO, $n = 58$, 89%) being the most common configuration. The most common responsible poisons were bupropion ($n = 10$, 14%), amlodipine ($n = 6$, 8%), and flecainide ($n = 4$, 5%). Forty-four percent of patients ($n = 32$) received CPR, 18% ($n = 13$) were cardioverted, and 92% ($n = 67$) received vasopressors with a median of 3 concomitant vasopressor infusions. Fifty-two patients (72%) survived, all coded as Major Effect. Twenty patients presented directly to an ECMO center; 53 patients (73%) were transferred to an ECMO center.
Results: Of the 53 patients transferred, 20 (37%) were cannulated at an outside facility. We found no difference in survival in patients undergoing outside facility cannulation (14/20, 70%) versus cannulation at an ECMO facility (37/52, 71%, $P = 0.92$). In sub-analysis of patients experiencing cardiac arrest *before* ECMO cannulation ($n = 40$, 55%), survival was 50% in both those cannulated at an outside facility (6/12, 50%) and at an ECMO center (14/28, $P = 0.79$). Median distance traveled after outside facility cannulation was 15.3 miles (IQR: 7.75–130.75, range 1.31–383.5). No patients had cardiac arrest or died during transport.
Conclusions: We found cannulation at an outside facility to be common in patients who received ECMO for poisoning. Survival

was similar in patients cannulated at an ECMO center compared to those cannulated at outside facilities. Outside-facility cannulation could extend the availability of ECMO for poisoned patients with severe shock. This has important implications for Poison Centers, who often coordinate the care and transfer of complex toxicologic patients in austere environments.

KEYWORDS ECMO; shock; poison center

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179. Lessons learned in sustaining a bedside clinical medical toxicology practice for almost twenty years

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Background: The Medical Toxicology (MT) practice at NorthShore University Health System existed for almost twenty years (from 1 July 2001, through September 20, 2020). I describe the financial lessons of one of the largest privately dedicated full time (1 FTE with moonlighters) MT practices for inpatient, outpatient, and forensic evaluations.
Methods: Financial data (charges, revenue, relative value units or RVU, and reimbursement rates or RR) of the practice encompassing five Chicago suburban hospitals and one outpatient clinic site were analyzed. Patient encounters were billed by Current Procedural Terminology (CPT) codes according to contracts negotiated by the medical group. Forensic revenue is defined as non-clinical revenue involving primarily Industry contracts, Independent Medical Evaluations (IME), and treater medical-legal services. This practice didn't involve addiction medicine services (other than acute inpatient withdrawal).
Results: COVID-19 related restrictions resulted in a decrease of 60% in charges from April to September 2020 with a corresponding decline of work RVU of 58% (687 pre-COVID/six months to 396 during COVID/six months). Our final denial rate had improved by 1.2% since MT Specialty CMS code implementation in October 2017. Electronic Medical Record (EMR) based MT inpatient order set ($n = 28$) usage started in year 7 and has been utilized over 10,000 times since its inception– this has been associated with a reduction of inpatient consultations after year 9. Neonatal consultations (almost exclusively Neonatal Abstinence Syndrome or NAS) RR was $< 10\%$. Forensic revenue as a percentage of total practice revenue rose from 37% ($116,020) in 2011 to 61% in 2018 ($172,622). Forensics RR was 100% with $>$ $1400/RVU (clinical patient revenue / RVU was $59.89 in FY 2019 and $69.89 in FY 2020).
Conclusions: Lessons learned during this almost twenty-year journey include: Due to its unique status, MT should be separated from multi-specialty group contracts with private payers. This is especially evident in the declining critical care code (99291) charges (from $1033 in 2003 to $655 in 2018; critical care made up approximately 25% of all initial inpatient charges) and low neonatal RR. Denial management procedures (especially reconsideration) are a vital component to capture revenue. EMR order set usage resulted in a marked decline in inpatient consultations. CPT code modifiers (especially 99358) increase revenue marginally due to its restrictive reimbursement. Overheads cost (rent, administrative assistance, practice management, insurance, biller cost) accounted for 35–40% of revenue. Forensic revenue provides substantial revenue support for MT practice. MT Specialty CMS code implementation resulted in marginal revenue increase. NAS consultations had the lowest RR despite being the most intensive and time-consuming consultations. The COVID 19 outbreak caused a mark reduction revenue (especially clinic census). Clinic revenue was greater than inpatient revenue. Target Accounts Receivable – 70 days (Practice takes 3 years to mature). MT practice attracts patients from a larger catchment area than that of traditional medical group practice. Finally, don't assume that Emergency Medicine billers can be competent in MT billing (particularly denial management).

KEYWORDS Financial; reimbursement; practice management

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180. Comparing beta blocker ingestions: a review of the Toxicology Investigators Consortium database

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Background: Beta antagonists represent a widely used class of medications. Overdose can result in hypotension, bradycardia, cardiac conduction delays and cardiac arrest. It is currently unclear which beta antagonist overdoses result in the highest morbidity and mortality. We sought to compare clinical features and treatments used in single-agent beta antagonist overdoses.
Methods: We queried the Toxicology Investigators Consortium (ToxIC) Database from January 2010 to June 2022 for all single-agent beta–blocker ingestions in adults and children. Statistics are descriptive.
Results: There were a total of 512 single-agent beta–blocker ingestions identified. The five most common agents were used for comparison and included metoprolol ($n = 187$), propranolol ($n = 147$), carvedilol ($n = 58$), atenolol ($n = 34$), and labetalol ($n = 32$). Hypotension (SBP < 80) was most common with labetalol (37.5%), followed by carvedilol (36%), atenolol (35%) metoprolol (28%), and propranolol (26%). Bradycardia ($P < 50$) was most common in atenolol ingestion (50%) followed by propranolol (42%). Labetalol was least likely to cause bradycardia (16%). Hypoglycemia (10%) and seizure (5%) were most common in propranolol ingestion, but seen in only 1.3% and 0.3%, respectively, of all other beta antagonist agents analyzed. Aggregate ingestion data revealed intravenous fluids were the most common therapy administered (34%), followed by glucagon (29%) and vasopressors (14%). Vasopressors were most commonly used in labetalol ingestions (22%) and least commonly administered in atenolol ingestions (8.8%). Lipid administration was highest in propranolol ingestions (9%). Only 2.4% of all ingestions required CPR, and there were very low fatality rates in the dataset (1.3%). Beta blocker toxicity is a complex condition and requires toxicologists to consider a number of treatment options. Although receptor selectivity may be lost in overdose, our data demonstrate differences in treatments selected and/or required for various beta antagonist overdoses. Consistent with previous reports, propranolol ingestions are most likely to result in seizures and hypoglycemia compared to other agents. Overall, despite treatment differences between agents, mortality was relatively low.
Conclusions: Our data from the ToxIC registry are consistent with previous literature on beta antagonist ingestions and indicate a relatively low overall mortality rate. Propranolol was more likely to result in seizures and hypoglycemia compared to other agents. Further studies may be warranted to identify specific treatment regimens based on agent ingested.

KEYWORDS Beta-blockers; treatments

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181. Intentional baclofen exposures reported to US poison control centers from 2000–2020

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Background: Baclofen is a gamma-aminobutyric acid $(GABA)_B$ receptor agonist approved in 1977 for the treatment of spasticity with off-label uses for alcohol use disorder, reducing cravings, and nonopioid analgesia. A previous study on baclofen exposures reports the top reason for exposure as suspected suicide. The purpose of this study is to further collect demographic information, effects, and outcomes of intentional baclofen exposures reported to US Poison Control Centers (PCCs).
Methods: A retrospective review of intentional baclofen exposures reported to US PCCs from the years 2000-2020 was performed. Coded reasons for exposure included suspected suicide, intentional misuse, intentional abuse, and intentional unknown. Cases were excluded if the medical outcome was confirmed non-exposure or unrelated effect. For clinical effects and therapies provided, polysubstance exposures were excluded. This study was deemed non-human subject research by our institutional review board.
Results: After exclusion criteria, a total of 36,765 intentional baclofen exposures were identified. The mean age was 39.6 years (median 40 years; range 4 days to 116 years; SD 14.9 years). The patients were 61.9% female. The top reason for intentional exposures was suspected suicide ($n = 28375$, 77.2%), followed by misuse ($n = 3153$, 8.6%), unknown ($n = 2719$, 7.4%), and abuse ($n = 2518$, 6.8%). The average percent increase in number of exposures per year was 10.7% (SD 10.4%, range -16.8% to 27.3%), with rates steadily increasing until 2018 and decreasing in 2019 and 2020. Over half of exposures included multiple substances ($n = 22471$, 61.1%), while 38.9% ($n = 14294$) were single-substance exposures. The top five most common coingestants were benzodiazepines ($n = 6372$), ethanol beverages ($n = 3594$), gabapentin ($n = 2844$), atypical antipsychotics ($n = 2339$), and acetaminophen with hydrocodone ($n = 2058$). In polysubstance exposures, the top three most common medical outcomes were moderate effect ($n = 9322$, 41.5%), major effect ($n = 5236$, 23.3%), and minor effect ($n = 4886$, 21.7%). Death was observed in 149 patients (0.7%). In single-substance exposures, the most common medical outcome was moderate effect ($n = 5404$, 37.8%), followed by minor effect ($n = 3444$, 24.1%) and major effect ($n = 2484$, 17.4%). Death was observed in 38 patients (0.3%). Over half of all exposures were admitted to a health care facility ($n = 23288$, 63.3%), with 50.5% ($n = 18571$) admitted to a critical care unit. The following clinical effects occurred in $\geq$10% of cases: drowsiness/lethargy ($n = 6532$, 45.7%), confusion ($n = 2620$, 18.3%), agitation ($n = 2487$, 17.4%), bradycardia ($n = 2412$, 16.9%), coma ($n = 1951$, 13.6%), vomiting ($n = 1602$, 11.2%), and respiratory depression ($n = 1584$, 11.1%). The most common therapies performed ($\geq$10% of cases) were IV fluids ($n = 6739$, 47.1%), oxygen ($n = 4370$, 30.6%), intubation ($n = 3323$, 23.3%), ventilator ($n = 3100$, 21.7%), benzodiazepines ($n = 2321$, 16.2%), sedation - other ($n = 2315$, 16.2%), and single dose charcoal ($n = 1460$, 10.2%).
Conclusions: Suspected suicide remains the top reason for intentional baclofen exposures. Intentional exposures have steadily increased from 2000 until 2018, when exposures began to decrease. More than half of all intentional exposures included coingestants. The top medical outcome reported was moderate effect and the most severe outcome was death but was rare. Most patients were managed in a health care facility, with IV fluids and airway management as the most common therapies provided.

KEYWORDS Baclofen; intentional exposure

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182. Hydrogen sulfide intentional suspected suicide exposures reported to US poison centers

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Background: In the early 2010s, the emergence of hydrogen sulfide (H_2S) as an agent of suicide was reported to US poison centers and there was concern that this ma y become a common form of suicide in the US This study uses NPDS data to look at trends in H_2S poisoning reported to US poison centers.
Methods: A retrospective review of exposures coded to the generic code for H_2S and suicidal intent in the National Poison Data System (NPDS) for the 15 year time period 1 January 2008 to 31 December 2022 was conducted. Aggregate data for number of cases by year, clinical effects, therapies, medical outcome and HCF utilization was analyzed.
Results: A total of 97 cases were identified; 67 (69.1%) were male and 26 (26.8%) were female and the gender of 4 (4.1%) patients was unknown. Ages ranged from 15 to 73 years, with a mean and median age of 33 and 28 years respectively. There were an average of 7.6 cases/year in the first ten years of the study and 3.2 cases/year in most recent 4 years, a decrease of 58% The most common symptoms coded were cardiac arrest 25, respiratory arrest 24, tachycardia 20, asystole 13, Coma 11, drowsiness/lethargy 9, hypertension 9, acidosis 8, respiratory depression 8, and cough/choke 8. In a 15 year retrospective review of NPDS data, intentional suspected suicide exposures to H_2S rose and fell with no discernible pattern between 2007 and 2017. The year 2012 had the most reported exposures with 12. After 2017, the number of exposures and fatalities decreased markedly. Cases coded to suicidal intent utilizing H_2S had a high mortality rate as 40% of reported cases were fatal (39 total deaths, 26 direct and 13 indirect), were reported to US Poison Centers. This data is likely an underrepresentation of the true number of exposures and fatalities since a regional poison center is not required to be contacted by a healthcare facility and/or medical examiner.
Conclusions: The number of H_2S suspect suicide exposures reported to US Poison Centers decreased in the last 6 years of the observational study and have remained stable 2017–2022. It is unclear why the number of exposures has recently decreased and further research may be needed as to the changing epidemiology of the use of this potent toxin as an agent of suicidal intent.

KEYWORDS Hydrogen sulfide; suicide; poison center

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183. The role of the QRS interval prolongation in prognosticating severe toxicity in overdose

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Background: Prior studies have evaluated the role of the QRS interval in prognosticating seizures and ventricular dysrhythmias

in tricyclic antidepressants. These findings are often extrapolated to other sodium channel antagonists, although doing so has not been validated. The purpose of this study was to evaluate whether QRS interval prolongation is predictive of severe findings in other xenobiotics

Methods: This was a secondary analysis of cases reported to the Toxicologic Investigators Consortium (ToxIC) Core Registry between 1 January 2010, and 31 December 2022. All cases with documented QRS interval prolongation were obtained. These data were analyzed to obtain the seven most frequent single-agent xenobiotic exposures with QRS interval prolongation. This included ethanol, which was excluded due to the concern that patient intoxication might mask other potential exposures. All cases of single-agent exposure to these xenobiotics were obtained, regardless of QRS interval duration. The inclusion criteria were older than 12 years with a single-agent exposure to one of these six xenobiotics. The variables evaluated were seizure, ventricular dysrhythmia, metabolic acidosis, and death. Statistical analysis was performed using relative risk, sensitivity, specificity, positive predictive value, and negative predictive value calculations. Prolongation of the QRS interval was defined as greater than 120 milliseconds by the ToxIC Core Registry.

Results: There were 1,390 cases of QRS interval prolongation identified of the 94,939 (1.5%) total cases during the study period. Eight-hundred cases were single-agent exposures. The most common single-agent exposures in descending frequency were diphenhydramine, amitriptyline, ethanol, bupropion, quetiapine, nortriptyline, and cocaine. There were 5,191 cases of single-agent exposures to these agents, excluding ethanol, of which 4,655 cases met the inclusion criteria. Patients with QRS interval prolongation had significantly increased relative risks of developing seizure, ventricular dysrhythmia, metabolic acidosis, and death compared to patients with normal QRS duration, except for ventricular dysrhythmia in nortriptyline and metabolic acidosis and death in nortriptyline and quetiapine. A normal QRS duration had a negative predictive value of greater than 90% that patients would not develop metabolic acidosis and 98% or greater that patients would not develop ventricular dysrhythmia or death from these six agents.

Conclusions: Previous studies suggest that a prolonged QRS in tricyclic antidepressant overdose is associated with an increased risk of seizure and ventricular dysrhythmia. This study demonstrates that QRS interval prolongation after exposure to these xenobiotics is associated with an increased risk of seizure, ventricular dysrhythmia, metabolic acidosis, and death. Furthermore, patients without a prolonged QRS are unlikely to develop ventricular dysrhythmias or death.

KEYWORDS QRS; sodium channel antagonist

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184. Confirmed drug exposures in ED patients presenting after opioid overdose with self-harm intent

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Background: The majority of patients who present after an opioid overdose do not intend to overdose. However, deliberate self-harm, including suicide attempts and non-suicidal self injury (NSSI), is often under recognized in this population. The purpose of this study is to determine the confirmed drug exposures present among patients presenting to the emergency department (ED) for an opioid overdose with intent to self-harm. A secondary objective is to determine the differences in confirmed drug exposures between patients with intent to self-harm compared to misuse/abuse.

Methods: This study utilized data from the Toxicology Investigators Consortium (ToxIC) Fentalog Study, a prospective, observational study of patients presenting to 10 ED sites with suspected opioid overdose from September 2020 to April 2023. Waste serum, drawn as part of routine clinical care, was collected, de-identified, and analyzed using liquid chromatography quadrupole time-of-flight mass spectrometry for the presence of over 1,000 novel psychoactive substances, drugs of abuse, and therapeutic agents. Classification of overdose intent was determined by chart review, and assigned one of the following categories: self-harm (including suicide attempt, NSSI, and unknown), misuse/abuse, therapeutic intent, drug concealment, and unknown. Study enrollment with waiver of informed consent was approved by a central IRB (WCG IRB). Bivariate statistical tests were used to determine the prevalence of confirmed drug exposures between those presenting with self-harm compared to those with misuse/abuse. All analyses were conducted in R v4.2.1.

Results: Patients presenting with self-harm intent comprised 10.6% of the total sample of opioid overdoses. The most prevalent drug exposures included adulterants (59.3%), fentanyl and fentanyl analogs (57.4%), prescription opioids (48.1%), and antidepressants (42.6%). Compared to patients with misuse/abuse intent, patients with self-harm intent had a lower percentage of fentanyl and fentanyl analogs (84.4 vs. 57.4%, respectively, $P < 0.001$) and stimulants (50.8 vs. 33.3%, respectively, $P = 0.02$). Diazepam was found more often in patients presenting with self-harm (22.2%) compared to patients with misuse/abuse intent (7.7%) ($P = 0.001$); however, the overall prevalence of prescription benzodiazepines was not statistically different between the two groups. Even though adulterants were one of the most prevalent drug classes found in patients with self-harm intent, adulterants were much more likely to be found in patients presenting with misuse/abuse compared to those with self-harm intent (76.9 vs. 59.3%, respectively, $P = 0.008$), including xylazine (24.2 vs. 7.4%, respectively, $P = 0.003$). The combination of fentanyl and stimulants were more prevalent among patients presenting with misuse/abuse intent compared to self-harm intent (44.0 vs. 25.9%, $P = 0.02$).

Conclusions: Fentanyl and fentanyl analogs, adulterants, prescription opioids, and antidepressants were the most prevalent confirmed drug exposures in patients presenting with self-harm intent. However, fentanyl/fentanyl analogs and stimulants were statistically more likely to be found in patients with misuse/abuse.

KEYWORDS Fentanyl; analytes; self-harm

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185. Antidepressant overdose: seizures and not hypoglycaemia are important

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Background: Hypoglycaemia is an uncommon effect of antidepressant overdose, and recent reports have suggested that it

occurs more commonly with venlafaxine and is associated with seizures. We aimed to investigate the relative frequency of hypoglycaemia and seizures in all antidepressant overdoses, and whether they are associated.
Methods: We extracted all cases of antidepressant poisoning presenting to two Clinical Toxicology Services in Newcastle and Brisbane from Jan 2020 to Apr 2023. Data are recorded prospectively in a clinical database, and were extracted, including demographics, dose (defined daily dose [DDD]), co-ingestants, blood glucose level (BGL), hypoglycaemia (BGL $<$ 4.0 mmol/L), seizures, length of stay (LOS) and intensive care unit (ICU) admission.
Results: Over a 40-month period, there were 1473 presentations for antidepressant overdoses to both services, median age 31y (Interquartile range: 22–46y); 972 females (66.0%). Most common were mirtazapine (248), escitalopram (212), sertraline (206), fluoxetine (165), amitriptyline (163) and venlafaxine (128). Co-ingestants were taken in 1176 presentations (79.8%). The median dose ingested was 14 DDD (IQR:5.5–29; range: 0.5–184 DDD), which varied between antidepressants. Hypoglycaemia occurred in 57/1473 (3.9%) presentations, four co-ingested insulin and three co-ingested sulfonylureas. Hypoglycaemia occurred most commonly with venlafaxine (6.3%) and escitalopram (5.6%). There was no association between dose and BGL. Seizures occurred in 46/1473 (3.1%) admissions, most commonly with dothiepin (16%) and venlafaxine (7%). Patients with seizures ingested a larger dose, median 30 DDD (IQR: 10–56), compared to those without seizures, median 12 DDD (IQR: 5.6–24; $P < 0.001$). Only 5/58 (9%) patients with hypoglycaemia had a seizure, and there was no difference in the BGL between patients having a seizure and those not (median 5 mmol/L versus 5.4 mmol/L). The median LOS was 15h (IQR: 8.8–24h), which was slightly longer for patients with hypoglycaemia (median 20h; IQR: 12.5–31h) and much longer in patients with seizures (median 41h; IQR: 25–117h). 51 patients (3.5%) were admitted to ICU, 2/57 (3.5%) with hypoglycaemia compared to 9/37 (24%) with seizures. There were no deaths.
Conclusions: Hypoglycaemia occurred uncommonly in antidepressant overdose, was not associated with ingested dose or seizures, and occurred with almost every antidepressant (2–6%). Seizures were dose-dependent and resulted in a longer LOS and more were admitted to ICU.

KEYWORDS Antidepressant; overdose; hypoglycaemia/hypoglycemia
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186. Suicide attempt rates from 2018 to 2022 in the state of Texas for pediatric patients ages 6–12 years

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Background: It is believed that the COVID-19 pandemic had an impact on mental health across all populations. With the social restrictions on public movement, children remained at home for school and had limited social contact for most of 2020 and some of 2021; mental health problems among children and adolescents were increasingly observed leading to significant mental health concerns. The objective of this study was to compare intentional suicidal exposures for children ages 6–12 years pre-pandemic, during the pandemic, and post-pandemic.
Methods: Data were obtained from the database of Texas Poison Center Network. Cases in which exposures to medication and substances that were intentional for suicidal intent were examined during 2018–2022 where the patient age was 6–12 years via any route of exposure. The distribution of pediatric exposures was determined for various factors related to patient demographics and type of substance.
Results: The total number of intentional suicides for children ages 6–12 years was 3,736. The total number of exposures was 547 in 2018, 597 in 2019, 736 in 2020, 1,035 in 2021, and 821 in 2022. There was a 9.5% increase from 2018 to 2019, a 24.4% increase from 2019 to 2020, a 40.1% increase from 2020 to 2021 and a 19.6% decrease from 2021 to 2022. Overall there was a 48% increase from 2018 to the peak of suicide attempts in children aged 6–12 years in 2021. The gender breakdown showed a significant increase in female to male ratio over these 5 years as follows: 2018 (4.7:1), 2019 (4.8:1), 2020 (6.2:1), 2021 (7.9:1) and 2022 (8.6:1). There were 8 unknown genders during the 5-year span.
Conclusions: The annual number of pediatric intentional suicide attempts significantly increased during the pandemic. There was almost a 50% increase between 2018 and 2021. A majority of the ingestions were female over male across all 5 years. As the state returned to pre-pandemic routines in 2022, the data shows a decline of over 20% comparing 2021 to 2022 in pediatric intentional suicide attempts thus indicating that the pandemic did have a significant impact on pediatric patients' mental health.

KEYWORDS Pediatric; suicide; COVID
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187. Patterns in suicide attempts by self-poisoning in adults aged 50+ from 2000 to 2021

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Background: Suicide is a major public health issue and a leading cause of death. Previous studies have suggested that the risk of suicide increases with age and is highest among the group of individuals who are aged 70 and older. Among adults who are aged 65 and older, drug poisoning has been implicated in about one in five completed suicides. As suicide and attempted suicide through self-poisoning are significant causes of morbidity and mortality in older adults, it is important to study and identify patterns in self-poisonings to target public health interventions within this group.
Methods: This is a retrospective review of cases of suspected suicide attempts by self-poisoning in patients aged 50 years and older reported to the National Poison Data System (NPDS) from 1/1/2000 through 12/31/2021. The first substance reported was analyzed. United States Census data were used to determine change in self-harm attempts over time. Changes in incidence, outcomes, and specific agents were evaluated with RStudio version 2022.07.2 + 576.
Results: There were 656,273 cases over the study period. Calls to poison centers related to suspected intentional self-poisoning in adults aged 50+ as a proportion of all calls to poison centers increased over time, from 7.2% in 2000 to a high of 15.2% in 2018, but then decreased over the next three years to 12.8% in 2021. Calls related to suspected intentional self-poisoning in adults aged 50+ as a proportion of the total US population over age 50 years increased from 15/100,000 in 2000 to 40/100,000 in 2019 but decreased over the next two years to 34/100,000 in 2021. Of all calls, 66.0% involved individuals who were aged 50–59, 23.0% aged 60–69, 7.6% aged 70–79, 2.8% aged 80–89, and 0.5% aged 90+ years. In all cases over the 2000–2021

period, the five most common agents of self-poisoning were benzodiazepines (14.8%), atypical antipsychotics (6.7%), other sedative/antipsychotic drug (4.5%), trazodone (4.2%), and acetaminophen with hydrocodone (3.6%). Benzodiazepines were the most common agent of self-poisoning in all age groups among adults aged 50+, though the proportion of cases involving benzodiazepines decreased from 16.6% in 2000 to 11.3% in 2021. Medical outcomes were also ascertained. 33.8% of cases resulted in moderate effect, 28.2% in minor effect, 14.8% in no effect, 10.5% in major effect, the outcome could not be determined in 11.6% of cases, and death, as ascertained from direct follow-up or indirect report, resulted in 1.1% of cases.
Conclusions: Self-poisoning attempts increased from 2000 through 2018, then decreased over the following three years. Suicide attempts among adults aged 50+ years were associated with significant morbidity, with 44.3% of cases resulting in moderate or major effects and 1.1% in death. Benzodiazepines were the most frequently reported first-ranked drug in this age group.

KEYWORDS Intentional overdose; self-poisoning; older adults

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188. Plasmapheresis as part of a multimodal treatment strategy for refractory calcium channel blocker poisoning

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Background: Calcium channel blocker (CCB) poisoning results in significant morbidity and mortality. We present two cases of patients who survived for whom plasmapheresis was used when their clinical status remained tenuous on ECMO.
Case series: Case 1: 14 y/o girl presented after ingesting amlodipine (125 mg), methylphenidate HCL (360 mg), hydroxyzine (750 mg), and acetaminophen (unknown). Initial vitals were: T 36.4, HR 135, BP 105/40, RR 20, Oxygen Saturation: 100% room air. After an acute change in mental status and hypoxia, she was intubated and given 3 grams of calcium gluconate. Blood glucose was 355 mg/dl. Epinephrine, norepinephrine and vasopressin, and high dose insulin euglycemic therapy with maximal dose of 5 units/kg/hr were initiated. Despite epinephrine at 0.4 mcg/kg/min, norepinephrine 0.3 mcg/kg/min, vasopressin 0.07 units/min, and ~700 ml lipid emulsion, her MAP was ~60. Venoarterial (VA) ECMO was initiated. During cannula placement, patient's pressures dropped to 60s/40s. She was started on ECMO and given methylene blue 2 mg/kg without improvement. The patient became bradycardic with a wide complex QRS. She received a bolus of 100 ml of lipid emulsion 20% and converted to sinus tachycardia (rate 140s) and her MAPs increased to high 60s/low 70s. Plasmapheresis was recommended to assist in drug removal since amlodipine is highly protein bound. She was started on plasmapheresis (1.5 volume plasma exchange with 100% albumin replacement) and her vasopressin requirement decreased to 0.05 units/min ~40 minutes after plasmapheresis ended. She was decannulated after 2 days of ECMO and extubated on hospital day (HD) 6. Case 2: 14 y/o girl presented after ingestion of ~4080 mg of verapamil ~1 hour prior to arrival to the hospital. Her initial vital signs: HR 96, BP 79/39, RR 24, Oxygen Saturation: 94% on room air. She received intravenous fluids, 2 grams calcium gluconate, and epinephrine and norepinephrine infusions. Serum glucose was 295. ECG showed 3rd-degree AV block. She was intubated, transferred, given lipid emulsion with no response, and placed on VA-ECMO. During ECMO catheter repositioning, she was on insulin 10 units/kg/hr, vasopressin 0.06 units/min, norepinephrine 0.7 mcg/kg/min, epinephrine 0.7 mcg/kg/min, and D12.5 at 80 cc/hr. Angiotensin II was given with reduction in vasopressor support. Plasmapheresis (1.5 plasma volume exchange with all 5% albumin) was performed. The verapamil concentration pre-plasmapheresis was 7500 ng/ml and post-plasmapheresis was 1300 ng/ml. This suggested enhanced clearance (half-life is 3–7 hrs). Patient was decannulated after 5 days of ECMO and extubated HD 10.
Discussion: Plasmapheresis is rarely described to treat CCB poisoning. Plasmapheresis may remove highly protein bound xenobiotics. Our cases showed clinical improvement and, for the verapamil, a decrease in plasma concentration with plasmapheresis likely greater than natural elimination.
Conclusions: Plasmapheresis can be considered within a multimodal approach to severe and refractory CCB poisoning for highly protein bound agents. Volume of distribution (Vd) should be considered as high Vd can lessen the effectiveness of plasmapheresis.

KEYWORDS Plasmapheresis; calcium channel blocker poisoning; verapamil

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189. Veno-arterial extracorporeal membrane oxygenation (VA-ECMO) and plasmapheresis (PLEX) therapies in cardioactive medications ingestions in pediatrics: case series

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Background: As toxicologists, we strive to determine the most appropriate time to recommend invasive therapy to patients with cardiovascular toxicity. Suggested criteria include systolic blood pressure (SBP), pH, PaO2, PaCO2, bicarbonate, lactic acid, and failure to improve hemodynamics with vasopressors and standard therapies (fluid resuscitation, calcium, hyperinsulinemia euglycemic treatment). Early evaluation for invasive bridge therapies may be required to decrease mortality. We reviewed calls to the Poison Center (PC) and interventions made in conjunction with VA-ECMO to determine potential benefit, specifically with plasmapheresis (PLEX).
Case series: Pediatric charts from the PC were reviewed from 2013 to 2023, including exposures to beta blockers, calcium channel blockers, flecainide, bupropion, tricyclic antidepressants, diphenhydramine, and colchicine. Six pediatric cases were identified where ECMO was recommended. Five out of six patients were female with a median age of 16 years. All of the exposures were intentional ingestions. The most common ingestion was calcium channel blockers. Upon arrival to the emergency department (ED), five out of six patients were hypotensive; and two out of six patients had altered mental status. The mean SBP between the patients was 79 mmHg. Five out of six required intubation during hospitalization. PC recommendations included: fluid resuscitation, vasopressors, calcium, hyperinsulinemia euglycemia

therapy, and early transfer to ECMO facility. All of the patients were transferred to an ECMO facility, and 66.6% (4/6) were cannulated on arrival. The mean time between the initial call to PC and VA-ECMO cannulation was approximately five hours. 75% (3/4) of the patients on VA-ECMO were decannulated within a mean of three days. Two of the patients were simultaneously on continuous renal replacement therapy. PLEX was performed in 75% (3/4) of the patients on VA-ECMO. 83.3% (5/6) of the patients were discharged home. There was one death.
Discussion: VA-ECMO should be considered to provide temporary hemodynamic support to the acutely poisoned patient. With VA-ECMO, other interventions can be considered to increase medication clearance and decrease time between exposure, metabolism, and elimination. PLEX has been described in the removal of highly protein-bound substances, specifically calcium channel blockers, in overdose. In this review, the patient who died was on VA-ECMO, but was the only patient who did not receive PLEX. This isolated case of death is likely multifactorial. However, the other three patients were successfully discharged and no neurologic sequela.
Conclusions: There is limited data about VA-ECMO in conjunction with invasive, adjuvant therapies in managing pediatric cardiovascular medication toxicity. Discussion with a PC can help to facilitate early consideration and transfer for these therapies. Combination of VA-ECMO and PLEX can be considered in highly-protein bound cardioactive medication overdose in pediatric patients. Further investigation, including full chart review is needed.

KEYWORDS Plasmapheresis; ECMO; pediatric overdoses

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190. Acute onset diabetes insipidus and pancreatitis in the setting of valproic acid overdose: a case report

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Background: Massive valproic acid (VPA) overdoses can induce severe central nervous system (CNS) depression, hyperammonemia, hemodynamic instability, and metabolic derangements, among other effects. Though pancreatitis is a known idiosyncratic reaction to VPA, it is uncommonly described in acute toxicity. Further, renal manifestations of VPA toxicity are poorly described and rarely reported. We present a case of severe VPA toxicity associated with pancreatitis and nephrogenic diabetes insipidus (DI).
Case report: A 27-year-old male with bipolar depression presented one hour after ingesting 80 500-mg delayed release sodium valproate (VPA) tablets (40 grams). He was confused but responsive with stable vital signs. Labs 1.5 hours post-ingestion included: VPA concentration 636 mcg/mL, lactate 6.7 mMol/L, blood glucose 66 mg/dL, and EKG: sinus tachycardia and prolonged QTc (504 ms). Approximately 6 hours post-ingestion, he became lethargic and hypotensive with hypercapnic respiratory failure; he was intubated and started on vasopressors. Head computed tomography did not show cerebral edema and chest x-ray was unremarkable. Activated charcoal, intravenous levocarnitine, and meropenem were administered. He was started on high-dose (~3500 mL/min/1.73m2) continuous renal replacement therapy (CRRT) 8.5 hours post-ingestion. VPA peaked at 1062 mcg/mL 12.5 hours post-ingestion, around which time he developed polyuria (4.4 liters urine output), hypernatremia (152 mEq/L), increased serum osmolarity, and decreased urine osmolarity consistent with diabetes insipidus (DI). Desmopressin was administered with favorable response. His ammonia level peaked at 368 mcmol/L 17.5 hours after ingestion. Meropenem, levocarnitine, vasopressors, and CRRT were discontinued and he was extubated by day 2 given significant decline in VPA concentrations and improved hemodynamics; however, he had persistent hypoglycemia days 1 and 2 post-ingestion with concurrent hypocalcemia and thrombocytopenia through day 3 (platelet nadir 48 K/mcL). On day 3, he had a recurrent episode of DI treated with desmopressin. Day 4, he developed abdominal pain with an elevated lipase to 287 U/L, consistent with acute pancreatitis. He was discharged on day 11 without sequelae.
Discussion: Pancreatitis has been associated with both chronic VPA therapy and acute overdose and was first reported in 1979 in children on chronic therapy. Some of the proposed mechanisms are a direct toxic effect from free radicals on the pancreatic tissue, depletion of superoxide dismutase, catalase, and glutathione peroxidase, and that VPA can inhibit histone deacetylates provoking an imbalance in pancreatic recovery after injury, predisposing the patient to pancreatitis. Regarding nephrogenic DI, no mechanism has been validated for VPA as a cause. Lithium, foscarnet, and clozapine induce dysfunction of the renal tubules, becoming impermeable to water secondary to partial resistance to ADH. This is a plausible mechanism in our patient, whom after DDAVP therapy demonstrated an increase of 52% in urine osmolarity and more than 50% decline in urine volume.
Conclusions: In this case, the patient developed rare complications of VPA toxicity: pancreatitis and DI. To our knowledge, this is the second reported case of VPA-associated with nephrogenic DI in the English literature. The mechanism of each has yet to be clearly elucidated.

KEYWORDS Nephrogenic diabetes insipidus; pancreatitis; valproic acid

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191. Uncommon clinical manifestation after massive bupropion overdose: ileus

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Background: Bupropion is a synthetic cathinone that inhibits neuronal uptake of dopamine and norepinephrine (NE), and is a nicotinic receptor antagonist. Commonly prescribed to treat major depressive disorder, generalized anxiety disorder, attention deficit hyperactivity disorder, and smoking cessation. Metabolism occurs in the liver, and the active metabolite is hydroxybupropion. In extended-release (ER) formulations, we expect a peak time of five hours post-ingestion and a half-life of twenty-one hours. In overdose, the most common clinical manifestations are seizures and cardiotoxicity. Additionally, psychosis, agitation, tremors, dry mouth, and serotonin toxicity have been documented. On this occasion, we would report a case of dysfunctional peristalsis in a patient after massive ingestion of bupropion.
Case report: This is a single-patient case report. A 16-year-old female with a history of depression presented to the emergency department (ED) two hours after an intentional ingestion of 9300 mg bupropion extended-release in a suicide attempt. The patient complained of dizziness on presentation but was awake, alert, and hemodynamically stable. Her initial EKG was normal sinus rhythm, heart rate (HR) 67, QRS 83 ms, and QTc 425 ms. While in the ED today patient began to have a progression of symptoms, including the new onset of tachycardia and agitation as well as some intermittent confusion which was treated with benzodiazepines and admitted to the ICU. Nine hours post-

ingestion required dexmedetomidine for agitation and additional benzodiazepines for two episodes of seizures. She was subsequently intubated for airway protection. Repeat EKG demonstrated sinus tachycardia, HR 150, QRS 161 ms, and QTc 603 ms; a sodium bicarbonate bolus was given without improvement. The patient was hypotensive requiring norepinephrine 0.1 mcg/kg/min. Whole bowel irrigation (WBI), continuous electroencephalography, lipid emulsion therapy, and extracorporeal membrane oxygenation (ECMO) facility transfer were recommended. After 4 L of polyethylene glycol via nasogastric tube and 23 hours post-ingestion, the primary team noticed the patient was not passing rectal effluent. WBI was discontinued, and an abdominal x-ray demonstrated an ileus. Forty hours post-ingestion, the patient had her first bowel movement. The patient was extubated and reintubated in 24 hours due to pulmonary edema. On day nine, she was extubated and hemodynamically stable. She was discharged home on day ten post-ingestion.

Discussion: Massive bupropion ingestions are difficult to manage given the lack of effective antidotes. Part of the management aims to prevent further absorption through activated charcoal and WBI. Yet our patient's ileus likely limited gastrointestinal decontamination and contributing to a prolonged hospitalization. While the patient did receive various therapies that could contribute to an ileus, as well as her hemodynamic instability leading to poor gut perfusion, bupropion itself may have played a role in the ileus as a nicotinic receptor antagonist. Paralytic ileus has been reported in patients chronically taking bupropion but uncommon in the setting of an overdose.

Conclusions: We present a massive bupropion overdose whose treatment was complicated by an ileus. In addition to hemodynamic instability, the nicotinic receptor antagonism of bupropion may have directly contributed to the patient's ileus. Gastrointestinal motility should be carefully monitored when administering WBI.

KEYWORDS Bupropion; ileus; whole bowel irrigation

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192. Comparison of linguamatics and FDALabel natural language processing text-mining to identify information in the OVERDOSAGE section of tramadol drug labels

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Background: The OVERDOSAGE section of prescription drug labels require analysis for outdated information. Prescription drug labels containing the same active ingredient in the same formulation should be identical. Natural language processing (NLP) text-mining can be used to efficiently query labeling to identify differences. Our purpose was to perform a comparison of results extracted through text-mining, using Linguamatics and FDALabel, to search DailyMed for targeted information in the OVERDOSAGE section of tramadol drug labeling and to identify differences among labeling versions.

Methods: The OVERDOSAGE sections of tramadol drug labeling was extracted using a custom query in Linguamatics, an NLP text-mining tool. Using the unique ingredient identifier (UNII) code, the query was able to identify drugs with the same active ingredient. The results were then compared to a search of the OVERDOSAGE sections of tramadol drug labeling performed on FDALabel. Labeling was then manually analyzed for differences.

Results: The query in Linguamatics, retrieved 237 drug labeling, under 30 drug application numbers; seven (23%) drugs are New Drug Application(s) (NDA); 23 (77%) are generic drugs approved under an Abbreviated New Drug Application(s) (ANDA). Results retrieved using the FDALabel platform were identical to results retrieved through Linguamatics. Depending on the link re-packagers use for labeling, a single drug application number may appear multiple times with different labeling versions (ex. ANDA201384), others may appear with the same labeling version (ex. ANDA200503). Four different versions of the OVERDOSAGE section were identified for Tramadol NDAs. Clinical manifestations were similar across versions. However, two (50%) versions did not mention seizures, one (25%) did not mention the clinical manifestations QT prolongation, partial or complete airway obstruction, and atypical snoring. Three (75%) versions discussed increased risk of fatal overdose with co-ingestants. Management was also similar across versions. All four versions state that naloxone should be used as an opioid antagonist, however, one (25%) version also mentions the use of nalmefene. Three (75%) versions discuss monitoring patients for spontaneous respiration, the potential need of additional administration of antagonist, and management of opioid dependent individuals. While all the versions discuss the potential need for advanced life-support techniques for cardiac arrest and serious arrhythmias, one (25%) version specifies the potential requirement for cardiac massage and defibrillation.

Conclusions: Linguamatics and FDALabel natural language processing text-mining efficiently extracted identical information of the OVERDOSAGE sections of tramadol drug labeling. Depending on the product selected, a search on DailyMed may not provide the most up to date labeling. This is due to re-packagers not linking the most recent labeling version. Manual analysis revealed the need to update and harmonize labeling information.

KEYWORDS Tramadol overdose; natural language processing; overdose management

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193. A fatal case of salicylate poisoning with paratonia and uncoupling of oxidative phosphorylation

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Background: Severe salicylate (ASA) toxicity can uncouple oxidative phosphorylation leading to depletion of ATP and multi-organ failure, which may include paratonia. Paratonia is a form of muscular rigidity presumably due to ATP depletion. There are case reports successfully utilizing ECMO in the setting of mitochondrial failure, but efficacy is variable and unproven. We report a case of fatal ASA toxicity exhibiting clinical signs of paratonia, in which ECMO failed to result in any clinical improvement due to uncoupling of oxidative phosphorylation.

Case report: A 42 yo (80 kg) male self-reported ingestion of 488 grams or 6,100 mg/kg of aspirin. Ten hours post ingestion, his mother found him altered and called EMS. Approximately 14 hours post ingestion the ASA concentration was $>$ 100 mg/dL, venous pH 7.6, pCO_2 20 mm Hg, bicarbonate 17 mg/dL, anion gap 21, and urine pH 7.0 while on a sodium bicarbonate (SB) infusion. Serum APAP was negative. He was lethargic with BP 132/76 mm Hg, HR 103 bpm, RR 27 bpm, T 96 F and 99% O_2 saturation on RA. He was transferred to a tertiary hospital where he became severely agitated and dislodged his IVs. His 16 hour post ingestion ASA concentration was 136 mg/dL with a serum pH 7.53. To facilitate acquiring dialysis access, the patient received a

SB bolus and underwent RSI with succinylcholine and ketamine. After intubation, the ventilatory rate was increased to 25 bpm, and SB escalated with an additional bolus and increased infusion. Activated charcoal 100 grams was given by NGT, and a hemodialysis (HD) catheter was placed. At 17.5 hours post ingestion, the ASA concentration was 160 mg/dL and ABG revealed pH 7.30, PCO_2 49 mm Hg and HCO3 25 mg/dL. Calcium and magnesium were administered for hypocalcemia (1.13 mmol/L ionized) and hypomagnesemia (0.3 mmol/L). The patient suffered cardiac arrest before HD could be initiated. Defibrillation of pulseless ventricular tachycardia resulted in PEA and then asystole. He was treated with epinephrine 1 mg IV, and paratonia made it difficult for the ECMO team to cannulate the patient. Despite initiation of ECMO, venous return blood remained 99% oxygenated. Resuscitation was discontinued after 40 minutes because there was no evidence of cellular consumption of oxygen.

Discussion: This patient succumbed to increasing serum ASA concentrations despite aggressive supportive care and efforts to decontaminate and enhance elimination. A fatal outcome is consistent with a case series of no survival without HD in intubated patients with serum ASA $>$ 80 mg/dL. The role of ECMO in patients with mitochondrial toxins is unclear, and post-arrest paratonia in this patient complicated the initiation of ECMO, which when implemented revealed that further resuscitative efforts would be futile.

Conclusions: In massive salicylate overdose, paratonia is a sign of uncoupling, and ECMO has an uncertain role in these clinical situations.

KEYWORDS Salicylate; paratonia; ECMO

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194. Octreotide for venlafaxine induced hypoglycemia

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Background: Venlafaxine is a selective serotonin and norepinephrine reuptake inhibitor with multiple effects in overdose including seizure, QT and QRS prolongation, and hypoglycemia. The mechanism of venlafaxine-induced hypoglycemia is unclear. Octreotide has been suggested for the prevention of recurrent venlafaxine-induced hypoglycemia. However, the effectiveness of octreotide in preventing recurrent venlafaxine-induced hypoglycemia is unclear.

Methods: This is a retrospective review of patients treated for venlafaxine exposure by a regional Poison Center from 1/1/2013 to 3/1/2023. The electronic medical record database utilized by the poison control system, Toxicall®, was queried for patients of all ages with venlafaxine exposure or overdose. Patients were excluded if: the chart was identified as a duplicate, there was inadequate clinical information for review, patients were confirmed to have no exposure, or there was concomitant exposure to a drug that is known to cause hypoglycemia including sulfonylureas or insulin. Patients who were coded as experiencing "hypoglycemia" as defined by APC code were then included for data analysis. Clinical effects, outcomes, and therapies were as defined by the APC codes.

Results: During the study period, a total of 2,391 patients were identified as having venlafaxine exposure or overdose with a known outcome. Of these, 84 developed hypoglycemia and were included in the study. The median age was 28 (range 1–74) years old, 74% ($n = 60$) of patients were identified as female. Fifteen (18%) patients had a single substance ingestion and 18 (21%) patients had a reported dose of venlafaxine with a median dose of 3,375 mg (300–15,000 mg). Most patients (82%) developed altered mental status (including CNS depression or confusion), 58 (69%) patients were tachycardic, 38 (42%) patients had a conduction disturbance including QRS or QTc prolongation, 35 (42%) patients were hypotensive, and 32 (38%) developed seizures. Sixty-eight patients (81%) received IV dextrose, 8 (9%) received oral glucose supplementation, 10 (12%) received octreotide, 2 (2%) received glucagon, 55 (65%) were treated with benzodiazepines, 41 (48.8%) patients were intubated, and 21 (25%) required vasopressors. Outcomes included: 1 (1.2%) minor, 38 (45%) moderate, 43 (51%) major, and 2 (2%) deaths. There was no standard dosing of octreotide. Three (3.6%) patients received single doses of 50 or 100 mcg subcutaneous (SQ) octreotide, 3 (3.6%) patients received multiple doses of 50 or 100 mcg SQ octreotide, and 3 (3.6%) patients were treated with continuous infusions. All patients who received octreotide were treated with dextrose infusions prior to receiving octreotide, which was then continued after receiving octreotide. After receiving octreotide, only one patient experienced recurrent hypoglycemia requiring supplemental boluses of dextrose to maintain euglycemia.

Conclusions: In this small cohort of patients who experienced hypoglycemia following venlafaxine overdose, all patients required supplemental dextrose infusions to treat hypoglycemia. However, after receiving octreotide, only one patient experienced recurrent hypoglycemia requiring additional dextrose supplementation. Octreotide may help prevent recurrent hypoglycemia and reduce the need for supplemental dextrose following venlafaxine overdose.

KEYWORDS Octreotide; venlafaxine; hypoglycemia

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195. Carbamazepine poisoning in Taiwan: a poison center-based study

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Background: This study aims to summarize the demographic and clinical characteristics of carbamazepine poisoning cases reported to Taiwan Poison Control Center (PCC-Taiwan) and to analyze baseline characteristics that may predict the severity of poisoning.

Methods: This was a retrospective review of all cases of carbamazepine poisoning reported to PCC-Taiwan from 1985 to 2021. Eligible cases were divided into two groups by their severity of poisoning (i.e., mild-to-moderate and severe-to-fatal poisoning). Bivariable and multivariable analyses were then conducted to identify the between-group difference in baseline characteristics by using Fisher's exact test and Wilcoxon rank sum test, and to find out the potential predictors of severity of poisoning by employing logistic regression analysis. All statistical analyses were computed on R statistical software, version 4.1.1, and *P*-values of 0.05 were considered statistically significant.

Results: After excluding 44 cases due to incomplete outcome or missing data and 3 duplications, a total of 276 cases were eligible for final analyses. Among them, the mean age was 26.2 years and female cases (141, 51%) slightly outnumbered male cases (133, 48%). Most (94%) of the cases were of acute poisoning with intentional exposure (65%). Among 89 cases with drug co-ingestion, the most frequently co-ingested drug was benzodiazepines (26%), followed by antipsychotics (22%). The most common symptoms were drowsiness (40%), tachycardia (14%), nausea and vomiting (14%).In terms of severity of poisoning, 254 (92%) cases were of mild-to-moderate effects, and 22 (8%) cases manifested severe-to-fatal toxicity. The mean amount of ingested carbamazepine was 6064.4 mg and 16711.1 mg in the mild-to-

moderate group and the severe-to-fatal group, respectively. In bivariable analysis, more cases presented drowsiness in the mild-to-moderate group. By contrast, more cases presented with hypotension and seizure in the severe-to-fatal group. In the multivariate analysis, we found that hypotension (adjusted OR [aOR] = 5.1, 95% confidence interval [CI] 1.15–22.54) was positively associated with severe poisoning, whereas drowsiness (aOR = 0.12, 95% CI 0.03–0.57) was negatively associated with the severity of poisoning.
Conclusions: Most cases of carbamazepine poisoning reported to PCC-Taiwan were of mild-to-moderate toxicity, with drowsiness being the major symptom. Only 8% of cases had a severe or fatal outcome. Cases presenting with hypotension were more likely to be associated with severe/fatal outcomes.

KEYWORDS Carbamazepine; poisoning; symptoms of overdose

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196. Amifampridine overdose leading to refractory status epilepticus

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Background: Amifampridine was approved in 2018 for multiple sclerosis and for Lambert Eaton Myasthenic Syndrome (LEMS). Its proposed mechanism is inhibition of presynaptic potassium channels. This leads to prolonged nerve depolarization and increased acetylcholine in the synaptic cleft. This improves motor function and strength of those with LEMS. We found no published literature of amifampridine overdose.
Case report: A 67-year-old man presented to the emergency department 30 minutes after taking 100 mg of his amifampridine and 24.5 g of acetaminophen in a suicide attempt. His initial vitals demonstrated hypertension and tachypnea. The patient complained of jitteriness and his exam was notable for diaphoresis and tremor. He was given 50 g of activated charcoal within the first hour of his ingestion. For tachycardia and tremors, he received a total of 4 mg IV lorazepam and 10 mg of diazepam at the outside hospital. Initial abnormal lab values included: lactate 20.4 mmol/L, K+ 6.2 mmol/L, acetaminophen concentration 67 mcg/mL. The patient had a seizure in transport to a tertiary care ICU. Another seizure started on arrival to the ICU (3 hours post ingestion) with subsequent PEA arrest lasting 5 minutes. Over the next 5 hours, the patient continued to have clinical and EEG diagnosed seizures, requiring increasing doses of antiepileptics including midazolam, diazepam, lorazepam, ketamine and levetiracetam. 13 hours post ingestion, his antiepileptic infusions were 5 mg/h midazolam and 146 mg/h ketamine. Despite this, the patient had one more generalized seizure 15 hours after ingestion, at which point he received a 15 mg/kg load of phenobarbital. He had no further seizures after phenobarbital. On HD 8 an MRI of the brain showed no abnormalities. Over the next several weeks, his sedation was slowly weaned. On HD 20 the patient was extubated and neurologically intact but was switched to comfort goals of care related to his underlying illness. He passed away on HD 22 from hypercapnic and hypoxic respiratory failure related to LEMS.
Discussion: Amifampridine is a medication approved for treatment of LEMS and is considered to be safe without serious side effects at therapeutic doses. In overdose, status epilepticus is possible. Amifampridine leads to seizures via increased acetylcholine concentrations in the synaptic cleft, causing overstimulation of central nicotinic receptors. Of note, our patient did not demonstrate any symptoms of peripheral muscarinic overstimulation, such as miosis, bradycardia, or bronchorrhea. Despite extremely high doses of other antiepileptics, seizure control did coincide temporally with phenobarbital administration. Phenobarbital increases chloride influx and cellular hyperpolarization even in the absence of GABA, which directly opposes the electrochemical changes induced by the nicotinic receptor. This argues for the use of phenobarbital in cases of amifampridine overdose, and in our case may have been what led to the termination of status epilepticus.
Conclusions: Amifampridine is a medication that may lead to refractory status epilepticus in overdose. In this case, the care team tried several antiepileptics, but phenobarbital appeared to be the most helpful in gaining seizure control as no seizures were seen after its administration.

KEYWORDS Amifampridine; 3,4-diaminopyridine; refractory status epilepticus

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197. Trends in poison centre calls for intentional self-harm in the elderly: a 10-year analysis

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Background: A concerning trend in the incidence of suicide by drug overdose in adults over 65 years old has been reported by some American organizations. Anecdotally, staff at a regional Canadian poison centre noted an increase in intentional self-harm calls which were resulting in severe outcomes in this age group. Our objective was to describe the trends in incidence and severity of intentional exposure calls to a regional poison centre amongst adults over 65 years old.
Methods: We performed a cross-sectional analysis of calls received to our poison centre between 1 January 2012 and 31 December 2022. We identified consultations requests for intentional human exposures for individuals 65-year-old and older. We excluded calls for exposures identified as unintentional, malicious or tampering. We calculated the yearly incidence of calls and the incidence of severe cases (coded as death or major outcome) to the poison centre over a 10-year period. To examine the trend in severity data over time, we used linear regression modelling.
Results: There were a total of 9461 intentional exposures calls in adults 65 and older from 2012 to 2022, representing 22.1% of the total exposure calls received for that age group to the poison centre during that period. 58.4% of callers were female. When comparing 2012 vs 2022 data, there was a significant increase in the incidence of intentional cases among males 84 vs. 103 cases per 1000; $P = 0.008$ and females 112 vs. 130 cases per 1000; $P = 0.02$. The linear regression model showed an increase of 6 cases per year for severe outcomes ($R2 = 0.61$, $P = 0.005$).
Conclusions: The incidence and severity of intentional calls have significantly increased in males and females from 2012 to 2022. Overall increases were observed across all age groups. This highlights an increased need for mental health support for older adults regarding poison prevention information and self-harm.

KEYWORDS Elderly; self harm; intentional overdose

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198. Description of elimination kinetics following massive co-ingestion of methanol and ethylene glycol treated with fomepizole

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Background: Ethylene glycol (EG) and methanol (MeOH) toxicity are associated with significant morbidity and mortality. Prompt recognition and antidotal therapy with fomepizole is standard treatment, with hemodialysis recommended under certain conditions. Some antifreeze products contain a combination of MeOH and EG. Combined ingestions of MeOH and EG either separately or from the same formulation, however, are rarely reported. Methanol follows concentration-dependent kinetics (i.e., first-order) at low concentrations and zero-order kinetics at higher concentrations (100–200 mg/dL). In the setting of alcohol-dehydrogenase (ADH) inhibition, both MeOH and EG exhibit first-order elimination kinetics. Typical average elimination half-lives of MeOH and EG in setting up ADH blockade are 52 hours and 17 hours, respectively. Our objective is to describe the effect on toxic alcohol/glycol elimination kinetics in the setting of MeOH and EG co-ingestion with subsequent fomepizole administration.
Case report: This is a case report of an 84-year-old woman who intentionally ingested one gallon of a 50/50 antifreeze and coolant formulation and was managed with fomepizole. She was initially alert and oriented but required intubation for airway protection during transport to the emergency department. Initial blood MeOH and EG concentrations were 300.2 and 887 mg/dL, respectively. Blood ethanol was undetectable, serum creatinine was 0.8 mg/dL, BUN 17 mg/dL, bicarbonate 24 mEq/L, anion gap 16 mEq/L, and arterial pH was 7.45. Hemodialysis was recommended upon poison center consultation due to an expected prolonged treatment course, but was not performed. Fomepizole was administered every 12 hours until blood MeOH and EG concentrations were undetectable (achieved after 230 hours of fomepizole therapy). Both MeOH and EG followed first-order kinetics with a half-life of 89.9 and 19.8 hours, respectively. No adverse effects were associated with fomepizole therapy and there was no evidence of toxic metabolite formation from either MeOH or EG.
Conclusions: Fomepizole was effective in preventing severe toxicity after massive co-ingestion of MeOH and EG. Each exhibited first-order kinetics in the setting of ADH inhibition and did not appear to affect each other's expected elimination kinetics. Massive combined ingestions may affect the typical elimination half-life expected for each in the setting of ADH blockade. Prospective in vivo research is warranted to investigate the influence of MeOH and EG co-ingestion on their respective elimination kinetics to optimize treatment and monitoring.

KEYWORDS Methanol; ethylene glycol; fomepizole

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199. Hold the fomepizole? Incidence of ethylene glycol and methanol toxicity in pediatric ingestions: a single center review

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Background: Methanol (MeOH) and ethylene glycol (EG) poisonings cause significant morbidity and mortality. Alcohol dehydrogenase (ADH) blockade is standard treatment, with extracorporeal removal recommended under certain conditions. Exposure confirmation typically requires measurement utilizing sophisticated techniques not readily available in many facilities. In the absence of definitive testing, the history, physical exam findings, and serum chemistries including the osmolar and anion gap are utilized to guide treatment. US poison centers are often consulted for potential toxic alcohol/glycol exposures in pediatrics. Pediatric exposures are often unwitnessed exploratory ingestions and unlikely to lead to toxicity; however, the incidence of treatable blood concentrations with either ADH blockade or hemodialysis is unknown. Our objective is to describe the incidence of MeOH and EG concentrations in children reported to our center.
Methods: A retrospective review of pediatric MeOH and EG ingestion cases reported to a single poison center between 1 January 2013, and 31 December 2022. Patients aged 0–12 years were included. The following data were abstracted: age, sex, clinical effect, reason, substance, management site, diagnostic testing for ethylene glycol and methanol, treatment with fomepizole or hemodialysis, and medical outcomes.
Results: A total of 328 cases involving pediatric ingestion of MeOH or EG met inclusion criteria. The mean age was 3.4 years, and 213 (64.9%) were male. Most cases were age 0–5 years (263; 80.2%), with remaining age 6–12 years (65; 19.8%). Reported ingestion amounts included: unknown (120; 36.6%), a "taste or lick" (168; 51.2%), and greater than five milliliters, sip, or mouthful (40; 12.2%). The most common management site was at home (181; 55.2%). A total of 147 (44.8%) cases were referred to a healthcare facility, of which 12 were admitted to a non-critical care unit, and 12 were admitted to a critical care unit. Of the cases followed to a known outcome, 154 (76.2%) had no effect, 27 (13.4%) resulted in minor effects, ten (5%) resulted in moderate effects, and three (1.5%) resulted in major effects. The most common products ingested were: antifreeze/coolant (158; 48.2%) and windshield washer fluid/deicer (95; 28.9%). Fomepizole was empirically administered in 58 (39.5%) of HCF cases. For patients treated at a healthcare facility (HCF), testing for EG or MeOH was performed in 88 (59.9%) cases, of which 75 (85.2%) were undetectable and 13 (14.8%) resulted in a detectable serum concentration. Two of the 13 cases warranted treatment (Our facility's threshold is $\geq$20 mg/dL). One was a 12-year-old suicide attempt who received hemodialysis ([MeOH] 67 mg/dL); the other was a 2-year-old ([EG] 21 mg/dL).
Conclusions: Incidence of EG and MeOH toxicity in pediatric ingestions was rare, especially in children $\leq$5. Most ingestions were managed at home and remained asymptomatic. Although fomepizole was frequently administered in patients in an HCF, detectable serum concentrations were rare, and of those only two met treatment thresholds. These findings may preclude empiric fomepizole administration in young children. Prospective evaluation can help inform triage and confirm these findings.

KEYWORDS Pediatrics; ethylene glycol; methanol

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200. Atypical severe bupropion and olanzapine toxicity with delayed cardiac decompensation and transient tachycardia requiring extracorporeal membrane oxygenation

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Background: Since 2017, bupropion alone caused more annual severe outcomes reported to America's Poison Centers than any class of antidepressants. Rare severe cardiotoxicity from gap junction inhibition may manifest as QRS prolongation and cardiogenic shock. We present a case of bupropion toxicity with multiple atypical features including transient tachycardia, delayed QRS prolongation, and delayed cardiogenic shock requiring ECMO.
Case report: 28-year-old male with a history of depression presented to the emergency department by ambulance after suspected ingestion of bupropion and olanzapine. The patient was found unconscious with clonic jerks and empty bottles of the patient's olanzapine 10 mg and bupropion XL 300 mg. Time of ingestion was unknown, but he was last seen normal six hours previously. Initial vital signs were pulse 141, temperature 36.6 °C, blood pressure 137/105, and room air oxygenation saturation 96%. He was intubated with a GCS of 5 and started on propofol, fentanyl, and midazolam infusions. The patient's CT scan showed no pathology and electrocardiogram showed sinus tachycardia with QRS interval 80 msec and QTc interval 431 msec. On day one, continuous EEG displayed multiple clinical generalized tonic-clonic seizures and subclinical seizures, which continued until day three. The patient had resolution of tachycardia and development of hypotension requiring vasopressors 1.5 hours and 6.3 hours after presentation, respectively. He had serial electrocardiograms, which showed development of QRS prolongation of 203 msec with right bundle branch block morphology and QTc prolongation to 608 msec at 15.8 hours after presentation. He was given sodium bicarbonate 100 mEq without significant change in the QRS interval and had escalating vasopressor requirements. Twenty-five hours after presentation, echocardiogram displayed severely reduced ejection fraction of 20–25% and he was transferred to a hospital with ECMO capabilities.Shortly after second hospital arrival, 32 hours after presentation, he developed bradycardia followed by pulseless ventricular tachycardia. ACLS was initiated and he was cannulated on veno-arterial ECMO 11 minutes into the cardiac arrest. The patient was on ECMO for 47 hours and decannulated after hemodynamic and echocardiographic improvement. He was extubated on hospital day eight and had normal cognitive function two days later. The patient had elevated venous blood concentrations of bupropion (274 ng/ml) and hydroxybupropion (4,718 ng/ml) 38 hours and olanzapine (191.4 ng/ml) 34 hours after presentation.
Discussion: This case was atypical as tachycardia resolved 1.5 hours after arrival, which was 14.3 hours prior to developing QRS prolongation. Additionally, this patient developed cardiotoxicity causing cardiac arrest that required ECMO 32 hours after being found unconscious, which is later than other reported cases. Slowed gut motility from olanzapine's antimuscarinic effects may have contributed to this patient's delayed toxicity.
Conclusions: This case displays that resolution of tachycardia, which is often interpreted as a marker of clinical improvement, does not preclude cardiac decompensation. Furthermore, QRS interval prolongation and cardiac decompensation may be delayed in bupropion toxicity. Finally, sodium bicarbonate did not improve QRS interval prolongation from bupropion, but cardiogenic shock was successfully treated with ECMO.

KEYWORDS Bupropion; olanzapine; ECMO

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201. A case report of intentional ingestion of an insecticide "Sniper DDVP" containing dichlorvos by a pregnant patient resulting in emergency cesarean section

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Background: There is a paucity of literature documenting ingestions of organophosphates such as dichlorvos by pregnant patients describing the potential for fetal toxicity and best management steps.
Case report: This is a single patient case report of ingestion of dichlorvos in a pregnant patient that resulted in a cesarean section being performed. A 22-year-old woman who was 32-weeks pregnant presented to the emergency department by ambulance for an intentional ingestion of an insecticide called "Sniper DDVP". She obtained the product from West Africa, which contained the organophosphate dichlorvos (concentration unknown). She was noted to have increased salivation per the emergency department provider. Her initial vital signs were BP, 126/78 mmHg; HR, 96 beats/min; RR, 26 breaths/min; T, 98.9°Fahrenheit; O_2 Sat, 98% (RA). After an initial dose of 1 mg of atropine was given in the emergency department she was urgently taken for cesarean section. A healthy pre-term infant was delivered with normal APGAR scores who did not require further resuscitation and had no evidence of cholinergic toxicity. Pralidoxime was administered to the patient (mother) after the procedure as a bolus of 1 gram. The patient did not have ongoing evidence of cholinergic toxicity was extubated on hospital day 3 and discharged without complication after psychiatric evaluation. The infant was discharged to the custody of family without complication. Initial plasma cholinesterase level for the patient (mother) resulted at 255 IU/L (reference range: 2504–6297 IU/L). Initial plasma cholinesterase level for the infant resulted at 1603 IU/L (reference range: 2504–6297 IU/L).
Discussion: This represents a case of an intentional ingestion by a pregnant patient of an insecticide containing the organophosphate dichlorvos resulting in evidence of mild cholinergic toxicity with increased salivation. Serum cholinesterase for both mother and infant were both decreased below reference range. However, this might be confounded as serum cholinesterase levels are decreased in pregnant women and infants up to 6 months of age without specific reference ranges. As robust literature regarding placental transfer of dichlorvos and other organophosphates is lacking, the best steps in clinical management with regards to obstetrical intervention are often unclear beyond providing supportive and antidotal treatment to the mother. While there are no specific criteria to perform a caesarean section in an organophosphate poisoned pregnant patient, in this case where a cesarean section was performed there was a good maternal and fetal outcome.
Conclusions: This case report of an intentional ingestion of dichlorvos by a pregnant patient where a cesarean section was performed with good maternal and fetal outcome highlights the

possibility of placental transfer of dichlorvos as both the patient and delivered infant had low serum cholinesterase levels.

KEYWORDS Dichlorvos; pregnant; caesarean section

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202. Enough negativity? Clinically significant salicylism with first detectable concentration twelve hours post-ingestion

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Background: Salicylate overdose is commonly reported. While delayed absorption of aspirin has been described, most report an initial negative salicylate concentration followed by a subsequent measurable concentration, or an initial low concentration followed by a delayed increase. We report a case with multiple negative salicylate concentrations that developed moderate salicylate toxicity with concentration peaking between 18.5- and 21-hours post ingestion.
Case report: A 19-year-old patient presented to the ED after reported ingestion of seventy-eight (325 mg) aspirin tablets (25.4g total) 30 minutes prior to presentation. The patient was nauseated, otherwise asymptomatic on presentation, and was given a dose of activated charcoal via NG tube. All labs returned normal, and a salicylate level drawn 2.5 hours post-ingestion was undetectable. Salicylate concentrations drawn 5.5 hours and 7 hours post-ingestion resulted at $<$ 5 mg/dl. At that time, the poison center closed the case. For unknown reasons, the primary team checked another salicylate concentration at 12 hours post ingestion, which returned at 31 mg/dl. At that time the patient's CO2 was 22 and anion gap 10. The patient was on a 1:1 hold during this entire time, and additional ingestion was not thought to have occurred. There was no report of coingestants. A peak salicylate concentration of 55 mg/dl was recorded at 18.5 hours post ingestion and again at 21 hours post ingestion. The patient complained of tinnitus and nausea and was started on an isotonic bicarbonate infusion to alkalinize the urine. A repeat dose of activated charcoal was given but the patient vomited it back up immediately. At this time pulse rate increased to 123 beats/min and serum CO2 dropped to 19. The aspirin level decreased over the next 16 hours without subsequent sequelae.
Discussion: Absorption of aspirin can be delayed and erratic due to the formation of bezoars. Even in large ingestions, the initial serum salicylate concentration can be undetectable, even though salicylates are typically rapidly absorbed in the stomach. For example, in a cohort of 313 aspirin-poisoned patients all ill enough to receive treatment with bicarbonate, 3.5% of patients (n = 11) had an initial undetectable salicylate concentration, and one of these patients died. Current literature is insufficient to determine the number and timing of post-ingestion salicylate concentrations after overdose, however a single concentration is almost certainly inadequate.
Conclusions: Aspirin absorption can be delayed after overdose, resulting in negative serum concentrations for more than 7 hours post ingestion. Further evidence is needed to determine the timing and number of serum salicylate concentrations post-ingestion to rule-out clinically important poisoning.

KEYWORDS Salicylism; aspirin; delayed absorption

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203. Fatality in a pediatric patient following massive ingestion of hydroxychloroquine despite ECMO

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Background: Hydroxychloroquine is a medication historically used against malarial infections, but more commonly used to treat inflammatory conditions such as rheumatoid arthritis and systemic lupus erythematosus. Acute ingestions of 12g of hydroxychloroquine are lethal in adults. There are very few reports of massive hydroxychloroquine ingestions in pediatric patients, and even fewer reports of pediatric hydroxychloroquine toxicity requiring extracorporeal membrane oxygenation (ECMO).
Case report: We present a case of a 16-year-old female with a history of lupus and depression who presented to a healthcare facility after an acute intentional ingestion of 24 g (169 mg/kg) of hydroxychloroquine. The patient arrived at the initial healthcare facility 2 hours post ingestion. Initial evaluation showed tachycardia, normotension, tachypnea and altered mental status. She acutely developed ventricular dysrhythmias, including ventricular tachycardia, pulseless ventricular tachycardia, and ventricular fibrillation. She required synchronized cardioversion twice, defibrillation, and administration of epinephrine, magnesium, calcium chloride, sodium bicarbonate, amiodarone and intravenous fluids. The patient was intubated during cardiopulmonary resuscitation. Return of spontaneous circulation was achieved after 17 minutes and the patient was started on an epinephrine infusion. She received midazolam and fentanyl infusions while on the ventilator. After initial discussion with the regional poison center and with cardiology, the patient was given lidocaine and intravenous lipid emulsion therapy (ILE). The patient was transferred to the tertiary care hospital after stabilization and admitted to the pediatric intensive care unit. Upon arrival at the PICU, the patient again developed cardiac arrest. The patient underwent CPR for approximately 45 minutes. The medical toxicologist evaluated the patient and recommended high dose diazepam infusion with vasopressor support, activated charcoal through the orogastric tube, and additional intravenous lipid therapy in addition to ECMO. The ECMO team performed cannulation and placement of the patient onto the ECMO circuit. A bedside echocardiogram after ECMO placement showed severely depressed biventricular systolic function. While on ECMO, the patient was started on molecular adsorbent recirculating system (MARS) therapy. Labs obtained throughout the patients hospital course revealed profound hypokalemia with rebound hyperkalemia (range 1.4 – 6.8), hypocalcemia, acidemia, and elevated lactic acid. A serum hydroxychloroquine concentration obtained 28 hours post ingestion was 2606 ng/mL (500–2000 ng/mL). Head imaging showed findings consistent with hypoxic ischemic encephalopathy.The patient developed multisystem organ failure on hospital day 2 despite extracorporeal life support. The patient died on hospital day 3, approximately 60 hours post ingestion.
Discussion: Hydroxychloroquine toxicity closely resembles chloroquine toxicity and is manifested by profound electrolyte derangements and cardiovascular collapse. Management recommendations include early intubation and mechanical ventilation, gastrointestinal decontamination, correction of hypokalemia, and cardiovascular support with IV fluids, pressors, and extracorporeal membrane oxygenation. High dose diazepam and epinephrine infusions are recommended for massive hydroxychloroquine ingestions. Other therapies warrant further investigation.
Conclusions: Hydroxychloroquine toxicity is a rarely encountered diagnosis. Healthcare providers should be aware that massive

ingestions of hydroxychloroquine cause significant morbidity and mortality.

KEYWORDS Hydroxychloroquine; pediatrics; ECMO

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204. Large anion-gap metabolic acidosis, multiorgan failure, and death resulting from naproxen overdose

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Background: Naproxen, a propionic acid derivative, is one of the most used and widely accessible non-steroidal anti-inflammatory drugs (NSAIDs) that can result in severe anion-gap metabolic acidosis (AGMA) in massive overdose due to accumulation of acidic metabolites. Its analgesic and anti-inflammatory therapeutic effects are achieved by a reversible, competitive, and non-selective inhibition of cyclooxygenase isoenzymes resulting in reduced prostaglandin synthesis. Acute NSAID toxicity predominantly affects the gastrointestinal, renal, and central nervous systems (CNS) usually only in very large or massive overdoses. Most published data on acute NSAID overdose involve ibuprofen, while reports of fatalities from NSAID overdose are usually complicated by coingestants.
Case report: A 23-year-old female with history of post-traumatic stress disorder (PTSD), depression, and prior suicide attempts, presented to the emergency department (ED) with agitation, altered mentation, nausea, vomiting, as well as tachypnea after intentional ingestion of an unknown amount of naproxen 500 mg tabs. Initial vital signs were afebrile, blood pressure 137/77, pulse 68, respiratory rate 46, oxygen saturation 96% on room air. During her ED course, the patient developed seizures, became obtunded and hypoxic, and required intubation. Patient also developed progressive anion gap metabolic acidosis (pH 7.1 with anion gap up to 33) along with elevated lactate up to 12.5, acute renal injury, tropinemia, as well as shock refractory to multiple pressors, intravenous fluids, bicarbonate, albumin, and steroid, and despite correction of acidosis with hemodialysis. In subsequent days, the patient remained hemodynamically unstable and began to develop multiorgan failure, including acute heart failure with demand ischemia, transaminitis with coagulopathy, renal failure, and acute respiratory distress syndrome (ARDS) with hypoxemia refractory to maximal ventilatory support. The patient subsequently suffered asystolic cardiac arrest and expired after 4 days of hospitalization. Patient's autopsy and toxicology findings were significant for pulmonary edema as well as a hospital admission blood naproxen concentration of 890 mcg/mL.
Discussion: This is an uncommon case fatality due to sequelae of multiorgan failure attributable to a primary massive naproxen overdose without the presence of confounding toxicity from coningestants. The admission blood naproxen level of 890 mcg/mL is approximately 13-fold higher than the average peak serum concentration of 71 mcg/mL after ingestion of 500 mg of naproxen, although individuals have survived overdoses of naproxen where serum concentrations exceeded 400 mcg/mL. Furthermore, the progressive pulmonary and cardiovascular toxicities seen in this case despite correction of acidosis suggest the potential for direct pulmonary and cardiotoxicity by unknown drug mechanisms. Generalized tonic-clonic seizure have been described with mefenamic acid overdose as well as ibuprofen overdose, and this manifestation appears to extend to naproxen well.
Conclusions: This patient's significantly elevated blood naproxen concentration adds to the data on the threshold concentration at which naproxen toxicity may be expected to become unsurvivable and irrecoverable despite maximal supportive care for a xenobiotic that does not have an antidote and that is not amenable to extracorporeal removal due to its high protein binding. Complications from massive naproxen overdose can include multiorgan failure and refractory shock leading to death.

KEYWORDS Naproxen; NSAID; fatality

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205. Orexin antagonist overdose should not keep you up at night: mild toxicity in a large suvorexant overdose

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Background: Suvorexant works as an orexin receptor antagonist and is utilized to treat insomnia. Orexin is a neuropeptide that regulates wakefulness and is mostly produced by the hypothalamus. Usual adult dosing of suvorexant is 5–20 mg with a half-life around 12 hours. Typical peak onset of action is around 2 to 3 hours in therapeutic dosing. Literature in overdose is limited.
Case report: A 67-year-old woman with past medical history of hypertension, CKD, diabetes, bipolar disorder, prior suicide attempts, chronic back pain and insomnia presented to the ED for reporting an intentional ingestion of 100 mg of her suvorexant as a suicide attempt. The patient presented to the hospital endorsing symptoms of sleepiness and fatigue, but was easily arousable and did not have any other medical complaints. All vitals were within normal limits. Lab work was unremarkable and acetaminophen, ethanol, and salicylate levels were negative. EKG showed normal sinus rhythm with normal intervals and no signs of arrhythmia. A quantitative suvorexant level was 1500 ng/mL (therapeutic 130–400 ng/mL) drawn 5 hours after reported time of ingestion. Pt was monitored for 6 hours in the ED and clinically improved. She was then transferred to psychiatric care.
Discussion: There is limited data on toxicity from suvorexant overdose. Historically insomnia medications have demonstrated tolerance in chronic use as well as significant oversedation in overdose. The class of medications that function as orexin receptor antagonists have demonstrated a favorable limited side effect profile in chronic use however acute overdose data is not well described. This patient presented with a clear story of overdose and a quantitative supratherapeutic serum level. She denied any coingestions and ethanol, acetaminophen and salicylate levels were negative pointing away from confounding exposures and developed only mild toxicity.
Conclusions: Despite taking an amount twenty times greater than her usual and a serum level 3.75 times the upper limit of normal, toxicity from suvorexant was minimal and improved quickly. Suvorexant toxicity in acute overdose is likely safe compared to alternative insomnia pharmaceuticals.

KEYWORDS Orexin antagonist overdose

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206. "Unwell"-butrin: PK properties of bupropion in an XL ingestion

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Background: Bupropion is a phenylethylamine antidepressant widely used for the treatment of depression and smoking cessation. It has several advantages compared to other antidepressants as it is less likely to cause weight gain and sexual dysfunction. However, it lowers the seizure threshold at therapeutic doses, and in overdose can cause cardiotoxicity refractory to standard ACLS. We present two cases of bupropion overdose.
Case series: Case 1: A 29y F presented obtunded to the ED after ingesting 8 g bupropion. She was intubated and treated with benzodiazepines for status epilepticus. She developed monomorphic ventricular tachycardia, initially stable, but became hypotensive and was cannulated for ECMO on hospital day 1. She spontaneously converted to normal sinus rhythm later that day. Her initial bupropion level resulted at 2894 ng/mL; hydroxybupropion was 4571 ng/mL. She was decannulated on hospital day 4 after 24 hours of hemodynamic stability. She was extubated on hospital day 9 and eventually was discharged to inpatient psychiatry services. Case 2: A 23 F presented for ingestion of 9 g bupropion. She was treated with benzodiazepines for seizures, and intubated. Initial bupropion/hydroxybupropion levels were found to be 2462/1745 ng/mL. She remained stable and did not require treatment with lipid emulsion therapy or ECMO. She was extubated on hospital day 4 and was discharged to inpatient psychiatry services on day 6.
Discussion: The pharmacokinetic (PK) parameters of bupropion in the setting of overdose have been reported in previous literature. We describe calculated PK parameters of the patients described. Utilizing serial levels of bupropion in the blood, concentration (C) vs. time (t) curves were created and evaluated for fit. Patient-specific PK parameters were calculated, which allowed for analysis of order of elimination (e.g., zero vs. first), as well as estimation of duration, for both the parent compound and hydroxybupropion metabolite. Calculated PK parameters include maximum concentration (C_{max}) and elimination half-life ($t_{1/2}$). The calculated PK parameters in Case 1 differ significantly from those published for bupropion at therapeutic doses, as well as the PK parameters calculated for Case 2. In Case 1, Cmax of both bupropion and hydroxybupropion are over twice the concentration of Cmax in Case 2, yet the half-life of bupropion is much shorter. The converse observation can be made for the elimination rate of hydroxybupropion. Differences may be explained through selective removal of xenobiotics via ECMO, saturable protein binding that increased the elimination of bupropion, or intervariations in absorption and/or metabolism of bupropion between patients.
Conclusions: There are multiple case reports documenting the successful use of ECMO in the resuscitation of bupropion overdose. However, there are few documenting the use of ECMO *without* any use of lipid emulsion therapy. Case 1 represents the first documented case to our knowledge of initiating ECMO alone prior to losing pulses in a bupropion-poisoned patient. The pharmacokinetic data highlight the unique elimination profile that may occur in such patients.

KEYWORDS Bupropion (wellbutrin); ECMO; toxicokinetics

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207. Massive ibuprofen ingestion associated shock treated successfully with hemodialysis

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Background: Massive ibuprofen ingestions constitute a rare subset of ibuprofen exposures. Rather than a mild course, these patients present with shock, CNS depression and metabolic acidosis. Owing to high protein binding, hemodialysis efficacy is unknown in toxin removal, however may assist in correction and stabilization of severe acidosis-related shock. We report a case of massive ibuprofen ingestion presenting in profound shock and metabolic acidosis, with improving hemodynamic parameters after emergent hemodialysis (IHD).
Case report: A 19-year-old woman presented to the emergency department after ingestion of approximately 180 g ibuprofen at an unknown time prior to presentation. Upon arrival, the patient was obtunded with orange vomitus noted around her mouth, with initial vital signs BP 94/40 mmHg, HR 111 beats/minute, respiratory rate 26 breaths/minute, SpO_2 98% on non-rebreather oxygen. Fluid resuscitation and vasopressors were initiated, and the patient was orotracheally intubated. An orogastric tube was placed, gastric lavage was performed, and 50 g activated charcoal was instilled. Initial laboratory studies were notable for metabolic acidosis (pH 7.28, pCO_2 37 mmHg, bicarbonate 17 mEq/L). Shock and acidosis progressed over the next several hours despite aggressive management (Max vasopressor rates achieved: epinephrine 0.4 mcg/kg/min, norepinephrine 0.4 mcg/kg/min, vasopressin 0.08 U/min, angiotensin II 80 ng/kg/min). Repeat arterial blood gas 2.5 hours after presentation showed worsening acidemia (pH 7.00, pCO_2 35 mmHg, Bicarbonate 8 mEq/L). With refractory acidosis, emergent IHD was performed 3.5 hours after presentation at a blood flow rate of 400 mL/min for a total of 2.5 hours. Shock and acidosis improved following IHD initiation, with multiple pressors successfully weaned. At the conclusion of IHD, only norepinephrine at 0.2 mcg/kg/min and vasopressin at 0.04 U/min were needed to maintain perfusion. IHD was followed by 12 hours of continuous renal replacement therapy (CRRT), and the patient thereafter did well. Ibuprofen level later returned elevated at 920 mcg/mL on presentation, 650 mcg/mL at conclusion of hemodialysis and 390 mcg/mL 20 hours into evaluation. Urine mass spectrometry identified only ibuprofen and olanzapine, a prescribed medication.
Discussion: This case of massive ibuprofen ingestion demonstrated improvement of hemodynamic parameters following hemodialysis. Traditionally, hemodialysis is not recommended for ibuprofen overdose, owing to the high protein binding (> 99%) of ibuprofen. The remainder of ibuprofen's physical characteristics, however, are favorable for removal via dialysis (volume of distribution =0.2 L/kg, molecular weight =206 Daltons). Toxicokinetics suggest protein binding may saturate leaving remnant poison in the blood amenable to dialysis, as with salicylate poisoning. While volunteer studies suggest ibuprofen's half-life does not change during routine hemodialysis, similar studies note ibuprofen metabolites accumulate in dialysis patients; furthermore ibuprofen metabolites are detectable in dialysate of such patients.
Conclusions: This patient's shock dramatically improved after hemodialysis. Improvement could be from enhanced clearance of ibuprofen or merely hemodialysis-related improved acid-base status. More data are needed to determine if hemodialysis is effective for shock from massive ibuprofen overdose.

KEYWORDS Ibuprofen; hemodialysis; critical care toxicology

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208. A 5-year profile of paraquat poisoning cases in a tertiary hospital, south-west Nigeria

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Background: Paraquat is a major herbicide commonly used in the agrarian community. It is known to contain 1,1- dimethyl 4,4-bypyridinium dichloride which is highly toxic to humans. Acute ingestion of paraquat often leads to mortality especially in low to middle-income countries (LMIC). This study reports the profile of paraquat acute poisoning cases at the emergency room of a tertiary teaching hospital in South-west Nigeria.
Case series: Cases (8) of acute ingestion of paraquat that presented at the emergency room of a Teaching Hospital over a 5-year period (January 2015 to December 2019) were described based on available data retrieved at the unit and a review of available case files. The demography, reason for poisoning, admission duration, and outcomes were described. The cases included 7 males and 1 female with a history of oral ingestion of paraquat for suicide. Only two cases (1 and 4) had complete information retrieved from the hospital case file. All were below 40 years and predominantly males. There were four (50%) mortalities, 2 discharged against medical advice, and only 2 (25%) cases were discharged home. The only male (Case 4) that survived had acute renal insufficiency and edenophagia which resolved a few days after. He spent a total of 10 days on admission and was subsequently discharged to the psychiatric clinic.
Discussion: This report showed a male predisposition towards acute paraquat ingestion and young people below 40 years are at risk for intentional suicidal purposes. Previous studies showed a male preponderance for paraquat poisoning though, other studies also reported female predominance. Young adults were reported to deliberately ingest chemicals. Paraquat is readily distributed to organs like kidneys where it elicits toxicity in a biphasic manner and presents as an early or late acute kidney injury (AKI). This may explain the delayed onset of AKI observed for Case 4 in this report as he developed renal insufficiency on the 6th day of admission. This however resolved following fluid management without a need for hemodialysis. A previous report from Southwestern Nigeria on a 23-year-old female described a case of AKI following acute PQ poisoning 3 days after ingestion which was successfully managed with hemodialysis. The renal impairment in case 4 is not as severe as that reported in other literature which may be due to the lower dose ingested (20 ml PQ as against 30 ml in a previously reported case). Hypokalaemia is also recognized in PQ poisoning from the development of RTA and increased kaliuria which was present in Case 4. This study found a mortality of 50% similar to earlier findings of 52% mortality from complications involving the pulmonary and renal systems.
Conclusions: The mortality from paraquat poisoning is high with prominent renal complications in this environment. Management of acute paraquat poisoning should ensure adequate respiratory support and fluid management to prevent renal complications and improve outcomes.

KEYWORDS Paraquat; acute poisoning; mortality

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209. Critically ill methemoglobinemia due to sodium nitrite ingestion facilitated by cellulose capsules

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Background: Over the past 20 years, the increasing availability of the internet and recent factors such as the COVID19 pandemic have led to a surge in the popularity of online shopping, particularly with websites such as Amazon. With this increasing popularity, there has been a concurrent trend of individuals purchasing substances online with the intention of committing suicide. Specifically, there has been a sharp increase in the use of sodium nitrite in suicide attempts given its widespread online availability. We present the case of a patient using sodium nitrite placed in cellulose medication capsules, both of which were purchased online, to commit suicide.
Case report: 18-Year-old female presenting to a local emergency department after taking an unknown amount of sodium nitrite. It was later reported that the sodium nitrite had been placed into empty cellulose capsules. When she arrived in the ED, the patient was markedly cyanotic with an SpO_2 of 85% despite ventilation with 100% FiO_2 via endotracheal tube. An ABG showed an undetectably high (> 30%) level of methemoglobin, and her blood was dark brown in color. Given these findings, methemoglobinemia was suspected and methylene blue was ordered. The patient's condition rapidly deteriorated to cardiac arrest, and methylene blue was administered at 1.5 mg/kg during her resuscitation. Approximately 5 minutes after methylene blue was initiated and after ROSC had been achieved, the patient's SpO_2 dropped as low as 58% with a subsequent improvement after 15 minutes to the mid to low 80's. A repeat ABG 30 minutes after methylene blue administration again demonstrated an undetectably high methemoglobin level. Given her critically ill status, another 1.5 mg/kg of methylene blue was administered 35 minutes after the initial dose. Her SpO_2 again dropped for several minutes before improving to 95%. A repeat ABG in the ICU showed a methemoglobin level of 12.7%. The patient was admitted to the MICU where she developed hyperthermia and rigidity concerning for serotonin toxicity secondary to methylene blue and home psychiatric medications. It was later determined she had suffered a catastrophic anoxic brain injury and care was withdrawn in accordance with her family's wishes.
Discussion: Severe methemoglobinemia is becoming a more common presentation given recent uptrends in sodium nitrite ingestion. In this case the use of a cellulose capsule likely increased the amount of sodium nitrite the patient could take orally. In addition, the online acquired capsules provided an additional variable with regards to expectations of toxicokinetic behavior. Had the patient had recurrence of methemoglobinemia, whole bowel irrigation may have been considered pending hemodynamic stability.
Conclusions: Methylene blue is an effective antidote in patients presenting with severe methemoglobinemia secondary to sodium nitrite exposure. Dosing and administration in critically ill patients should be revisited, and adjunctive therapies such as whole bowel irrigation theoretically may be of use in patients who are at risk of ongoing exposure such as when the toxic agent is placed in capsules to facilitate the ingestion of larger amounts.

KEYWORDS Methemoglobinemia; sodium nitrite; online purchase

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210. Massive mycophenolate overdose with monumental level but minimal malady

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Background: Mycophenolate mofetil is an immunosuppressant to treat autoimmune disorders or prevent organ rejection post-transplantation. It is rapidly metabolized to the active metabolite mycophenolic acid (MPA) and inactive metabolite, MPA glucuronide. MPA is a reversible inhibitor of inosine monophosphate dehydrogenase that preferentially depletes guanosine nucleotides in T and B lymphocytes and inhibits their proliferation. Primary concerns following mycophenolate overdose include infection due to leukopenia or pancytopenia, and hypotension. Massive overdoses of mycophenolate are rare, and concern for severe toxicity is thought to be low. Based on current literature, we present a case with the highest reported levels of MPA and MPA glucuronide without any significant symptoms developing.
Case report: A 19-year-old woman weighing 75 kg ingested up to 60 tablets of her mycophenolate mofetil 500mg for self-harm about 20 minutes prior to ED arrival. Past medical history is notable for seizure disorder on levetiracetam and lacosamide, likely related to her autoimmune T-cell encephalitis. Her arrival vital signs were: blood pressure 110/69, heart rate 91 beat/min, respiratory rate 30 breath/min, and oxygen saturation at 99% on room air. Blood pressure nadir was 98/69, without intervention. She denied any abdominal pain, but did report a tingling sensation in the hands. She was administered lorazepam and 50 g of activated charcoal in the ED. Her blood ethanol level was 62 mg/dL, and urine drug screen was positive for THC and benzodiazepines. Acetaminophen and salicylate levels were negative, and anti-epileptic levels were not elevated. Two hours post-ingestion, MPA and MPA glucuronide levels were 68.5 mg/L (reference range: 1.0–3.5 mg/L) and 342 mg/L (reference range: 35–100 mg/L), respectively. Repeat levels 22 hours post-ingestion were MPA 2.0 mg/L and MPA glucuronide 32 mg/L. Complete blood count (CBC) at 2 hours, 22 hours, and 36 days post ingestion were all within normal limits.
Discussion: This case reports the highest MPA level to date and a calculated elimination half-life of MPA at 3.9 hours, which suggests that elimination kinetics of MPA are likely non-saturable even in the setting of a massive overdose. This patient had minimal symptoms, did not develop significant hypotension or delayed cytopenia, and was successfully discharged home within 36 hours of presentation. This is consistent with prior case reports where only mild effects are noted. A prior case reporting a 25 g overdose of mycophenolate reported serial levels of MPA of 37.2, 1.1, 0.4, and 0.1 mg/L at 20, 24, 48, and 72 hours post-ingestion. Clinical effects in that case included slight anorexia and headache, and a moderate leukopenia at a nadir of 2040 mm3 five days post-ingestion.
Conclusions: In this case of 30 g of mycophenolate, rapid drug clearance and minimal clinical effects were observed. This case demonstrates the rapid drug clearance of mycophenolate mofetil, despite a massive ingestion which was supported by elevated MPA and MPA glucuronide levels. Despite high levels, patients may not experience significant side effects and should be treated with standard supportive care.

KEYWORDS Mycophenolate; levels

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211. Severe flecainide toxicity treated with sodium bicarbonate, intravenous lipid emulsion and lidocaine infusion

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Background: Flecainide is a Vaughn-Williams Class 1C antidysrhythmic. Flecainide has a long half-life and a narrow therapeutic index with a steep dose response curve. This results in severe toxicity in overdose. Symptoms of flecainide toxicity include widening of the QRS, bradycardia, hypotension, and death. We report a case of severe flecainide toxicity with persistent QRS widening refractory to sodium bicarbonate treated with lidocaine.
Case report: A 53-year-old female presented to the emergency department with a decreased level of consciousness 4 hours after an intentional overdose of flecainide. She had ingested 6000 mg in a suicide attempt. She also ingested 5 tablets each of duloxetine, zopiclone, and hydroxyzine. Her initial vitals were: HR 40 bpm, BP 52/26 mmHg, oxygen saturation 100% via BMV. Her initial QRS was 198 msec and QTc was 684 msec. She was intubated on arrival. No GI decontamination was given. Atropine failed to improve her heart rate. A sodium bicarbonate infusion and epinephrine infusion were started and she was transferred to a tertiary care centre. On arrival her HR had increased to 78 bpm, BP 120/80 mmHg and her QRS was 240 msec. Her blood gas on presentation was: pH 7.57/pCO2 33 mmHg/bicarbonate 30 mmol/L, sodium 153 mmol/L. The bicarb infusion was stopped for concerns of alkalemia. Isoproterenol was attempted with no improvement in QRS. She received 8 boluses of intravenous lipid emulsion (ILE) at 1.5 mL/kg with no effect. She was evaluated for VA-ECMO but was not felt to be a candidate. The poison centre was contacted 24 hours after presentation to the tertiary care centre and lidocaine was recommended. She received 3 mg/kg/hr for 6 hours, then 2 mg/kg/hr for a further 14 hours. Her QRS dramatically improved from 255 msec to 140 msec, with a HR 76 bpm and BP 109/70 mmHg. The sodium bicarbonate infusion was also briefly restarted but again stopped due to alkalemia. After 20 hours on the lidocaine infusion she developed mild clonus. The lidocaine infusion was decreased to 1 mg/kg/hr for concerns of possible local anesthetic systemic toxicity and the bicarbonate infusion was restarted. By day 3 post ingestion the lidocaine and bicarbonate were both successfully weaned off. The QRS remained at 140 msec and QTc remained above 600 msec until day 5 when her ECG normalized. She was extubated on day 5 and recovered neurologically intact.
Discussion: Sodium bicarbonate is the agent of choice for management of sodium channel antagonist toxicity. Lidocaine is a Class 1B antidysrhythmic that has successfully reversed sodium channel antagonism by cocaine. When given to cocaine poisoned canine papillary myocytes, lidocaine displaces cocaine binding to the sodium channel through competitive antagonism. Its fast on/off kinetics avoid any synergistic effect. Previous case reports also document success when used in refractory flecainide toxicity.
Conclusions: In this case report, lidocaine narrowed the QRS in a severe flecainide poisoned patient after a failure of sodium bicarbonate and ILE. Lidocaine can be considered in severe flecainide toxicity refractory to other measures.

KEYWORDS Flecainide; sodium bicarbonate; lidocaine

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212. Should we wait to cannulate? The role of venoarterial extracorporeal membrane oxygenation (VA-ECMO) in venlafaxine overdoses resulting in cardiogenic shock

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Background: Venlafaxine is a serotonin-norepinephrine reuptake inhibitor known to cause severe cardiac toxicity in overdose. We compare outcomes in two venlafaxine overdoses resulting in cardiogenic shock, contrasting the use of veno-arterial extracorporeal membrane oxygenation (VA-ECMO) versus standard medical management.
Case series: Case 1: A 32-year-old female presented to the emergency department (ED) obtunded after being found with empty bottles of gabapentin and venlafaxine extended-release (ER). Ten hours after arrival to the ED, the patient developed hypotension and multiple tonic-clonic seizures prompting intubation. She became increasingly hypotensive, and an electrocardiogram (ECG) demonstrated intraventricular conduction delay with a QRS of 180 milliseconds. Eighteen hours after arrival, she developed ventricular tachycardia with a total of four arrests over 25 minutes. Point-of-care echocardiography estimated left ventricular ejection fraction (LVEF) at 5–10%. A multidisciplinary team elected for immediate cannulation and initiation of VA-ECMO, coupled with a left ventricular assist device. This led to significant improvement in her shock state while supportive care was maintained. On hospital day (HD)-4, the patient was decannulated, and a formal echocardiogram estimated LVEF at 60–65% with normal biventricular function. The patient was ultimately discharged on HD-7 without sequelae. Case 2: A 58-year-old female presented to ED after ingesting 196 venlafaxine 150 mg ER capsules. Toxicology evaluated patient at bedside, where the exam was no for sedation and tachycardia. Twelve hours after arrival, she was intubated after a tonic-clonic seizure. She became increasingly unstable with hypotension and wide-complex tachycardia. Bedside echocardiography estimated LVEF at 10% and an ECG demonstrated QRS of 189 milliseconds. The patient was started on multiple vasopressors & dobutamine for hemodynamic support. The dobutamine drip was weaned over 8 hours, but vasopressor support continued for the next 36 hours. On HD-3, mental status slowly recovered and she was weaned off vasopressors, but laboratory studies indicated acute kidney injury and ischemic hepatitis. Nephrology was consulted, and intermittent hemodialysis was initiated. On HD-4 the patient was extubated. A repeat echocardiogram demonstrated a LVEF of 40–45% with residual global hypokinesis. The patient denied further dialysis and elected to move to comfort measures only after consult with ethics and psychiatry.
Discussion: Venlafaxine overdose can cause severe cardiogenic shock, yet there is no agreement on optimal care. While a comparison of individual patients cannot stand alone as evidence to support early use of VA-ECMO, the stark contrast in patient outcomes prompts discussion of utilizing VA-ECMO earlier in the clinical course of a significant venlafaxine overdose with progressive cardiogenic shock. Prompt cannulation could potentially prevent sequelae of prolonged vasopressor needs, as evidenced in our case's resultant multisystem organ failure ultimately resulting in a poor outcome.
Conclusions: This case comparison emphasizes clinician recognition of progressive hemodynamic instability in venlafaxine overdoses as an indication for engaging their closest available ECMO team. VA-ECMO may be superior to inotrope and vasopressor support alone, and prevent anticipated end-organ complications that lead to poor functional outcomes. A case-control study of VA-ECMO vs. medical therapy for venlafaxine-induced cardiogenic shock would further clarify the ideal treatment approach.

KEYWORDS Venlafaxine; ECMO

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213. Restrictive digoxin-specific antibody therapy in acute-digoxin-poisoning-associated significant hyperkalemia, a case report

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Background: It's feasible and safe to titrate doses of digoxin-specific antibodies (Digoxin-Fab) in acute digoxin poisoning; however, the adequate criteria to give titrated doses in acute digoxin toxicity with significant hyperkalemia ($K > 7.0$ mmol/L) isn't well established. We offer a case of acute digoxin poisoning with significant hyperkalemia with a restrictive antidote strategy in a resource-limited environment.
Case report: A 30-year-old, 57 kg female suffering from dizziness, nausea and non-bilious vomiting visited our emergency department (ED) about 4 hours after acute ingestion of digoxin tablets. Initial EKG revealed sinus bradycardia (43-beat-per-minute [bpm]). 0.5 and 1 mg of intravenous (iv) atropine were administered for an episode of unstable bradycardia, and 25 mg IV phenytoin was administered for an episode of heart rate < 40 bpm. 40 mg of Digoxin-Fab was administered about 9 hours post-ingestion due to elevated plasma digoxin concentration and hyperkalemia (total digoxin 27 ng/mL; K 7.4 mmol/L, serial lab data). Although there were episodes of hypotension necessitated low-dose norepinephrine (1.59 mcg/min) with junctional bradycardia (ranging from $35 \sim 55$ bpm), no further Digoxin-Fab was administered. The patient was transferred to the general ward two days later and was discharged uneventfully on the fifth day in the hospital.
Discussion: Titrated strategy for the administration of Digoxin-Fab in acute digoxin poisoning might be suitable for highly selective patients in antidote-limited environments. In this case, the criteria for titrating Digoxin-Fab is (1) heart rate < 35 bpm, (2) norepinephrine refractory hypotension, (3) ventricular dysrhythmia, or (4) no improvement or rebounding in significant hyperkalemia. Since digoxin inhibits the cardiac Na/K antiporter, causing hyperkalemia in digoxin overdose, titrating the antidote according to the response of normalisation of serum potassium concentration might be reasonable and feasible in Digoxin-Fab-limited environments.
Conclusions: Titrating the doses of Digoxin-Fab according to clinical response and normalisation of significant hyperkalemia might be a feasible strategy in the antidote-limited area. Further prospective studies might be performed to evaluate the efficacy of this restrictive strategy.

KEYWORDS Digoxin; antidote; restrictive therapy

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214. Adolescent fatal colchicine poisoning from insurmountable disseminated intravascular coagulopathy

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Background: Colchicine, a potent microtubule inhibitor and destabilizer, is well known to produce profound multiorgan system failure with a classic progression of symptoms, including early gastrointestinal effects, followed by cardiac failure, pancytopenias, renal injury and infection risk. Management for colchicine poisoning remains challenging owing to lack of effective antidote and limited therapies to enhance toxin removal. We report an adolescent fatal colchicine poisoning due to insurmountable disseminated intravascular coagulopathy (DIC) that limited other supportive critical care therapies.
Case report: A healthy adolescent girl presented to the emergency department 2.5 hours after intentional overdose of 54 mg Colchicine (0.68 mg/kg). Presenting vital signs included BP = 130/88 mmHg, Temp = 100.1 °F, Pulse = 79 beats/minute, RR = 21 breaths/minute, SpO_2 = 100% on room air. She was intubated to facilitate aggressive gastrointestinal decontamination (gastric lavage followed by multiple-dose activated charcoal (50 g/dose), and subsequently transferred to a pediatric ICU for ongoing management. Twelve hours post ingestion, she developed diarrhea, a mixed respiratory and lactic acidosis, and leukocytosis. Clotting factors were normal. Over the ensuing 24 hours, the patient developed progressive hypotension requiring multiple vasopressors, toxic cardiomyopathy (ejection fraction (EF) of 40%), anuric renal failure, acute liver injury, and new profound coagulopathy. Charcoal was discontinued after 4 doses due to ileus. Aggressive supportive management was continued with continuous renal replacement therapy (CRRT) for volume and acidosis management, correction of coagulopathy, and vasopressor infusion. Thirty hours post ingestion, venoarterial extracorporeal membrane oxygenation was considered for cardiopulmonary support giving escalating multiple vasopressor needs, however was deemed unsafe due to uncorrectable DIC with near continuous need for cryoprecipitate and fresh frozen plasma, and unclear benefit given stable EF of 42%. There was evidence of hepatic failure with coagulopathy and refractory hypoglycemia, though transaminases were not checked in the last 20 hours of her life. CRRT was stopped due to persistent filter clotting, and the patient had severe persistent bleeding from her mouth and all access lines. In total, she received 4 platelet infusions, 7 doses of cryoprecipitate, and 13 units of fresh frozen plasma. Due to severity of DIC and ongoing progression of multiorgan system failure, the patient was transitioned to compassionate care and died 64 hours post ingestion.
Discussion: The clinical course following colchicine-poisonings is well-described and while coagulopathy is included in previous reports, this is generally supportive with usual factor, plasma and platelet replacement. In our case, disseminated intravascular coagulation was profound, limited other aggressive management for her poisoning, and was thus a major contributor to her death. While aggressive gastrointestinal decontamination was performed rapidly, as recommended, the benefit was limited by unavoidable delays to intervention and ileus associated with critical illness.
Conclusions: Disseminated intravascular coagulopathy, an under described consequence of severe colchicine toxicity, adds complexity to other critical care measures described in the supportive care of colchicine-poisoned patients, such as CRRT and ECMO. Awareness of the risk for this complication may assist in anticipatory management for severe colchicine poisoning.

KEYWORDS Colchicine; coagulopathy; pediatrics
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215. The use of ertapenem for reducing toxic valproic acid concentrations

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Background: Valproic acid (VPA) overdoses commonly cause central nervous system (CNS) depression and hyperammonemia, with more severe effects possible, including bone marrow suppression, cerebral edema, and coma. Typical management consists of supportive measures, administration of carnitine for hyperammonemia, and renal replacement therapy (RRT). Carbapenems interact with VPA by inhibiting the enzyme acylpeptide hydrolase, which causes an enhanced elimination of VPA from the body. We present two intentional overdose cases where administering ertapenem significantly reduced elevated VPA concentrations in addition to other standard therapies.
Case series: Case 1: A 28 year-old male with a history of bipolar disease, blindness, and suicidal ideation, presented to our hospital's ED after intentionally ingesting 30–40 tablets each of haloperidol 5 mg and divalproex sodium 500 mg in a suicidal gesture. He became more somnolent while in the ED but did not require endotracheal intubation. His initial lab values included a VPA concentration 236.5 mcg/mL and ammonia of 154 mcmol/L. The local poison center was consulted and recommended serial laboratory analyses. His repeat VPA and ammonia concentrations peaked at 653 mcg/mL and 365 mcmol/L respectively. He was administered loading and maintenance doses of carnitine for the hyperammonemia, and 1 g of ertapenem eleven hours after arrival. His subsequent VPA concentrations decreased to 500 and 365 mcg/mL two and five hours after administration of the ertapenem. Case 2: A 61 year-old female with a history of bipolar disorder, atrial fibrillation, sick sinus syndrome, and COPD presented to our hospital's ED five hours after intentionally ingesting approximately 200 tablets of divalproex sodium ER 500 mg in a suicidal gesture. She was unresponsive, hypothermic, hypotensive, and bradypnic requiring IV fluid, external warming, and endotracheal intubation in the ED. Her initial lab values included a VPA concentration of 616.8 mcg/mL and ammonia of 199 mcmol/L. The local poison control center was consulted and recommended serial laboratory analyses. Her repeat VPA concentrations trended down for two days, but then had a second peak at 210.1 mcg/mL. Her ammonia concentrations peaked at 1,311 mcmol/L. She was administered loading and maintenance doses of carnitine for hyperammonemia and received 2 doses of 1 g of ertapenem, the first being administered six and a half hours after arrival. After the first dose, her subsequent VPA concentrations decreased to 343.2 and 162.1 mcg/mL three and seven hours after ertapenem administration. The second dose of ertapenem was administered after the second VPA concentration peak two days after her initial presentation. Her subsequent VPA concentration was 119.2 mcg/mL six hours after ertapenem administration.
Discussion: Valproic acid overdose can cause significant toxicity, which requires management with conventional therapies of supportive care and carnitine. Administering ertapenem in these

cases was valuable to help rapidly decrease toxic VPA serum concentrations without significant risk. The rebound in one patient's VPA concentration was mitigated with a second dose of ertapenem.
Conclusions: In addition to supportive care and carnitine for hyperammonemia, ertapenem should be administered to symptomatic patients with toxic concentrations of VPA. More than one dose of the carbapenem may be needed if VPA concentrations rebound.

KEYWORDS Valproic acid; carbapenem; enhanced elimination
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216. Successful use of expired physostigmine to treat anticholinergic delirium in a pediatric patient

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Background: Physostigmine is the primary antidote for moderate to severe antimuscarinic toxicity. The sole distributor, Akorn Pharmaceuticals, paused manufacturing of physostigmine for several years and then closed permanently in 2023. Most physostigmine supplies in the US expired in 2021. The FDA extended the expiration date for some lot numbers through April 2022. Any remaining physostigmine is now beyond the manufacturer and FDA-extended expiration dates. Other cholinesterase inhibitors are available (eg, rivastigmine), but are not well-studied for anticholinergic poisoning.
Case report: A 16-year-old girl presented to the ED after an unwitnessed ingestion of several potential medications including sertraline, cyclobenzaprine, oxycodone, and prochlorperazine. Time of ingestion was suspected to be about 12 hours prior to arrival. Past medical history was significant for anorexia, anxiety, major depressive disorder, and previous suicide attempts. The physical exam was significant for bilateral clonus, agitated delirium, dry mucous membranes, non-reactive mydriasis, and tachycardia to 138 beats per minute concerning for mixed serotonergic/anticholinergic toxidromes. An electrocardiogram displayed sinus tachycardia with normal QRS and QT intervals. Standard laboratory results were within normal limits. Serum acetaminophen, salicylate, and ethanol concentrations were negative. The urine toxicology screen was positive for tricyclic antidepressants and oxycodone. Lorazepam 1 mg IV was administered followed by a second 1 mg dose 45 minutes later. Mild improvement in mental status was noted but was short-lived. Physostigmine 0.5 mg was administered one hour after the second lorazepam dose. The patient improved and was able to interact with her family and state her name. A second 0.5 mg dose was given 20 minutes later, which resolved her agitated delirium significantly. She was admitted to the hospital for 11 days until a psychiatric bed was available. She was medically cleared of the overdose on day 3.
Discussion: We report the successful use of expired physostigmine for anticholinergic delirium. The decision to use an expired medication involved discussion with the clinical team caring for the patient, toxicology, pharmacy, hospital compliance and ethics, and the family. Available data demonstrate that medications, when stored in controlled environments, can maintain their potency beyond the manufacturer-set expiration dates. Periodic testing of the supply is recommended. In this case, there were no tricyclic antidepressants available, so the TCA-positive urine screen was attributed to cyclobenzaprine.
Conclusions: Expired physostigmine may still be an option for managing anticholinergic delirium.

KEYWORDS Physostigmine; anticholinergic; expired
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217. Rebound methemoglobinemia in phenazopyridine overdose

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Background: Methemoglobinemia is a potentially fatal condition that can occur with the use or misuse of strong oxidizing agents. Phenazopyridine induces methemoglobinemia after metabolism to aniline-based byproducts. It can also discolor body fluids, which may interfere with laboratory analyses and generate additional diagnostic challenges. We present a case of a suicide attempt after a polydrug ingestion, which was confounded by phenazopyridine-induced pseudo-icterus, xanthoderma, and rebound methemoglobinemia.
Case report: A 12-year-old male presented via EMS after his mother found him unresponsive in bed. On presentation, he was obtunded with an oxygen saturation of 89% on 15 L nonrebreather mask and exhibited a yellow/orange tint to his skin, sclera, oral secretions, and orange/red discoloration of his urine. The discoloration could be wiped off of his skin with alcohol swabs. The Initial workup was significant for an acetaminophen concentration 28 mcg/mL, and a markedly abnormal point-of-care urinalysis with large bilirubin, + ketones, + blood, > 300 protein, + nitrites, large leukocyte esterase. However, urine microscopy demonstrated no abnormalities. Notably, his creatinine was 1.00 mg/dL, AST 14 U/L, ALT 8 U/L, total bilirubin 0.6 mg/dL. An arterial blood gas revealed a methemoglobin concentration of 23.9%. Fifty milligrams of methylene blue (MB) was administered with subsequent improvement in oxygen saturation. Nevertheless, he had persistent confusion and was intubated for severe CNS depression. Repeat methemoglobin was 4% two hours thereafter. His neurological status improved, and he was extubated ten hours later. Although he remained alert and oriented, his pulse oximetry later dropped to 80% and a repeat ABG demonstrated a methemoglobin concentration of 20%. Eighty-three milligrams (1.5 mg/kg) of MB was again administered and the ICU team re-intubated the patient. One hour later, the methemoglobin level again improved to 6.5% and remained low for the remainder of his hospital stay. He was extubated the next morning and had complete resolution of his skin/secretion discoloration. He disclosed having ingested acetaminophen and three other medications that were hidden in his dresser. Empty bottles of phenazopyridine, gabapentin, and promethazine were subsequently recovered. The phenazopyridine concentration was 0.13 mcg/mL.
Discussion: Phenazopyridine is an azo dye that may discolor any bodily fluid. Under normal clinical circumstances, only the urine is affected but this may still interfere with urine dipstick interpretation due to colorimetric analytic dependence. Phenazopyridine causes methemoglobinemia after metabolization to aniline-based metabolites, predominantly phenylhydroxylamine. Our patient had an initial resolution of methemoglobinemia after MB administration but rebound methemoglobinemia occurred requiring repeat MB dosing. This may be due to the coupled oxidation of phenylhydroxylamine and oxyhemoglobin to nitrosobenzene and methemoglobin, respectively. Nitrosobenzene is enzymatically reduced to phenylhydroxylamine and can continue to generate methemoglobin. Gabapentin and promethazine are not known to cause methemoglobinemia but likely contributed to the patient's CNS depression.
Conclusions: This case highlights clinical findings of phenazopyridine toxicity, including physical exam manifestations of pseudo-

icterus and xanthoderma, analytic interference, and rebound methemoglobinemia that complicated the patient's clinical course. Physicians should be aware of and consider these issues when treating phenazopyridine toxicity.

KEYWORDS Methemoglobinemia; phenazopyridine; rebound

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218. Predicting adverse cardiovascular events in bupropion overdose

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Background: Bupropion cardiotoxicity is an infrequent but severe consequence of overdose, leading to shock and dysrhythmias. This rarity and the possibility of delayed toxicity present challenges for clinicians attempting to predict adverse cardiovascular events (ACVE) in bupropion overdose. Previous research has identified predictors of ACVE in drug overdose in general using information available to clinicians on initial emergency department presentation, but predicting ACVE in bupropion overdose has not been well-studied.
Methods: We conducted a secondary analysis of prospectively collected data via the Toxicology Investigators Consortium (ToxIC) from April 2015 through July 2018. We included patients 18 years or older with suspected acute or acute-on-chronic toxicologic exposures to bupropion. We excluded patients with documentation that signs and symptoms were unlikely related to exposure and those with missing data. The primary outcome was ACVE, a composite outcome of the following: ventricular dysrhythmia, vasopressor use, treatment with cardiopulmonary resuscitation, or elevated troponin $> 99^{th}$ percentile. Secondary outcomes included individual ACVE components, altered mental status, seizures, and ICU admission. Candidate predictors included demographic variables, ingestion circumstances, corrected QT interval (QTc) on initial electrocardiogram, and initial serum bicarbonate concentration. Variables with the highest association with ACVE on univariate analysis were included in a multivariable logistic regression model with ACVE as the dependent variable. We also tested a model previously found to predict ACVE in drug overdose in general using prior cardiac history, initial QTc prolongation, and low initial serum bicarbonate. Optimal cutoffs for ordinal variables were performed using receiver operator characteristic (ROC) curves. A prediction tool was created using the presence of any predictor variables, and test characteristics were calculated.
Results: Out of 364 patients screened, 7 were excluded, leaving 357 included for final analysis. The median age was 33 years, and 56.0% were female. Thirty-three (9.2%) patients developed ACVE. Increased number of unique exposures, initial QTc $\geq$500 milliseconds, and initial serum bicarbonate $<$ 20 milliequivalents per liter (mEq/L)—cutoffs determined *a priori*—demonstrated the strongest association with ACVE on univariate analysis and were included in the model. Number of unique exposures (OR 1.50, 95% CI 1.17—1.92) and initial serum bicarbonate $<$ 20 mEq/L (OR 4.76, 95% CI 2.11—10.76) independently predicted ACVE. The decision rule created using the presence of either three unique exposures or initial serum bicarbonate $<$ 20 mEq/L was 53.7% specific with 96.1% negative predictive value (NPV). The presence of both risk factors was 95.7% specific with 92.5% NPV. Applying the previous model predicting ACVE in drug overdose in general, only serum bicarbonate $<$ 20 mEq/L was predictive of ACVE (OR 4.27, 95% CI 1.91—9.46). Increased number of unique ingestions, initial QTc $\geq$00 milliseconds, and initial serum bicarbonate $<$ 20 mEq/L were also associated with vasopressor use, seizures, and intubation on univariate analysis.
Conclusions: Previously derived prediction tools for ACVE in drug overdose can be modified and applied to suspected bupropion overdose with reliable specificity and negative predictive value. The combination of poly-ingestion and low serum bicarbonate predicts ACVE in bupropion overdose.

KEYWORDS Bupropion; adverse cardiovascular events; prediction tool

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219. Ingestion of boric acid vaginal suppositories reported to a statewide poison control system

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Background: Boric acid has a chemical structure of H_3BO_3 and is an inorganic weak acid. It has many applications in industry, but as a human therapeutic its only current use is as a secondary or tertiary treatment for bacterial vaginosis or vaginal yeast infections. It typically comes as a 600 mg vaginal suppository and with proper use is tolerated with no or minimal side effects. However, toxicity can occur after intentional large or chronic exposures. Toxicity can include nausea, vomiting and diarrhea, and with high concentration ingestions hypotension, seizures, metabolic acidosis, renal failure, rhabdomyolysis, cardiac dysrhythmias and corrosive injuries are reported. Accidental exposures involving boric acid reported to the Statewide Poison Control System (SPCS) have historically been from ant and roach killers, but a recent call increase involving ingestion of boric acid vaginal suppositories (BAVS) has been noted. The purpose of this study was to describe ingestions of BAVS to quantify the problem, determine potential causes and see if significant toxicity develops.
Methods: This retrospective review of the SPCS database queried for all BAVS exposures between 1 July 2017 and 1 July 2022. The chart notes of each case were manually reviewed to abstract demographics, clinical effects, treatments, management site, and medical outcome.
Results: A total of 402 cases were identified. Sixteen cases (4%) involved accidental pediatric ingestions (ages 0.8 – 8 years); 14 managed on-site and 2 treated and released from the Emergency Department (ED) after brief observation. Two of the 16 children developed self-limiting vomiting and no treatments were performed. Five cases (1%) involved questions about possible toxicity despite appropriate use. The remaining 381 (95%) cases involved unintentional therapeutic errors due to mistaking the BAVS for an oral medication or misunderstanding the directions for use. Ages: 20 cases age 13–19 years, 309 cases age $>$ 19 years, 52 cases involved adults of unknown age. Gender: 380 were female (including one pregnant female). The only male adult ingestion involved a male age 28 years who mistook the suppository for a different oral medication. No cases were referred to the ED by the poison center but in 18 (5%) cases the patient went directly to the ED who then called the poison center. No patients were admitted. Clinical effects included nausea, abdominal pain, diarrhea, vomiting, and throat irritation and occurred in 26 (7%) of the unintentional-therapeutic error cases. Treatments: Anti-emetics were administered to two of the 18 patients who presented to the ED. Of all 397 BAVS ingestions, 28 (7%) resulted in minor gastrointestinal (GI) symptoms and rarely required medical intervention.
Conclusions: Prior to September of 2020, there were no reported exposures to BAVS reported to the SPCS. A sudden promotion of

these suppositories on social media likely increased product use and subsequent exposure calls to the SPCS. Accidental ingestion of BAVS results in minor GI symptoms and rarely requires medical intervention. Changes to the dosage form appearance as well as improved directions for use should be incorporated by manufacturers to reduce accidental ingestions and prevent unnecessary ED visits.

KEYWORDS Boric acid; vaginal suppositories

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220. Medication errors in group homes

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Background: Medication errors present serious patient risks in any healthcare setting. While underlying causes of medication errors have been researched, medication errors among group home residents have not been well studied. This patient population is more vulnerable to medication errors due to their specific healthcare needs and intellectual difficulties. Events have been reported to a poison control center, where the staff records the details, medications, and clinical outcomes. The information gathered while conducting this project will illustrate the types of errors occurring, bring to light the frequency of errors, and facilitate discussion to prevent future medication errors among an overlooked and underserved population.
Methods: A query of calls made to a single poison control center was performed for therapeutic errors that occurred in a group home over a 5 year period. The search parameters included all therapeutic errors with exposure site "other" between 1 January 2018, and 31 December 2022. Search results were then reviewed individually to identify cases that occurred in group home facilities. These cases were analyzed for outcome, substances involved, type of medication error, and management site.
Results: The database search yielded 949 cases. Chart review narrowed this to 428 medication errors that occurred in a group home. Examining the cases' medical outcomes, most cases were classified as having no effect (46.0%), followed by minor effects (18.0%) and moderate effects (3.3%). There were no major effects or deaths reported. Cases that were not followed were judged as nontoxic (12.1%), having minimal clinical effects possible (19.2%), or being potentially toxic (0.7%). Some cases were later confirmed as a non-exposure (0.7%). The most common drug class involved in these unintentional medication errors were atypical antipsychotics which occurred in 172 cases, followed closely by anticonvulsants which occurred in 161 of the cases. The three most common scenarios were inadvertently taking/giving someone else's medication, the wrong medication taken/given, and the individual inadvertently taking/given medications twice, occurring in 40.9, 21.3, and 18.7% of cases, respectively. Patients were managed at the group home 89.7% of the time, while 4.0% were already in to a health care facility, and 6.3% were referred to a health care facility.
Conclusions: Medication errors are occurring in patients residing in group homes. The majority of errors result in no effect or minor effects, and serious outcomes are uncommon. The most common medication error is that the patient takes someone else's medication. Medications frequently involved in those errors are atypical antipsychotics and anticonvulsants.

KEYWORDS Medication errors; medication safety; group homes

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221. Characterizing colchicine toxicity due to medication errors reported to two regional poison centers over the past decade

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Background: Colchicine, an anti-inflammatory medication that inhibits tubulin polymerization, is approved in the United States for treatment of gout and Familial Mediterranean Fever (FMF). Colchicine is also used off-label for other inflammatory conditions, including pericarditis. A growing body of research suggests inflammation plays an important role in the development of cardiovascular disease and that low-dose colchicine can reduce risk of ischemic cardiovascular events. Colchicine is well tolerated at therapeutic doses but has a narrow therapeutic index. Higher doses, organ dysfunction, and drug interactions increase the risk for significant toxicity. Although colchicine toxicity is well characterized at therapeutic doses and in overdose, there is little information about the type and severity of toxicities associated with medication errors. Given the growing interest in colchicine use, it is imperative that healthcare professionals understand the risks associated with colchicine medication errors. We conducted a retrospective review of poison center data to characterize colchicine medication errors and subsequent toxicities over a ten-year period.
Methods: This was a retrospective chart review of colchicine ingestions reported to two regional poison centers from 1 July 2012, to 30 June 2022. All unintentional colchicine ingestions were included. Patients with coingestants, intentional exposures, malicious exposures, or those involving a child.
Results: One-hundred and forty-seven ($n = 147$) cases were identified and 33 ($n = 21$ males, $n = 12$ females) met inclusion criteria. The median age was 54 years and most cases involved unintentional therapeutic error ($n = 28$; 84.4%). The average mg/kg ingested was 0.06 mg/kg. Clinical severity was minor in most cases (61%), and symptoms typically included diarrhea, nausea, and vomiting (54, 39, and 30%) with a duration of symptoms not exceeding 24 hours in most cases (61%). Only two cases escalated to a critical care site for management. The most common treatments were intravenous fluids (12/33), activated charcoal (6/33), and antiemetics (5/33). No patients required oxygenation, intubation, antibiotics, vasopressors, hemodialysis, colony-stimulating factors, or extracorporeal membrane oxygenation (ECMO). Most reported errors occurred secondary prescribing errors (24%) or misunderstandings or miscommunication of dosing to the patient (36%).
Conclusions: With increasing prescribing and growing indications for colchicine, there is a need for provider and patient education to prevent medication errors. Physicians, pharmacists, and healthcare systems should recognize the signs and symptoms of colchicine toxicity, and propensity for medication errors given the medication's narrow therapeutic index and variable dosing strategies.

KEYWORDS Colchicine; medication errors

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222. Hemodynamic instability, myocardial injury, left ventricular outflow obstruction, and mitral regurgitation after inadvertent brilliant green dye administration

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Background: Brilliant Green (BG) is a triarylmethane dye used for skin marking and topical disinfectant in the preoperative setting. It has carcinogenic, genotoxic, and antimicrobial properties in animals and is not meant for intravenous use. In mouse models, BG caused cardiac and acute lung injury when administered parenterally in a 3 mg/kg solution. There are no reports of humans receiving BG parentally, making its effects unknown. We present a case of a patient with inadvertent intravenous administration of BG.
Case report: A 72-year-old female with a prior hysterectomy, bilateral salpingo-oophorectomy, depression, hypertension, and intermittent supraventricular tachycardia three years prior presented for elective cystoscopy and vaginectomy for symptomatic stage III uterovaginal prolapse. During the procedure, a medication error occurred where 3 mL of BG was administered intravenously rather than the intended indigo carmine for confirming ureteral patency. The patient's blood pressure decreased to a minimum of 94/41 mmHg, and she developed tachycardia with a heart rate ranging from 110 to 120 bpm. She also became hypoxic with an oxygen saturation of 91% while wearing 3 L oxygen via nasal cannula. A post-operative twelve-lead EKG showed diffuse ST depression and ST elevation in aVR. Troponins obtained three hours apart were 27 ng/L and 53 ng/L. After the inadvertent intravenous administration of BG, the patient reported palpitations, arm pain at the site of the injection, and left lower extremity pain. The pain improved with heat packs and intravenous hydromorphone 0.5 mg. The injection also coincided with paroxysms of diaphoresis and a new grade II holosystolic murmur at the apex. After surgery, a transthoracic echocardiography (TTE) revealed hyperdynamic left ventricular ejection fraction, new left ventricular outflow tract (LVOT) obstruction, and systolic anterior motion of the mitral valve with moderate regurgitation (MR). Her vital signs improved within one day, and she was discharged two days after her operation feeling well. One week later at her follow-up appointment, she endorsed chest pain, dyspnea, and palpitations. Stress exercise echocardiogram performed two months after surgery revealed near resolution of LVOT obstruction and decreased degree of MR.
Discussion: The patient's symptoms, hemodynamic changes, EKG abnormalities, and troponinemia were temporarily associated with the inadvertent parenteral BG administration. While this could have been due to stress from the procedure, the timing and similar findings in animal models of BG administration suggest an effect from BG (e.g. transient vasospasm). Type I non-ST elevation myocardial infarction (NSTEMI) is less likely in this patient without multiple significant risk factors for coronary artery disease. The patient had a TTE from one year prior without LVOT obstruction or MR.
Conclusions: While BG has been shown to cause cardiac and pulmonary injury after intravenous administration in mouse models, there are no prior reports of human exposure to intravenous BG. We describe a patient who experienced hypoxia, tachycardia, hypotension, NSTEMI, LVOT, and MR after intravenous BG was inadvertently administered during surgery, suggesting it is cardiotoxic. Separation of medications from other substances used during procedures is important to avoid medication error.

KEYWORDS Brilliant green; brilliant green dye
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223. 20-Fold dosing error of tranexamic acid during total knee replacement surgery

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Background: Tranexamic acid (TXA) is a synthetic amino acid analogue that interferes with the activation of plasminogen to plasmin. This produces an antifibrinolytic effect preventing clot breakdown reducing the risk of bleeding. TXA exhibits its hemostatic effects via competitive inhibition at the lysine residue of plasminogen, leading to prevention of tissue plasminogen activator-catalyzed conversion of plasminogen into plasmin with inhibition of degradation of fibrin-containing clot. IV TXA is recommended for multiple indications including total joint arthroplasty. We report a 20-fold dose error of IV TXA given during outpatient orthopedic surgery.
Case report: 59-Year-old male undergoing a total knee replacement received 10-fold overdoses of tranexamic acid at both the open and close of his surgery. The intended tranexamic acid dose was 1 gram IV per administration, totaling 2 grams perioperatively. The total dose administered was 20 grams. He received 10 grams at 9:30am and 10 grams at 10:50am. The patient had normal renal function with a GFR of greater than 100 mL/min/1.73 m^2. He did not develop any neurological sequelae or adverse reaction and was discharged home about 4 hours after the second dose with prophylaxis for venous thromboembolism, which included sequential compression boots and aspirin 325 mg twice daily. He was monitored at home over the next two days with telephone calls and video conference and was seen in the clinic on day 3 and reported no ill effects.
Discussion: Therapeutic doses of TXA have an overall safe profile with common adverse effects largely being nausea, vomiting, diarrhea, and headaches. Rare and severe adverse effects include thromboembolic events including deep vein thrombosis, pulmonary embolism, cerebral thrombosis, and renal cortical necrosis. Patients with renal insufficiency are at increased risk of visual impairment and seizures, especially when TXA is given as a continuous infusion. The pharmacokinetic profile of tranexamic acid is well-described. The estimated half-life is about 2 hours and thought to be 97% renal elimination. When given as a continuous infusion, it sequesters in the cerebrospinal fluid, increasing the risk of seizures. We were unable to identify any toxicokinetic data to determine if elimination is saturated in overdose. Most existing overdose data relates to inadvertent intrathecal administration of TXA during spinal anesthesia with outcomes that have included seizures, hypertension, and death. Minimal data exists surrounding intravenous exposures above 4,000 mg. The origin of the error was unable to be determined. Tranexamic acid is available as a 1,000 mg/10 mL single-dose vial.
Conclusions: While the risks of intravenous TXA overdose still need to be defined, this case demonstrates that a 20-fold intravenous overdose of TXA in a healthy male adult can occur

without no injury in the immediate post operative days. Further data is necessary to determine optimal monitoring for thromboembolic and other adverse events after this type of error.

KEYWORDS Tranexamic acid; medication error

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224. Characterization of nirmatrelvir-ritonavir (Paxlovid®) calls managed by a regional poison center

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Background: In June 2022, the Food and Drug Administration (FDA) approved an Emergency Use Authorization on nirmatrelvir-ritonavir (Paxlovid®) for treating patients with mild-to-moderate coronavirus disease 2019 (COVID-19) who are at high risk for symptom progression. Since then, our regional poison center has received calls regarding administration, drug interactions, adverse effects, medication errors, and overdose of this medication. Because nirmatrelvir was a new drug, scanted information about overdose or medication errors is available. The objectives of this study are to (1) characterize the types of exposure calls and (2) characterize drug-drug interactions in drug information calls of nirmatrelvir-ritonavir.
Methods: This was an IRB-approved retrospective analysis of calls reported to a regional poison center from 6/1/22 to 4/30/23. Exposure calls' inclusion criteria included cases coded for nirmatrelvir-ritonavir with an exposure call type. A descriptive analysis was conducted to assess the relevant demographic and clinical characteristics. Drug information calls' inclusion criteria included cases coded for drug information. Each coded substance was compared against a list of established and other potentially significant drug interactions published by the FDA.
Results: There were 24 unique nirmatrelvir-ritonavir human exposures during the study period; 54.2% were females. Of the 23 cases with age documentation, the mean [IQR] age was 62.2 [50–78.5] years. Nineteen cases (79.2%) were single substances, and five (20.8%) had one or two co-ingestants. The majority of cases were acute (20/24, 83.3%), and the remaining cases were acute-on-chronic (2/24, 8.3%) or chronic (2/24, 8.3%). The reasons for exposures were unintentional-therapeutic error (14/24, 58.3%), adverse reaction (8/24, 33.3%), and unintentional-general (2/24, 8.3%). Two patients experienced symptoms related to nirmatrelvir-ritonavir exposures (GI upset and diarrhea, respectively). Three other patients reported symptoms that are unknown if related to the exposures. The remaining 20/24 (83.3%) cases were managed at home. Three patients with therapeutic errors received treatment consisting of dilute/irrigate/wash ($n = 2$) and food/snacks ($n = 1$). Two patients with adverse drug events received fluids ($n = 1$) and bronchodilators ($n = 1$). In terms of medical effects, 2/24 (8.3%) had no effect, 2/24 (8.3%) had minor effects, 3/24 (12.5%) were judged as nontoxic, 14/24 (58.3%) were minimal clinical effects possible, 2/24 (8.3%) were unrelated – probably not responsible, and 1/24 (4.2%) was unable to follow, potentially toxic exposure. The duration of minor effects on the two cases was $< = 2$ hours and < 3 days, respectively. Twenty of the twenty-four cases (83.3%) were managed on-site, 3/24 were treated and released, and 1/24 (4.2%) was lost to follow-up. During this study period, there were 45 drug information cases. Twelve substances were identified as known or potentially significant drug-drug interactions with nirmatrelvir-ritonavir.
Conclusions: Most nirmatrelvir-ritonavir exposures called into our regional poison center were therapeutic errors, followed by adverse drug reactions. Based on our analysis, reported symptoms were generally mild. Treatment was largely supportive. In addition, poison centers can serve as a resource for drug-drug interaction identification and patient counseling.

KEYWORDS Nirmatrelvir-ritonavir; therapeutic error; drug-drug interactions

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225. Methotrexate toxicity in the setting of therapeutic error, a multicenter retrospective review

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Background: Methotrexate (MTX) is a folic acid antagonist that is commonly used in a variety of conditions for its immunosuppressive effects and as a disease-modifying agent. Typical oral treatment regimens include weekly dosing. Patients occasionally misunderstand labeled prescription information and take methotrexate daily instead of weekly. There is a paucity of literature evaluating methotrexate toxicity in the context of daily versus weekly dosing. This study aims to characterize thresholds (total dose and time) for developing toxicity from unintentional, daily MTX ingestion in adults.
Methods: This was a multi-center retrospective cohort study using electronic records from regional poison centers and hospital data between 1 January 2000 and 24 January 2023 evaluating methotrexate toxicity following therapeutic errors. Electronic medical record data was used when available. Inclusion criteria included adults $\geq$18 years of age who had a therapeutic error for oral methotrexate dosing by taking it greater than weekly. Exclusion criteria included pediatric ingestions, single acute overdose, pregnancy, intrathecal or intravenous dosing, or co-ingestion of other cytotoxic or myelosuppressing medications. Organ system dysfunction was defined as any cytopenia, stomatitis/esophagitis, severe dermatologic manifestations, kidney dysfunction, and transaminitis. The primary outcome was the relationship between dose and time and presence of organ system dysfunction.
Results: The search identified 387 cases and after exclusion, 72 cases remained. Mean age was 61 (SD 14.5) years with 69% female. There were 68/72 cases (94%) prescribed MTX weekly, and of these 62 (86%) took MTX daily. Mean duration and dose of MTX was 6 days and 73 mg (SD 56.8), respectively. End organ dysfunction was observed in 31 (43%) cases, 29 (94%) of which included stomatitis/mucositis. Leucovorin was administered to 31 (43%), gCSF in 6 (8.3%), antibiotics in 9 (12.5%), and glucarpidase in no patients. Average hospital LOS was 4.4 days for the entire cohort versus 6.3 days for those with organ system dysfunction. There were two deaths. No patient developed organ system dysfunction if MTX was taken for < 3 days, or a total dose of < 32.5 mg.
Conclusions: Taking MTX daily when prescribed weekly can result in serious toxicity and death. Daily dosing for < 3 days or total dose < 32.5 mg resulted in no organ system toxicity. Limitations include the retrospective nature of the data, unblinded chart, and a lack of interrater reliability assessment due to the multi-centered nature of the study.

KEYWORDS Methotrexate; therapeutic error; organ dysfunction

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226. What dose makes the poison? Identifying dosages of 2,4-dinitrophenol from social media commentary

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Background: As little as 400 mg of 2,4-dinitrophenol (DNP) can cause cardiovascular collapse. Yet, online forums discuss using DNP for weight loss with few adverse effects. Our understanding of DNP use comes from autopsies and reports to Poison Control. Online commentary provides a unique window into DNP use because the FDA prohibited DNP for human use in 1938. In a study of 105 comments, we found that users describe taking 150–200 mg of DNP each day and withstanding 300–400 mg each day by also using cetirizine or diphenhydramine. We used manual curation for that because current methods do not reliably extract dosage from online comments. Our primary objective was to develop a method that automatically extracts dosages of DNP from online commentary, thus allowing us to study larger data sets. Our secondary objective was to develop a method that did not require extensive computational resources.
Methods: We searched online bodybuilding forums for deidentified publicly available comments that mentioned DNP, 2,4-DNP, dinitrophenol, or 2,4-dinitrophenol. Noting that any reasonably likely expression of dosage must contain a substance and amount, we searched each comment for sequences of numbers, units, and frequencies modifying those keywords. We identified substances by using our previously described approach of manually reviewing all nouns. We computed the correlation between mention of two substances.
Results: We obtained 6,742 unique comments longer than 5 words from 5 online discussion forums from 2018 to 2022. We identified 11 patterns of numbers, units, and frequencies that occurred more than once in those comments. Compared to a manual review of 2,616 of these 6,742 comments, these 11 patterns identified doses with a sensitivity and specificity of 0.50 and 0.98. Using these 11 patterns, we extracted dosages from the 6,742 comments. The median dose was 250 mg each day (interquartile range 200–400 mg each day). The top 4 substances that users mentioned along with DNP were ephedrine, caffeine, growth hormone, and testosterone propionate. Cetirizine was mentioned in 67/6,742 (1%) of comments and diphenhydramine in 762/6,742 (11%) of comments.
Conclusions: Online users report tolerating doses of DNP that are half the reported minimal fatal dose. Agents that are mechanistically unlikely to help with toxicity from DNP, like diphenhydramine and cetirizine, are mentioned frequently, as are other ergogenic supplements and canonical anabolic agents. Grammatical rules can identify dosages from online commentary and do not require large amounts of training data, unlike other machine learning approaches. However, the low sensitivity suggests that more rules are needed to capture how people express dosage online.

KEYWORDS 2,4-Dinitrophenol; social media; weight loss agents

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227. Ashwagandha (*Withania somnifera*) exposures reported to poison centers from 2015 to 2021

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Background: Ashwagandha, an herbal tonic with a unique equine urine odor derived from the Sanskrit words for horse and smell, has been utilized in Ayurvedic and Unani medicine for centuries. The shrub contains a variety of phytochemicals including steroidal lactones, alkaloids, steroids, salts, and flavonoids that are derived from various parts of the plant. Currently, ashwagandha is marketed in various formulations as a dietary supplement and adaptogen for improving mental and physical well-being. Recent studies have explored the potential of ashwagandha withanolides in silico for chemoprophylaxis against COVID-19. Despite its longstanding use, there is a paucity of data on the toxicity associated with unregulated use and overdose of ashwagandha.
Methods: This was a retrospective review of ashwagandha exposures reported to the National Poison Data System (NPDS) from 2015 to 2021. Inclusion criteria was limited to single-substance human ingestion cases coded with a Poisindex product code for ashwagandha (4015958, 8315429, 8287306). Confirmed non exposures were excluded. Trend analysis and descriptive statistics were performed using absolute case counts and relative proportions.
Results: A total of 350 ashwagandha exposures were identified to meet inclusion criteria. The mean case count more than doubled during the COVID-19 pandemic from 35 cases per year (2018–2019) to 76.5 cases per year (2020–2021), which aligns with published reports indicating that ashwagandha may impede proteins necessary for viral replication. During the 7-year study period, adverse reactions and therapeutic errors were the most common coding categories for cases; however, in 2021, there was a disproportionate increase in cases involving accidental exposure (13 cases in 2019 vs. 92 cases in 2021) and intentional self-harm (1 case in 2019 vs. 10 cases in 2021). Among children aged 0–12 years, no cases resulted in moderate or major effects. However, among teenagers and adults (aged 20+ years, $n = 26$), 8 and 15%, respectively, had a moderate or major outcome. 1 outlines the proportion of cases managed in a healthcare facility. Gastrointestinal symptoms were the most commonly reported clinical effects, including vomiting (11%), nausea (9%), diarrhea, and abdominal pain (6%). Serious symptoms reported included seizures ($n = 2$, 0.6%), renal failure ($n = 1$, 0.3%), dysrhythmias ($n = 1$, 0.3%), and liver dysfunction ($n = 3$, 0.9%). A narrative review of three cases involving a major outcome revealed that two patients presented with acute liver injury and jaundice, while the third patient presented with seizures but had a history of epilepsy.
Conclusions: Poison Centers responded to an increase in ashwagandha exposures during the COVID-19 pandemic. While many patients remained asymptomatic, serious symptoms including seizures, and liver dysfunction were reported among teen and adult populations.

KEYWORDS Ashwagandha; Withania somnifera; adaptogen

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228. Characterization of GLP-1 agonist exposures from a single poison center

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Background: Glucagon-Like Peptide-1 (GLP-1) agonists are increasingly prescribed medications for type II diabetes and weight management. These medications were well tolerated in clinical trials with the primary side effect of nausea and vomiting; hypoglycemia rarely developed. With rising social popularity, wider FDA indications for use, and exponentially rising market share, this study sought to characterize GLP-1 agonist exposures reported to a regional poison center (PC).
Methods: This was a retrospective chart review. All reports involving GLP-1 agonists from 01/14/2014 to 05/01/2023 reported to a single PC were abstracted and characterized. Descriptive statistics analyzed demographics, call volume, calls per drug, behavioral use patterns, frequency of hypoglycemia and other side effects. Calls were heterogenous and were analyzed by caller's report. Overdoses were designated as small or large. "Small" overdoses were defined as either a same day second injection or a single extra injection in a seven-day window. "Large" overdoses were either more than a double dose error or daily use of the medication. Significant hypoglycemia was defined by blood glucose (BG) nadir $\leq$ 80 mg/dL or requiring intravenous dextrose solutions.
Results: Two hundred thirty-seven calls involved GLP-1 agonists. Annual increase in calls rose sharply over the period of interest from 2014 (n = 10) to 2022 (n = 70) and likely higher still in 2023 (n = 29 as of May 1). Majority of calls (69.2%) involved unintentional therapeutic error, 50.2% small overdoses and 18.9% large overdoses. There was no appreciable association between dose of GLP-1 agonist used in overdose and consistent clinical effect. In a subgroup excluding information calls, needlesticks, intentional polypharmacy ingestions, and occupational ocular exposures (193 calls), most calls involved about semaglutide (36%), followed by liraglutide and dulaglutide (25% and 26.5% respectively). Hypoglycemia without exposure to other hypoglycemic medications (sulfonylureas, insulins) was identified in eight cases (3.4%) of which five required overnight hospitalization for treatment. Three cases of anaphylactic reactions were recorded. In the isolated GLP-1 agonist exposure cohort of 193 calls, 55% had no symptoms from their overdose regardless of size; 25% reported nausea and/or vomiting; and $<$ 1% reported abdominal pain, chest pain, tachycardia, headache, or other symptoms.
Conclusions: PC GLP-1 agonist reports are rapidly increasing. A high number of therapeutic errors were reported without serious effect, regardless of amount of overdose. Hypoglycemia necessitating medical treatment was present in $<$ 5% of cases of isolated GLP-1 agonist use, similar to Phase III trials, but 66% of hypoglycemic patients required overnight hospitalization. Predisposing factors for hypoglycemia were unpredictable based on available data. The retrospective nature of patient-reported concerns limits granular data analysis. Most (69%) of the calls in this retrospective cohort were unintended overdoses from misunderstood instructions. Considering the average cost of a GLP-1 agonist is $1058 for a 30-day supply, an extra dose error costs $>$ $250. While it is reassuring that these overdoses are not frequently causing patient harm, it suggests that dosing instructions need to be made clearer to patients.

KEYWORDS Semaglutide; GLP-1 agonist; hypoglycemia

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229. How many shots are too many? A poison center's experience with GLP-1 agonists

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Background: Glucagon-like peptide (GLP)-1 agonists use has increased over the last decade for improved glycemic control in type 2 diabetes mellitus, reducing cardiovascular risk, and weight loss. However, there is little data regarding GLP-1 agonists in overdose.
Methods: This is a descriptive study evaluating and characterizing GLP-1 agonist exposures reported to a single poison center between 2005 and 2022. Cases involving GLP-1 agonist exposure were included. Descriptive data analysis was conducted to evaluate demographics, circumstances of exposure, and adverse effects.
Results: A total of 166 charts were identified; 152 charts met inclusion criteria. There were 116 (76%) females and 36 (24%) males. Specific agents included dulaglutide (n = 38, 25%), exenatide (n = 18, 12%), liraglutide (n = 22, 14%), semaglutide (n = 65, 43%), and terzepatide (n = 9, 6%). Subcutaneous injection (n = 141, 93%) was the primary route of exposure, followed by ingestion of oral tablets (n = 10, 7%). A history of diabetes mellitus was reported in 65 (43%) cases and 10% (n = 11) clearly indicated the medication was being used for weight loss. Most were single substance exposures (n = 146, 96%) but concomitant antidiabetic medication use was recorded in 51 (35%) cases. Almost all exposures were unintentional (n = 143, 94%) and 26% (n = 40) involved double dosing within an hour of the first dose. Many of these involved first time use errors secondary to misunderstanding of how to use the injection pen (n = 32, 21%). An additional 25 (16%) reported double dosing within 24 hours of the first dose and 12 (8%) patients reported injecting the medication daily instead of once weekly as directed. The most commonly reported adverse effects were 'weakness' (n = 16, 10%), nausea and vomiting (n = 28, 18%), and abdominal cramping (n = 8, 5%). Four patients developed hypoglycemia, 2 of which were self-harm attempts using entire pens of semaglutide and dulaglutide, respectively, along with co-administration of entire pens of glargine. These resulted in intensive care unit (ICU) admissions and continuous dextrose infusions for 3 days each. A third patient mistakenly injected semaglutide 40 mg instead of insulin and had resolution of hypoglycemia within 24 hours after a dextrose bolus and feeding. A fourth patient took a double dose of dulaglutide, requiring a continuous dextrose infusion and ICU admission. Acute liver injury, acute kidney injury, and pancreatitis were not reported in any cases. Most patients were monitored at home (n = 94, 62%), 4 (3%) were admitted to the ICU for glucose checks, 7 (5%) were admitted to the floor, 22 (14%) were discharged from the ED, and the remaining were lost to follow-up. Fifty-four (36%) experienced no effect, 26 (17%) minor effect, and 7 (5%) moderate effect with the rest lost to follow-up.
Conclusions: Hypoglycemia was rare in this cohort, but occurred in the setting of a single agent GLP-1 agonist exposure in two cases. Two additional cases of hypoglycemia involved co-administration of insulin. Many overdoses were related to poor understanding of how to utilize injection pens, indicating that patients may require improved education. Limitations associated with retrospective chart reviews and poison center data are inherent to this study.

KEYWORDS GLP-1 agonist; weight loss; diabetes mellitus

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230. Horner syndrome following confirmed *Crotalus horridus horridus* envenomation

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Background: Snake envenomation has the potential to cause an array of short- and long-term complications. We report a case where a rattlesnake bite to the hand progressed into Horner's syndrome. Horner's syndrome affects the face and eye unilaterally due to damage to the sympathetic innervation and classically involves miosis, anhidrosis, and ptosis on the affected side.
Case report: A 24-year-old male landscaper with no medical history presented to an emergency department in the Southeastern United States within one hour of envenomation to the left hand by a rattlesnake (visualized *Crotalus horridus horridus*) while working. He was noted to be diaphoretic and drooling with angioedema of the face requiring immediate intubation. Swelling progressed from the wrist to the bicep by day 2 with erythema extending onto the chest, abdomen, and face. A total of 16 vials of crotalidae polyvalent immune fab were given. The patient self-extubated on day 6 after which he reported paresthesia in both arms and weakness that was greater in the arm contralateral to the bite site. Neurology was consulted due to concern for Horner's syndrome; pyridostigmine therapy was trialed for suspected neuromuscular junction pathology without gross improvement. A CT of the head, neck, and spine was unremarkable. No coagulopathy or thrombocytopenia was noted during hospitalization. The patient was discharged on day 14. On follow-up in an outpatient snake envenomation clinic on day 23, the patient was noted to have minimal residual edema but a variety of persistent neurological effects. He reported subjective changes in swallowing, a smaller left pupil, and anhidrosis on the left side of his face. Strength in both arms was improved from discharge but decreased bilateral grip strength, right wrist drop, decreased shrug, and left sided ptosis persisted. The patient also exhibited hyperalgesia to light touch to the right dorsal thumb, index, and lateral middle finger. Follow up studies including electromyography and MRI of the cervical spine were recommended but unable to be obtained due to insurance issues and the patient was lost to follow-up.
Discussion: In contrast to most North American pit viper envenomations, this patient exhibited significant neurologic symptoms. While the patient's swelling was severe during his hospitalization, these effects had almost fully resolved by the time of follow-up several weeks later. Examination at this time showed significant persistent neurological deficits including left sided Horner's syndrome. Due to his distribution of neurological deficits that could not be attributed to a single CNS or peripheral lesion, the patient's symptoms were hypothesized to be related to an autoimmune reaction triggered by the venom. Because the patient was lost to follow-up after the initial clinic appointment, it is unclear to what extent these deficits were reversible.
Conclusions: This case demonstrates significant neurological sequelae including Horner's syndrome after a confirmed *Crotalus horridus horridus* envenomation potentially caused by an autoimmune reaction to the venom.

KEYWORDS Snakebite; Horner syndrome; Crotalus horridus horridus

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231. Persistent complications following snake envenomation: results of a specialized snake post discharge clinic

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Background: While acute management of pit viper envenomation has been extensively studied, less is known about complications after discharge. A specialized outpatient follow-up clinic staffed by medical toxicologists and wound care experts was launched in 2021 to treat snakebite patients age ≥5 years throughout the state with referrals initiated by the local poison center.
Methods: This was a retrospective study of patients evaluated after hospital discharge in a specialized snake envenomation clinic between 6/1/2021 and 12/31/22. Data were extracted from clinic records and details of initial hospital course were obtained from poison center charts. Complications and/or clinic interventions were correlated with patient demographics, bite circumstances, and factors during hospitalization using t-tests for continuous variables and Fisher's exact test for categorical variables.
Results: Forty patients (50% male; mean age 34 years, range 5–74 years) were included. Snake species was identified in 30 cases comprising of *Agkistrodon contortrix* ($n = 24$), *Agkistrodon piscivorous* ($n = 2$), and *Crotalus horridus horridus* ($n = 4$). Complications noted at follow-up included persistent lymphedema ($n = 29$), open wounds (bullae or eschars; $n = 8$), and signs of infection ($n = 2$). Interventions included compression ($n = 21$), physical therapy ($n = 15$), and debridement ($n = 4$). No delayed coagulopathy was observed. Persistent lymphedema was more common in *Agkistrodon* vs rattlesnake envenomations (80.8 vs. 25%, $P = 0.048$) and patients with nadir fibrinogen ≥170 mg/dl (78.8 vs. 0%, $P = 0.005$). Patients ≤12 years old (60 vs. 14.3%, $P = 0.046$), with bites to digits (60 vs 6.7%, $P = 0.001$), and with bullae (100 vs. 13.5%, $P = 0.006$) were more likely to have open wounds in clinic. Compression was more frequently prescribed in *Agkistrodon* vs *Crotalus* envenomations (65.4 vs. 0%, $P = 0.026$), lower extremity bites (73.9 vs. 23.5%, $P = 0.003$), patients without systemic symptoms (60.6 vs. 14.3%, $P = 0.040$), and patients treated with F(ab')2 vs Fab antivenom (100 vs. 40.6%, $P = 0.040$). Patients with bullae (100 vs. 32.4%, $P = 0.046$) and those who required opioid analgesia (45.5 vs. 0%, $P = 0.033$) were more commonly referred to physical therapy. Debridement was more likely to be needed with bites to the digit (30 vs 3.3%, $P = 0.042$), bullae (66.7 vs. 5.4%, $P = 0.022$), shorter lengths of stay (mean 2 days vs 3.3 days, $P = 0.001$), and quicker follow-up after the envenomation (mean 6 days vs. 9.72 days, $P = 0.047$).
Conclusions: Persistent lymphedema and need for physical therapy were common upon follow-up after snake envenomation while wounds requiring debridement and infection were less frequent. In this small study, *Agkistrodon* envenomations were more likely to present with persistent lymphedema than rattlesnakes. *Agkistrodons'* propensity to induce local tissue damage without severe systemic coagulopathy may also explain why absence of hypofibrinogenemia and systemic symptoms were associated with persistent lymphedema at follow-up. Bullae formed during hospitalization and bites to digits were associated with need for debridement and physical therapy, suggesting these patients especially may benefit from close follow-up after discharge. Persistent swelling, issues with wound healing, and functional

deficits are common in patients who have been discharged from the hospital after snake envenomation. *Agkistrodon* envenomations, bites to digits, and bullae may be associated with higher rates of these complications.

KEYWORDS Snake envenomation; pit viper; lymphedema

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232. Clinical and demographic findings in patients with *Crotalus oreganus* envenomation

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Background: *Crotalus oreganus* (Northern Pacific Rattlesnake) is the only venomous snake occurring naturally in Oregon. Clinical and laboratory data on patients envenomated by *C. oreganus* are not well described in the literature. This study aims to describe the clinical and demographic features of *C. oreganus* envenomation.
Methods: The Toxicall® database was searched for cases within Oregon with snakebite as the substance datafield from 2019 to 2021. A total of 30 cases were included. Included cases were those in which a patient reported an indigenous rattlesnake bite and an ER physician had examined the wound and deemed it consistent with a snake bite. Documented data points including date of bite, age and sex of patient, location of bite, symptom description, hospital length of stay, and antivenom received vs. dry bite were pulled from the chart. Clinical and Laboratory data such as vital signs, INR, PTT, Fibrinogen, and Platelet count were also pulled when available.
Results: All but 1 bite occurred in summer months between May and September. Most patients were male (86%) between the age of 18-64. 26% were dry bites. Crofab® was used in the majority of cases (56%). Anavip® was used in 16% of cases. Five patients under 18 years old were envenomated. 77% were bitten in the hands/fingers whereas 23% were bitten in the foot/ankle. 83% of envenomations had significant swelling at the site of the bite. Almost half of the envenomated patients described neurologic symptoms like paresthesia of the limbs or perioral tingling. All of the cases receiving Anavip® got an initial 10 vial dose, and one case required two additional 10 vial doses. All of the cases receiving Crofab® were managed with a 6 vial loading dose followed by 3 maintenance doses of 2 vials, except one patient who was found to have a thrombocytopenia ($<$ 50 K/mcL) on follow up labs and required readmission for a total of 9 days and 54 vials of Crofab® for prolonged thrombocytopenia. A total of 3 envenomated patients had a platelet nadir $<$ 100 K/ml. No patients had an abnormal INR. 3 patients had a slight elevation in partial thromboplastin time. No patients had a significantly abnormal fibrinogen. No spontaneous bleeding was reported. No deaths or significant morbidity such as limb loss, or hemodynamic instability occurred. There were no reported adverse effects to either antivenom. The mean length of hospital stay among all envenomated patients was 2 days.
Conclusions: Between 2019 and 2021 in the state of Oregon, Northern Pacific Rattlesnake envenomations were managed with both Crofab® and Anavip® without severe morbidity or any mortality. Significant thrombocytopenia or coagulopathy is relatively rare in the reported cases.

KEYWORDS Crotalus oreganus; rattlesnake

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233. The circumstances surrounding snakebites in the United States: a survey of surreptitious serpent-person skirmishes

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Background: In 2013, the ToxIC North American Snakebite Registry (NASBR) began collecting detailed prospective information regarding characteristics of North American snakebites. Published studies from this registry demonstrate an increased prevalence of snakebite in men, but the activities surrounding the bite have not been examined at a granular level. The objective of the study was to describe the circumstances at the time of a snake bite in patients reported to NASBR.
Methods: This was a secondary data analysis of cases reported to the NASBR between 2013 and 2021. A standardized data collection tool was utilized to extract variables of interest, which included age, sex, calendar month of bite, type of snake involved, location where bite occurred and circumstances surrounding the bite (entered as free text by investigators). These circumstances were divided into eight major categories defined by the authors, which included "hobbies", "chores," "sports and recreation," "water-related," "vehicle-related," "dog-related," "other animal-related" (which included intentional interactions with the snake), and "other activities" which were assigned based on review of the case narrative and agreed upon by authors. These categories were further divided into more specific subcategories.
Results: Of 1249 snakebites with circumstances reported, the most common activities were sports and recreational (n = 368; 29.5%), hobbies (n = 181; 14.5%), and other animal-related activities (n = 169; 13.5%). Of sports and recreational activities, "walking" (228/368; 62%) and "hiking" (62/368; 16.8%) were most common. "Playing" and "gardening" were the most common hobbies, and taking out trash and yardwork were the most common chores. For cases in other situational categories, the majority of dog-related cases involved walking a dog when bitten by the snake (24/36; 66.7%), and most vehicle-related activities described the patient stepping in or out of a car when bitten (21/32; 65.6%). Of the 1249 cases, 39 described the patient attempting a "Good Samaritan" activity, which included trying to save a human (n = 8/39; 20.5%), save a pet (n = 11/38; 28.2%) or save the snake (n = 10/38; 25.6%). 59 of the 1249 total cases (4.7%) describe the patient reaching into a blind space when the snakebite occurred. In 86/1249 cases (6.9%) the patient reported a history of ethanol consumption in the 4 hours preceding the snakebite, and 129/1249 cases (10.3%) involved recreational or illicit drug use. Comparing intentional (n = 178) and unintentional (n = 1071) snake-human interactions, most intentional interactions resulted in upper extremity bites (167/178; 93.8%) and all non-native snakebites were intentional interactions. Indoor and outdoor locations where snakebites occurred were also recorded.
Conclusions: The majority of cases involved unintentional interactions with snakes in adult patients. Over 50% were associated with everyday activities (sports and recreation, hobbies, chores). Drugs or alcohol were involved in a minority of cases.

KEYWORDS Envenomation; snake bite

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234. Association between daily high temperature and copperhead envenomations reported to a regional poison center

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Background: Venomous snakebite incidence is projected to increase along with increases in mean temperature and continued global climate change, as habitats for these snakes increase in size and grow towards polar regions. There is limited published literature on the association between temperature and copperhead envenomations, particularly along the northern terminus of the Eastern copperhead range, where envenomation incidence may be more sensitive to temperature variation. The objective of this study was to determine the association between ambient air temperature and incidence of copperhead envenomation between 2005 and 2022 reported to a regional poison center.
Methods: This was a retrospective case-crossover study of copperhead envenomations reported to a regional poison center between 1 January 2005 and 30 November 2022. Copperhead envenomations were identified by a generic code search. All cases were reviewed by two independent reviewers, with a third reviewer resolving disagreements. Cases were excluded if no bite occurred, the case occurred outside of the region covered by the poison center, or the snake was kept as a pet. Information on daily high temperature was from Climate Data Online, a repository of weather station data provided through the National Oceanic and Atmospheric Administration. Control dates for temperature data were 7 days before date of envenomation to account for increased human activity on weekends vs. weekdays. An odds ratio for the association between temperature and copperhead envenomation was calculated using conditional logistic regression to account for matching. A Student's *t*-test was utilized to compare differences between daily high temperature on case days vs. control days.
Results: 624 Envenomations were included. Cases per year increased from 23 in 2005 to 50 in 2022. The population was 61% male with a mean (SD) age of 40.9 years (20.1). 45% of bites occurred between 1600 and 2200, 36% between 1100 and 1600, 16% between 0500 and 1100 and 11% between 2200 and 0500. There was a 6.5% (95% CI: 4.5–8.5%) relative increase in odds of copperhead envenomation for each one-degree Fahrenheit increase in daily high temperature. There was a significant difference ($P < 0.0001$) in mean maximum temperature on case days (84.98°, SE: 0.29) vs. control days (82.43°, SE: 0.36).
Conclusions: In this case-crossover study comparing daily high temperature on days with envenomation compared with control days 7 days prior, we found a positive association between daily maximum temperature and copperhead envenomations. This analysis, completed in a humid subtropical climate region on the northern edge of historical copperhead habitat, suggests that snake envenomations are likely to increase with increasing daily maximum temperatures. Hospitals and health departments should target availability of antivenom to temperature conditions when envenomations are most likely to occur, which may happen earlier in the spring and later in the fall in this region.

KEYWORDS Snake bite; envenomation; climate

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235. Non-native North American envenomations reported to (state) poison center network 2013–2022

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Background: The treatment and predicted clinical course in patients envenomated by indigenous North American (NA) snakes is well documented, and treatment options are widely available. However, a significant portion of snake envenomations is caused by non-indigenous snake species. Specific antivenoms are less often available, and clinical course may vary widely. This study aimed to describe exotic snakebite envenomations reported to our statewide poison center network.
Methods: Charts for venomous exotic (non-native NA) snakebite exposure cases reported to our state poison center network from 2013-2022 were obtained from the database (Toxicall®). Cases were excluded if the patient did not present to a healthcare facility (HCF), or if the snake was not venomous. Charts were assigned for double review and abstraction to one of three toxicologists in a data entry template accompanied by a data entry guide. Abstracted variables included demographics (age, sex), snake type, bite site, time to presentation, antivenom administration/source, laboratory values, clinical interventions, and medical outcomes. After the abstractions were complete, any discrepancies among cases were adjudicated by the third abstractor. Descriptive statistics were performed and presented as means and standard deviations (SD) for describing continuous variables, and frequencies and percentages for dichotomous variables.
Results: Of 12,430 snakebites reported to our poison center network from 2013 to 2022, 53 were by exotic venomous snakes, of which only 32 arrived at a HCF and were included as cases. Males were more likely to be envenomated (28, 87.5%), and 22 envenomations occurred at home (68.8%). Twenty-eight (87.5%) bites occurred to the hand/wrist. Regarding clinical effects, 26 (81.3%) reported cytotoxicity (e.g., edema), 10 (31.3%) described neurotoxicity (e.g., numbness, respiratory depression), and only one (3.1%) had coagulopathy. Five (15.6%) required intubation. There were no deaths reported. Regarding disposition, 19/31 (61.3%) patients were admitted with 11/19 (57.9%) of those admitted to an intensive care unit. Nine of 31 (29.0%) were discharged from the emergency department and 3/31 (9.7%) left against medical advice. Regarding snake type, vipers caused 15 (46.9%) envenomations, and elapids caused 17 (53.1%). The most common snakes were of the *Naja* genus (cobras) with 11/32 (34.3%). Antivenom was administered in 12 (37.5%) cases with one reported case of adverse reaction (8.3%). Of 16 cases in which antivenom was obtained, 13 (81.3%) were supplied by zoos. Time in healthcare facility ranged from one hour to over seven days, with a median of 26 hours. No fasciotomies were performed. Of 32 recorded toxicology consults, 10 (31.3%) were at bedside, while 22 (68.8%) were completed by phone.
Conclusions: In our state, exotic snakebite envenomations had a wide range of clinical outcomes, but no fatalities. Envenomations occurred primarily outside the setting of accredited zoos; however, zoos supplied nearly all antivenom administered. This emphasizes the importance of close relationships and infrastructure for coordination between zoos and toxicology services.

KEYWORDS Exotic snakebite; non-native snake envenomation; exotic snake envenomation

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236. Flatlining from snakebites: use of thromboelastograms to manage VICC from *Crotalus horridus horridus*

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Background: Venom-induced consumptive coagulopathy (VICC) is a potentially life-threatening hemotoxic complication from crotalinae envenomations. Traditionally, coagulation lab studies such as fibrinogen, platelets, prothrombin time/international normalized ratio (PT/INR), and partial thromboplastin time (PTT) are used for diagnosis and progression of VICC. However, the dynamic changes of clotting factors and active clot formation are not always captured with traditional lab studies. Thromboelastography (TEG) is a valuable tool to track active clot formation from whole blood, allowing real-time evaluation of response to antivenom administration in an *vivo* state. Many components contribute to clot formation; abnormality in the alpha angle (a marker of real-time fibrin cross linking) on TEG reflects changes in fibrinogen activity. We present a case where TEG components were successfully used to monitor for antivenom efficacy.
Case report: A 26-year-old male presented following envenomation with self-identified *Crotalus horridus horridus* (timber rattlesnake). This was the patient's second snakebite in 6 months. His previous envenomation was with a *Sistrurus miliarius* (pygmy rattlesnake), treated with crotalidae polyvalent fab [ovine] (FabO). On physical examination, the patient had two puncture marks on the left index finger with associated swelling extending to the elbow. Ancillary studies revealed an undetectable fibrinogen and severely elevated INR of 12. A TEG drawn upon patient arrival demonstrated a flatline with indeterminate alpha angle, K times, max amplitude (MA), and LY 30 confirming severe VICC. Four vials of FabO were administered at 4.75 hours after envenomation without improvement of either coagulation lab values or TEG variables obtained an hour after antivenom administration. A second bolus of 6 vials of FabO was administered 3.5 hours after the first bolus. An hour after the second bolus, the TEG had a detectable alpha angle of 21°, MA of 18 mm, an indeterminant K time, R of 9 min, and Ly30 of 14%; fibrinogen remained undetectable, and the INR was 2.26. Maintenance dosing of FabO was initiated based on a detectable alpha angle. Detectable fibrinogen [66 mg/dL; normal range 220–498 mg/dL] lagged 19 hours post-envenomation. At 28 hours post-envenomation, the fibrinogen further improved to 120 mg/dl and the INR was 1.22. The patient required a total of 16 vials of FabO and was discharged home on day 2 of hospitalization.
Discussion: The utilization of thromboelastograms for monitoring and anticipating coagulopathy trends has been previously documented for *Crotalinae* (pit viper) envenomation. Our patient had severe VICC with undetectable fibrinogen and indeterminate TEG values, with resolution following multiple doses of antivenom. A detectable alpha angle on TEG, prior to a detectable plasma fibrinogen concentration, allowed for a quicker transition to maintenance FabO dosing. Similarly, other reported cases suggest TEGs demonstrate dynamic changes in clotting function earlier than traditional laboratory studies allowing improved antivenom therapy guidance.
Conclusions: TEGs may offer better real time monitoring of response to antivenom in cases of severe VICC although further study is required.

KEYWORDS Snake; crotalidae; VICC

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237. Malayan pit viper envenomation successfully treated with western antivenin

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Background: We report a single case of an envenomation by a Malayan pit viper. The patient had been treated in Thailand at a local facility. Upon her return home, presented with recrudescence of pain at the site and a new petechial rash. As the most appropriate antivenin was not available locally, she was treated with the Antivipmyn® Equine Bioclon, a biFAB product, stocked in local hospitals for treatment of the local crotalid bites. She made a complete recovery.
Case report: While visiting a beach in Thailand, a 26 year female was bitten on her foot by a snake, identified by local experts as being a Malaysian Pit Viper. At a rural clinic, she had local pain, bruising and swelling. Coagulation markers were abnormal at 6 hours so she was transferred to a larger facility where she received 2 vials of Malayan Pit Viper Antivenin, Queen Saovabha Memorial Institute, separated by 10 hours for resolution of her clotting time. She also received tetanus toxoid, analgesia and antibiotics. She returned to her home and presented to hospital with recurrent pain, bruising to the sole of her affected foot and a new petechial rash on her affected leg. Coagulation parameters were somewhat consistent with disseminated intravascular coagulation with an INR $>$ 10, pTT 87, D-dimer $>$ 20 microgr/mL, fibrinogen $<$ 0.15. She was not anemic. Her platelets were not decreased in number. A clotting time was not performed. The AntiVenom Index suggested that the most appropriate antivenin was that which she had received in Thailand. The product was not easily available. Timing to delivery would have been days. The consulting hematologist had determined that the patient should otherwise have blood products and factors because of her high risk of spontaneous bleeding. As Antivipmyn® is used in our jurisdiction for our local venomous Crotalid, the massasauga, it was decided to treat this patient with this product. Known to cause significant, protracted coagulopathy, it was reasoned that the cross reactivity of Antivipmyn® could be effective against similar components of the Malayan pit viper venom. The patient was treated with her first vial of Antivipmyn® at 2000. Over the subsequent hour, she received the total loading dose of 6 vials. Within 2 hours, her INR fell to 5.3 (from $>$ 10) and over the course of 10 hours it fell to 1.9. Platelets and hemoglobin remained stable for the duration of her hospitalization. She was kept in hospital for a total of 4 days with daily repeat testing. No further dosing was required.
Conclusions: In conclusion, although Antivipmyn® is not specifically made against the venom of the Malayan pit viper, the viper is a crotalid with envenomation symptoms comparable to that of North American and Central American crotalids. Use of available Antivipmyn® led to complete resolution of coagulation abnormalities in a patient at risk of significant bleeding following her exotic snake envenomation. Local antivenin might be considered in similar cases in the future.

KEYWORDS Exotic snake envenomation; Antivipmyn®

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238. All warmed up and ready to bite: a survey of temperature variability and northern Pacific rattlesnake bites in Central California

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Background: Rattlesnake bites are a rare but sometimes life-threatening reason for ambulance transport to a hospital. Ecologic studies have shown a preference in Pacific rattlesnakes for temperatures between 26.4 - 32.3°Celsius (C) and have posited that with climate change there may be an increase in rattlesnake activity which may in turn lead to an increase in rattlesnake bites. While some large database and national registry studies have examined whether weather variables are associated with bites, no studies to date have specifically examined the frequency of bites within this ambient temperature range.
Methods: This is a retrospective review of all ambulance transports under the "snake bite protocol" from a single emergency medical services (EMS) company that serves as the primary provider for four counties in the Central Valley of California from 1 January 2017 to 1 January 2023. The EMS service area incorporates 15,000 square miles with a mix of grasslands, chaparral, and forest, and over 1 million inhabitants. The Northern Pacific rattlesnake (*Crotalus oreganus oreganus*), a subspecies of the Western rattlesnake, is the primary snake responsible for envenomations in the study area. The zip code of the transport and general demographic data were extracted from the prehospital patient chart. The zip code was then used to query the Weather Underground's publicly available database for maximum and average daily temperatures on the date and location that the transport originated. Summary statistics were calculated using R (Comprehensive R Archive Network (CRAN)).
Results: 48 EMS transports using the snake bite protocol occurred during the 6-year study period. The number of transports per year range from 3 in 2018 and 2022 to 12 in 2021. Transports originated from 27 zip codes. One transport was excluded because the narrative history identified the bite as being from a pet snake as opposed to a presumably wild snake. Patients' average age was 38.8 (range 1–84 years old), and 78% were male. The average maximum temperature was 31.5 °C, and the average daily temperature was 23.8 C on the date the bite occurred. 41/47 (87.2%) transports occurred when either the average daytime temperature or the maximum temperature was between 26.4 and 32.3 °C.
Conclusions: In this study, bites tended to occur when ambient temperatures were within the Northern Pacific rattlesnakes' preferred temperature range, which may occur with increasing frequency with climate change. However, this study is limited by the granularity of the available temperature data. The difference in the number of transports per year may be due to a variety of factors including changes in human preferences for outdoor activities and areas of recreation, expansion of human development into previously uninhabited areas, increased snake activity due to variability in weather from year to year, longer term changes in climate or some combination of these factors. Future studies are needed to further examine the role of ambient temperature in the incidence of snake bites.

KEYWORDS Snake bite; climate change

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239. Opioid resistant pain in a Texas coral snake (*Micrurus tener*) envenomation

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Background: The Texas Coral Snake, *Micrurus tener,* is a venomous snake found in southeast Texas. Envenomations are rare and characterized by severe pain with minimal swelling. Prior literature has shown most patients do well with intravenous pain control, do not develop respiratory failure, and do not need antivenom. We present a case of photo confirmed envenomation with severe pain refractory to opioids requiring antivenom administration with no apparent effect.
Case report: This is a single case report. A 20-year-old female encountered a *Micrurus tener* snake in a park. The snake was picked up by her and then bit her left hand twice. The patient presented to our ED in severe pain with paresthesias radiating up the extremity. The patient had a photo of the snake, and it was confirmed by toxicology to be *Micrurus tener*. During the initial 24 hours of admission she received opioids, a hydromorphone pump, one dose of ketamine, and benzodiazepines. Only ketamine was reported to improve her pain, and it was not continued in the ICU. After high doses of opioids she continued to have refractory pain, paresthesias, and then developed subjective difficulty breathing. She was administered six vials of Costa Rican coral snake antivenom from the local zoo. Four of these vials were expired, and two were new. She tolerated this well, yet her pain remained severe until 36 hours into admission. She did not have any further progression of her respiratory symptoms. She slowly improved and was discharged on hospital day three, however did continue to have paresthesias. On her four week follow up in our clinic she had paresthesias that were still present but much reduced in severity. She had difficulty with the dexterity of her left hand which unfortunately required her to leave her job.
Discussion: Our patient's pain did not improve with anything except ketamine, which was not continued in the ICU. The effect of the antivenom was also largely felt to be minimal for her pain, however her subjective respiratory symptoms did not worsen. Her symptoms remained for weeks after discharge and were quite debilitating. Residual disability and symptoms have been noted in prior literature.
Conclusions: Micrurus tener envenomations are rare bites that primarily cause pain and paresthesias that can be opioid refractory in which case ketamine, antivenom, and alternative regimens may be considered.

KEYWORDS Envenomation; Texas coral snake; paresthesias

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240. African rhinoceros horned viper envenomation

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Background: The African Rhinoceros Horned Viper (*Bitis nasicornis)* is a potentially lethal snake endemic to the wetlands of central and west Africa. This venom has the potential for cardiovascular, renal, soft tissue, pulmonary and hematotoxic effects. African Rhinoceros Horned Viper bites are an exceedingly rare occurrence in North America. We present a rare pediatric

envenomation of the African Rhinoceros Horned Viper in the southeast US requiring antivenom.
Case report: A 15-year-old male patient presented to the emergency department (ED) after being bitten on the index finger by *Bitis nasicornis* while working at a local animal rescue facility. Patient was found to be tachycardic on arrival with no evidence of hematotoxicity, or rhabdomyolysis. Inoserp PANAFRICA antivenom was secured however weather delayed patient transport to the closest facility to the antivenom and numerous agencies declined to transport the antivenom to the patient. A local zoo was able to produce SAIMR Polyvalent Antivenom and arrange for police transportation of the antidote to the patient. Twelve hours after being bitten, the patient received his initial dose of antivenom. After a total of six vials of antivenom he was discharged home, only sustaining local tissue injury/hemorrhagic blebs. Follow up visits show resolution of the soft tissues injury and return of normal function.
Discussion: Exotic snake envenomation represents an ever-present minority of snake envenomation reported to public health monitoring groups such as local poison control and National Poison Data System (NPDS). This patient represents a unique data point as most snake envenomations, including exotic snakes, occur in patients with a mean age of 33–35 years old and are rare, with around 37 cases reported yearly. Analysis of these rare toxicologic events is important to improve the care delivered to this small group of patients. Although there is a ACMT position statement regarding best practices of facilities who house poisonous snakes, there is minimal literature regarding how exotic antivenom can be made available to patients, especially in developed countries, and no formal transportation process exists for many poison centers. This lack of protocol can lead to treatment delays as seen in this patient. Some literature supports antivenom transport and administration by prehospital teams including ground and helicopter-based ambulance services.
Conclusions: Exotic antivenom transportation represents a potential pitfall in the treatment of the acutely envenomated patient. Fortunately, this patient suffered minimal toxicity in the spectrum of possible disease, however, the delay in receiving antivenom of twelve hours could have led to a deleterious health outcome. Continued stocking and up to date registry of rare snake antivenom was key to the success of this patient during index and subsequent visits. Formal protocols should be developed between antivenom registry participants, poison center and hospitals regarding transportation of critical antidotes to appropriate patients similar to the ACMT position statement regarding institutions housing venomous animals.

KEYWORDS Snake bite; pediatric; envenomation

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241. Delayed *Micrurus tener* envenomation treated with Costa Rican, anti-coral snake ICP antivenom

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Background: North American coral snakes are found throughout eleven southeastern states in the United States. Clinically significant elapid envenomations occur with the Eastern coral snake, *Micrurus fulvius,* and the Texas coral snake, *Micrurus tener*. Coral snake venom contains α-neurotoxins that competitively bind and block postsynaptic acetylcholine receptors leading to weakness and paralysis. Currently the only FDA-approved antivenom (AV) is *Micrurus fulvius*-derived equine IgG (Pfizer/Wyeth, Philadelphia, PA). This antivenom is largely unavailable as production ceased in 2006. Coralmyn (Bioclon Institute) is equine $F(ab')_2$ derived from *Micrurus nigrocinctus nigrocinctus* and has been used in the absence of available IgG antivenom. Currently, both products are difficult to procure even with local zoo assistance. Here we report a case of a *Micrurus tener* envenomation that was successfully treated with expired IgG anti-elapid AV (*Micrurus nigrocintus, Micrurus d. carinicaudas, Micrurus fulvius*) from the Instituto Clodomiro Picado (ICP).
Case report: A 39-year-old man with a history of hypertension and type-II diabetes was transferred to our referral facility due to concern for coral snake envenomation with resulting neurotoxicity. The patient was bitten 14 hours prior on his face while sleeping under an underpass. Vital signs were heart rate 62 beats per minute, blood pressure 146/85 mmHg, respirations 35 per minute, oxygen saturation 95% on 2 L nasal cannula, temperature 97.7 °F. Exam on arrival was no for slurred speech, ptosis, 3+/5 strength in all extremities. NIF was −60 cm H_2O. Labs were no for leukocytosis to 12.3 K/uL, otherwise unremarkable. The local zoo was contacted to obtain antivenom. Neither the Pfizer nor Coralmyn AV were available. ICP anti-coral snake AV (expired June 2018) was recommended. Nineteen hours after envenomation repeat exam showed 2-/5 strength in the bilateral upper extremities, with NIF −12 cm H_2O. The patient was endotracheally intubated for impending respiratory failure Twenty hours after envenomation he was administered 3 vials of AV after being pretreated with diphenhydramine and famotidine and passing the serum skin test. The patient was extubated the following morning to high-flow nasal cannula. Physical exam on hospital day 2 was no for completely resolved weakness. The patient was discharged on hospital day 6 and lost to follow-up.
Conclusions: FDA-approved elapid AV is unavailable in the United States, as is the alternative Bioclon. Clinicians may turn to non-FDA approved AV due to the lack of available options. *Micrurus tener* was previously considered a subspecies of *Micrurus fulvius,* which supports the use of the ICP AV. There is currently no literature supporting the use of anti-elapid ICP AV in the treatment of *Micrurus tener*. In this case, three of the recommended ten vials were used with symptomatic resolution the following day. Further research is required to investigate the efficacy of anti-elapid ICP AV for *Micrurus tener* envenomations. Also, the need for an available FDA-approved elapid AV should be further explored.

KEYWORDS Elapid; coral snake; antivenom

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242. Hand compartment pressures decrease after Crotalidae polyvalent immune fab in suspected timber rattlesnake (*Crotalus horridus*) envenomation

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Background: The North American pit vipers (crotalinae; rattlesnakes, copperheads, and cottonmouths) have venom with cytotoxic and proteolytic enzymes that often result in profound local tissue destruction. Current guidelines recommend administration of antivenin as first-line management. Fasciotomy for snakebite is controversial and is indicated in other traumatic causes of compartment pressures above 30 mmHg, but carries risks of scarring, infection, contractures, and amputation.
Case report: A 40-year-old male presented to a regional hospital one hour after sustaining a snakebite. While clearing brush from his yard he heard a rattle and was bitten on the right index finger. He had considerable knowledge as a snake breeder. He identified the assailant as a timber rattlesnake (*Crotalus horridus*) based on color and banding. Examination revealed puncture wounds to the volar

and dorsal surfaces of right index finger and significant swelling extending to his mid forearm. Initial bloodwork including hemoglobin (15.2 g/dL), platelet count (250 K/cumm), PT/INR (11.2 sec/1.0), fibrinogen (342 mg/dL), and D-dimer (456 ng/mL) were within reference limits. The patient required transfer to a tertiary center due to unavailability of antivenin at originating site.The toxicology service evaluated this patient 3.5 hours following envenomation. He received six vials of crotalidae polyvalent immune fab (CroFab®) 4 hours post-envenomation and was admitted for serial evaluation and pain control. Admitting physicians prescribed hydromorphone patient-controlled analgesia. The orthopedics service was consulted for concerns of hand/forearm compartment syndrome and recommended continued non-operative medical care. Orthopedics re-evaluation raised concern for compartment syndrome based on clinical exam. Emergent fasciotomy was scheduled however, our toxicology service recommended assessment of hand compartment pressures with a Stryker® intracompartmental gauge. Thenar, hypothenar, and dorsum compartment pressures measured 30, 30, and 16 mmHg, respectively. A second 6-vial dose of antivenin was given immediately after pressure measurement. Reassessment of thenar and hypothenar compartment pressures two hours later revealed a decrease to 27 and 12 mmHg, respectively. Fasciotomy was not performed and he received maintenance antivenin with two vials every six hours for three doses. His pain and exam improved overnight and he was transitioned to oral pain medications. He did not develop thrombocytopenia or coagulopathy and was discharged home at 40 hours post-envenomation. The patient provided written consent for this case report.

Discussion: Current management of crotalid snakebite focuses on antivenin administration and supportive care. If concern for compartment syndrome exists, compartment pressures should be quantitatively assessed prior to surgical intervention. We report a patient who sustained a suspected timber rattlesnake envenomation with hand compartment pressures borderline for compartment syndrome. Compartment pressures were evaluated before and after the second dose (6-vials) of antivenin with a reduction in pressure observed. A total of 18 vials of antivenin were administered and fasciotomy was not performed.

Conclusions: Antivenin is first line therapy in crotalid envenomation. Incidence of compartment syndrome from crotalid envenomation is rare and compartment pressures should be assessed prior to surgical intervention. Antivenin may obviate the need for fasciotomy despite initial compartment pressure meeting surgical indication.

KEYWORDS Crotalinae envenomation; compartment syndrome; fasciotomy

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243. Adverse events of F(ab')$_2$AV and FabAV use for rattlesnake envenomations: a three-year retrospective poison center study

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Background: Thousands of Crotalid envenomations occur in the United States annually, roughly 25% of which are due to rattlesnakes. Two antivenoms are available: Crotalidae-polyvalent ovine immune FabAV (CroFab®) and Crotalidae equine immune F(ab')$_2$AV (ANAVIP®). Though the two have been compared in clinical trials, few real-world comparisons are available.

Methods: This is a retrospective study of rattlesnake envenomations referred to a single-state Poison Control system between October 2018 and August 2022. All patients treated with either antivenom were included; patients treated with both antivenoms were excluded. Demographics, clinical presentation, antivenom use, and acute adverse event (AE) data were collected by chart review. AEs were defined as "minor" if one organ system was affected without hemodynamic instability or involvement of a potentially dangerous anatomic location and were defined as "serious" if multiple organ systems were affected, hemodynamic instability occurred, and/or a potentially dangerous location was involved.

Results: In total, 481 patients were included: 360 received FabAV and 121 received F(ab')$_2$AV. Median age was 47 years and 46 years, respectively. Both groups were approximately 25% female. The most common finding in both groups was localized swelling. Neurotoxic symptoms were reported in approximately 25% of each group, predominately sensory changes (numbness, tingling, paresthesia). Venom anaphylaxis occurred in one case. The FabAV group received a median six vials (n = 354, IQR: 6–12 vials). The F(ab')$_2$AV group received a median of 10 vials (n = 360, IQR: 10–20 vials).Following antivenom administration, 27 individual AEs were reported in 18 FabAV patients and three were reported in three F(ab')$_2$AV patients. The most common minor AE was rash/urticaria, which occurred in two FabAV and two F(ab')$_2$AV patients. Two FabAV patients developed itching without rash. All were treated with antihistamines, with or without corticosteroids. Other minor AEs in the FabAV group include nausea/vomiting (one), tinging (one), and facial flushing (one). One F(ab')$_2$AV patient developed tingling. Serious AEs were reported in five FabAV patients: one developed urticaria, wheezing, throat swelling, and tachycardia, one developed hypotension, tachycardia, acute rash, shortness of breath, new hypoxia, and vomiting, one developed hypotension and bradycardia, and two developed "anaphylaxis" without further clarification. All were treated with antihistamines, steroids, and/or epinephrine. The F(ab')$_2$AV group had no reported serious AEs.

Conclusions: AEs were more frequently reported in the FabAV group compared with the F(ab')$_2$AV group for unclear reasons. One potential explanation is that immunoglobulin G cleavage with papain to form FabAV also produces free intact Fc regions, whereas pepsin cleavage to form F(ab')$_2$AV does not. Intact Fc regions not removed by subsequent purification processes would remain immunogenic. Other considerations include underreporting and documentation errors. Our findings are tempered by the inherent limitations present in retrospective Poison Center data and are limited by absent data regarding delayed AEs, such as serum sickness. Either treatment can be considered for rattlesnake envenomation, with attention to potential adverse events.

KEYWORDS Rattlesnake; snake bite; antivenom

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244. First presentation of a non-indigenous bite by *Sistrurus miliarius* (Pygmy rattlesnake) treated with ANAVIP in Arizona

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Case report: A 60-year-old male was changing out a water bowl when he was bitten on the right fourth finger by a captive

Pygmy rattlesnake. At presentation to the health care facility there was already notable swelling in the hand with significant pain reported by the patient. There were no initial lab abnormalities. This was the patient's third snake bite, having been treated with Wyeth several decades prior (and developing serum sickness two weeks out) and later on receiving Crofab® (with no adverse reaction) in prior events. The decision was made to treat the patient with Anavip® due to the degree of swelling which had progressed into the forearm within two hours of presentation. On day 2 the patient's swelling and induration in the affected extremity were noted to have worsened, so an additional 10 vials of Anavip® were administered. It was also noted on day 2 that the patient's creatinine kinase level was rising. On presentation it was 92 and by day two have risen to over 1000. The patient was given fluids for the CK elevation and there was a downtrend by day 3. The patient was subsequently discharged and recovered fully with only minimal sensory deficits (numbness in the affected digit) on follow up several weeks later.
Discussion: This case illustrates the clinical progression of a bite from an infrequently encountered species of rattlesnake in a state where the snake is not native; *Sistrurus miliarius*. It is also the first reported instance of such a bite being treated with Anavip® (Fab2 Antivenom), and to good effect.
Conclusions: Fab2 antivenom is a newer and increasingly used antivenom that is only recently indicated for all North American vipers. This case illustrates its successful use in a rare situation. The case also illustrates the clinical progression and outcome of an infrequently encountered species of rattlesnake. The case will include lab work, clinically relevant details and anonymized pictures.

KEYWORDS Sistrurus miliarius; antivenom

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245. Two cases of hypersensitivity reactions due to North American pit viper antivenom administration with confirmed elevation of galactose-alpha-1,3-galactose (alpha-Gal) IgE

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Background: We present two cases of galactose-alpha-1,3-galactose (alpha-gal) allergy discovered in patients with hypersensitivity reactions to antivenom during treatment of North American pit viper envenomation, one involving Crotalidae Immune Polyvalent (FabAV), and the other Crotalidae Immune F(ab')2 (Fab_2AV). Both cases were confirmed with alpha-gal IgE concentrations.
Case series: Case 1: A 2-year-old female was bitten on the finger by an unidentified snake. Swelling progressed up the forearm. Six vials of FabAV were administered. During infusion she developed facial edema, urticaria, and significant wheezing. FabAV was promptly discontinued. Methylprednisolone, intramuscular epinephrine and diphenhydramine were administered. She was transferred to a pediatric intensive care unit due to the severity of her reaction. FabAV was not reinitiated. She did not require additional antivenom or develop coagulopathy. She was discharged on day four. Alpha-gal IgE concentration was 13.7 kU/L (reference $< = 0.09$ kU/L). Case 2: A 47-year-old male was bitten twice on his toe by an unidentified rattlesnake. He initially reported blurred vision which later resolved. Swelling progressed to his right calf. Ten vials of Fab_2AV were administered. After completion, he developed pruritus, diffuse urticarial rash, facial edema, throat itching and dysphagia. Symptoms gradually resolved with intravenous methylprednisolone, diphenhydramine and famotidine. He did not require additional antivenom. He was discharged on day four. Alpha-gal IgE concentration was 38.8 kU/L.
Discussion: Alpha-gal has been implicated in anaphylactic reactions to non-primate mammalian food products, heparin, porcine valve replacements, and monoclonal antibodies such as cetuximab. Evidence of mammalian oligosaccharide galactose-alpha-1,3-galactose has been previously established in both FabAV and Fab_2AV products, with the relative amount three times higher in Fab_2AV. Alpha-gal allergy is attributed to antigen transfer of saliva from the Lone Star tick to human hosts. Lone Star ticks are found in the southeastern United States (US), ranging from Oklahoma to North Carolina, with cases reported as far north as Minnesota. Incidence of sensitization is reported to be 15–30% in Lone Star tick-endemic areas in the US, with the number of confirmed alpha-gal cases increasing from 12 in 2009 to 34,000 in 2019. Alpha-gal IgE levels of 3.51–17.50 kU/L are considered high, and > 17.51 very high. Mild anaphylactoid reactions to antivenom occur at a low rate. It will be important to further define prevalence of severe hypersensitivity reactions given the increasing frequency of alpha-gal allergies in the southeastern US. We suggest: seeking a history of meat allergy prior to antivenom administration in Lone Star tick-endemic areas, or from individuals who have lived in these areas. Maintaining caution during antivenom administration and preparedness for serious adverse reactions. Testing patients with severe reactions for alpha-gal IgE and counsel accordingly regarding possible future reactions to mammalian products.
Conclusions: Greater availability of rapid alpha-gal IgE testing should be undertaken for Lone Star tick-endemic areas. Future research should focus on possible product improvement. Risk factors should be identified as to whether absolute alpha-gal concentrations in antivenom are associated with more severe reactions, or whether choice of antibody production species impacts severity or incidence of hypersensitivity reactions.

KEYWORDS Alpha-gal; allergy; antivenom

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246. Real world delays in antivenom administration: patient, snake or hospital factors (ASP-33)

This abstract was originally published in this Supplement, but has been removed after being withdrawn from presentation at NACCT 2023.

247. Sneaky snakebites: an overview of reported unusual clinical effects and adverse reactions to treatment with antivenom following crotalid envenomation

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Background: Domestic crotalid envenomation can result in edema, pain, erythema, ecchymosis, hematotoxicity including coagulopathy, thrombocytopenia, and hypofibrinogenemia, and neurotoxicity. The following species of crotalids are found in our state: *Agkistrodon contortrix* (copperheads), *Agkistrodon piscivorous* (cottonmouths), *Crotalus atrox* (western diamondback rattlesnakes), *Crotalus horridus* (timber rattlesnakes), *Crotalus viridis* (prairie rattlesnakes), *Sistrurus miliarius streckeri* (western pygmy rattlesnakes), and *Sistrurus catenatus tergeminus* (western massasauga rattlesnake). While neurotoxic effects are generally not expected except in our timber rattlesnakes, the other clinical effects associated with crotalids are well documented. Unusual systemic effects to venom and adverse drug reactions (ADRs) to the two available antivenoms in the United States, Crotalidae Immune Polyvalent Fab (FabAV; commercially known as CroFab®) and Crotalidae Immune F(ab')$_2$ (Fab$_2$AV; commercially known as ANAVIP®), have been observed. Here, we report on the frequency of unusual clinical effects and ADRs to antivenom following crotalid envenomation reported to our poison center over a two-year period.

Case series: Five hundred and twenty-seven (527) cases of crotalid envenomation were reported to our poison center between May 2021 and May 2023. By species, there were 219 copperhead bites, 29 cottonmouth bites, 4 western diamondback rattlesnake bites, 4 timber rattlesnake bites, 2 prairie rattlesnake bites, 68 western pygmy rattlesnake bites, and 201 unknown crotalid bites. Of these cases, 57 were documented as "Unable to follow – judged as potentially toxic." The most frequent unusual clinical effects reported were nausea (76/527 = 14.4%), vomiting (39/527 = 7.4%), thrombocytopenia (31/527 = 5.9%), and numbness (15/527 = 2.8%). Thrombocytopenia was particularly observed following pygmy rattlesnake envenomation (12/68 = 17.6%). Other clinical effects included abdominal pain (5 cases), diarrhea (6 cases), diaphoresis (9 cases), peripheral neuropathy coded for tingling (8 cases), paresthesia (2 cases), headache (4 cases), dizziness (2 cases), chest pain (4 cases), hypotension (8 cases), bradycardia (2 cases), rhabdomyolysis (2 cases), and blurred vision (2 cases). There were 38 reported cases of ADRs to antivenom – 23 patients received CroFab®, 13 patients received ANAVIP®, and 2 patients received and experienced ADRs to both antivenoms. Most common ADRs were hives (18/38 = 47.4%), pruritis (12/38 = 31.6%), rash (8/38 = 21%), anaphylactoid reaction (5/38 = 13.2%), oropharyngeal edema (5/38 = 13.2%), and hypotension (5/38 = 13.2%). Other no ADRs included a case of asystole, a case of bronchospasm, and reports of chest pain, dyspnea, and respiratory depression.

Discussion: In these cases, gastrointestinal effects were the most frequently reported of the unusual clinical effects. The ADRs to antivenom and the antivenom administered are reported for each case. We could not confirm the identification of the species in a majority of these cases and documented identification as reported by the patient.

Conclusions: Gastrointestinal, neurological, and cardiovascular effects are relatively uncommon but important complications of crotalid envenomation in our region. Notably, isolated thrombocytopenia is associated with pygmy rattlesnake envenomation, and ADRs to antivenom were more frequent in our state than previously reported. Further investigation is necessary to evaluate patient characteristics including allergies and regional issues contributory to these findings.

KEYWORDS Crotalid envenomation; adverse reactions to treatment

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248. Establishing a psilocybin baseline poison center adolescent use rate

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Background: The State of Oregon voted in 2020 to legalize the use of psilocybin for use in supervised facilitated therapy. The first facilitators are expected to be certified in 2023. The city of Denver in late 2019; and in 2020 the cities of Washington, D.C., Santa Cruz, Ann Arbor, San Francisco, Oakland, Detroit, Seattle, and Cambridge, Mass. (all university cities) have each decriminalized possession. It is likely that other individual cities or states may follow as preliminary investigation into the benefits of psilocybin suggests some therapeutic potential. One of the arguments often raised against decriminalization is the impact on children. However, in no state or city is psilocybin use under the age of 21 permissible. In order to consider the impact on youth misuse nationally the aim of this study is to establish a baseline of calls to poison centers prior to the regional liberalization of adult use in 2020.

Methods: Data from the National Poison Data System (NPDS) covering all US poison centers were obtained for the entire years 2000–2020. Calls were limited to adolescents between the ages of 14 and 19. Calls coded as psilocybin mushrooms as the sole substance in NPDS were analyzed.

Results: Over the 21 years, poison center calls concerning adolescents between 14 and 19 years of age, involved 4377 cases

coded as psilocybin mushrooms, with 3115 cases that coded it as the single primary substance. (Average: 148/year) The peak year 2004 had 264 calls, and the lowest year 2018 had 69 calls. There was a downward trend over time after 2004, with a small rise in calls in the last 2 years. The age with the most calls was 17-year-olds (764 calls). Call volume per month was highest in April through August. It was lowest in January. Of single substance cases with a treatment location recorded, 64% of calls resulted in treatment in a health care facility, with 5% admitted to an ICU. There were 65 cases coded as major outcomes and 1 case was coded as death (19 y.o. with pre-hospital arrest/CPR etiology unconfirmed). The reason of call by intention coded as suicide was 1–2 %, but rose to 3% between 2017 and 2019; all other cases were intentional misuse or abuse.
Conclusions: This study establishes the baseline incidence of psilocybin misuse, which can be used as a comparison to ascertain the impact that psilocybin legislation may have on adolescent exposure after 2020. Psilocybin calls to poison centers for adolescents are few and averaged 148 calls per year over the two decades prior to legislative changes. Call trends were declining prior to any legislation permitting its use under regulated conditions in adults.

KEYWORDS Psilocybin; epidemiology; NPDS

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249. Kratom cardiotoxicity: a report of reversible brugada pattern and QTC prolongation

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Background: Kratom is derived from *Mitragyna speciosa* and contains the active alkaloids mitragynine and 7-hydroxymitragynine. These compounds bind opioid, alpha-2 adrenergic, and 5-HT2A receptors producing stimulant and analgesic effects. *In vitro* studies show kratom can inhibit myocardial potassium channels. Cases in the literature describe an association between kratom use and a variety of EKG abnormalities, including prolonged QT intervals.
Case report: The patient, a 25-year-old male, was self-medicating for anxiety and ADHD chronically with kratom. He presented to the emergency department (ED) after experiencing witnessed seizure-like activity. He reported ingesting kratom daily for the past three years and his recent daily intake was approximately 84 g. He vaped menthol nicotine but denied any changes to his vaping habits or use of other recreational drugs. Thirty minutes after his last dose of kratom, he experienced witnessed rigors and seizure-like activity for approximately two minutes. His girlfriend called EMS and he presented to the ED. His initial workup revealed an EKG with a type 1 Brugada pattern, QRS of 160 msec, and QTc of 654 msec. He had mild electrolyte abnormalities with a potassium of 3.2 mmol/L and calcium of 8.4 mg/dL, undetectable ethanol level, and negative urine drug screen. He received bicarbonate and was admitted to the hospital on cardiac telemetry. During his admission, serial EKGs showed progressive shortening of his QRS and QT/QTc intervals, and resolution of the Brugada pattern. A brain MRI revealed no intracranial abnormalities and EEG monitoring did not capture any epileptiform discharges. He had no structural cardiac abnormalities by echocardiography. His only previous EKG, performed eight years prior to this presentation, did not show a Brugada pattern or QT/QTc prolongation. The patient's kratom was analyzed by gas chromatography mass spectrometry and liquid chromatography quadrupole time-of-flight mass spectrometry. Data processing against a large-in-house database containing more than 1,000 drugs was conducted. The sample was positive for mitragynine and consistent with kratom products; no other drugs or analytes of interest were identified.
Discussion: Kratom has been associated with hepatic damage, thyroid dysfunction, seizures, memory impairment, and cardiac conduction abnormalities. A systematic review described EKGs performed on kratom users revealed a variety of EKG abnormalities. However, only two published meeting abstracts report kratom use unmasking a Brugada pattern. In both cases, no testing of the kratom was performed to rule out contaminants. We believe that kratom was the culprit for the patient's cardiotoxicity. This conclusion is based on the patient's negative family history of sudden cardiac death, previously unremarkable EKG, his EKG on presentation, which normalized with kratom abstinence, lack of significant electrolyte derangements to explain his EKG abnormalities, and no structural abnormalities on echocardiography. Additionally, there were no contaminants detected in the kratom sample.
Conclusions: Kratom is an unregulated and legally sold substance that can cause neurologic and cardiac toxicity. This case highlights kratom's ability to cause significant cardiac conduction abnormalities in a patient without structural anomalies or additional confounding xenobiotics.

KEYWORDS Kratom; Brugada; QT interval

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250. Dietary supplement adverse events reported to the center for food safety and applied nutrition adverse event reporting system

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Background: The United States (US) Center for Food Safety and Applied Nutrition (CFAN) Adverse Event Reporting System (CAERS) is a national database that contains reports of food, dietary supplement, and cosmetic product adverse events and product complaints submitted to the US Food and Drug Administration (FDA). Healthcare professionals (e.g., physicians, pharmacists, nurses), consumers (e.g., patients, family members, lawyers), and manufacturers submit reports to CAERS. The reports are generally voluntary, although manufacturers are required to send reports of serious adverse events they receive from healthcare professionals and consumers to the FDA. Adverse events are coded to terms in the Medical Dictionary for Regulatory Activities (MedDRA), a validated, internationally standardized medical terminology. The adverse events include minor to major medical events as well as complaints about taste, color, defective packaging, and other non-medical issues. The objective of this study was to describe dietary supplement adverse events reported to CAERS.
Methods: Cases were adverse events with a Product code of 54 [Vit/Min/Prot/Unconv Diet (Human/Animal)] reported to CAERS with a report created date of 2004–2021. Cases with "Exemption 4" in the Product field were excluded because it was unclear what these cases represented. The distribution of cases was determined for various factors.
Results: A total of 75,669 dietary supplement adverse events were reported, representing 60.7% of the 124,617 total adverse

events reported during 2004-2021. The annual number of reports increased from 709 in 2004 to 8,445 in 2016 then decreased to 4,734 in 2021. The distribution by patient's age was 658 (0.9%) 0–5 years, 364 (0.5%) 6-12 years, 976 (1.3%) 13–19 years, 4,841 (6.4%) 20–29 years, 6,974 (9.2%) 30–39 years, 7,295 (9.6%) 40–49 years, 9,379 (12.4%) 50–59 years, 10,745 (14.2%) 60–69 years, 10,150 (13.4%) 70–79 years, 7,567 (10.0%) 80+ years, and 16,720 (22.1%) unknown age; 49,728 (65.7%) of the patients were female, 23,218 (30.7%) male, and 2,723 (3.6%) unknown sex. The medical outcomes (a record can have more than 1) were 47,296 (62.5%) other serious or important medical event, 20,069 (26.5%) hospitalization, 15,589 (20.6%) visited a health care provider, 12,480 (16.5%) visited emergency room, 5,813 (7.7%) other serious outcome, 5,636 (7.4%) life threatening, 5,418 (7.2%) other outcome, 3,618 (4.8%) disability, 1,622 (2.1%) required intervention, 1,267 (1.7%) death, and 112 (0.1%) congenital anomaly. The most commonly reported MedDRA terms (a case can have more than 1) were 7,401 (9.8%) choking, 6,362 (8.4%) nausea, 6,098 (8.1%) dyspnea, 5,578 (7.4%) diarrhea, 5,556 (7.3%) vomiting, 4,773 (6.3%) dizziness, 3,995 (5.3%) headache, and 3,807 (5.0%) hypersensitivity.

Conclusions: Patients age 50+ years accounted for 50.0% of the dietary supplement adverse events, and the majority of patients were female. The most frequently reported outcome was other serious or important medical event followed by hospitalization and visited a health care provider. The most frequently used MedDRA terms were choking, nausea, dyspnea, and diarrhea. A limitation of the CAERS database is that it does not separate dietary supplements into more specific subgroups.

KEYWORDS Dietary supplement; CAERS; FDA

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251. Oleander seeds in candlenut weight loss product strike again

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Background: Candlenuts (*Aleurites moluccana*) are sold online as a weight loss agent due to their purgative effects. Candlenuts and yellow oleander seeds (*Thevetia peruviana)* share similar physical features. At least one case describes unintentional poisoning from mixed yellow oleander seeds and candlenuts with subsequent toxicity and a reported fatality. We present a case of yellow oleander poisoning secondary to consuming candlenuts that was identified early and successfully managed with digoxin immune fragments.

Case report: A 55-year-old female presented to the ED with complaints of nausea, vomiting and diarrhea after ingesting 12 candlenuts labeled "Indian Nuts for Weight Loss" that were purchased online. Shortly after arrival, she was given activated charcoal and calcium gluconate for hyperkalemia (K+ 5.9 mEq/L). She developed bradycardia (pulse range 40–50 beats/min). A serum digoxin concentration resulted that was above the upper limit of quantification (> 5 ng/mL). The patient was given all 8 of the vials of digoxin immune fragments that the hospital had available. Her heart rate improved above 60, and the potassium decreased to 4.5 mEq/L. She experienced transient episodes of bradycardia, nadir 39 beats/min, over the following 12 hours. By 20 hours after her initial presentation, she was stable for discharge. On follow up 3 days after presentation, she reported being back to baseline. The Maryland State Department of Health analyzed samples of the candlenuts with high performance liquid chromatography coupled with high resolution time of flight mass spectrometry (HPLC-Q-TOF-MS) and identified the product as yellow oleander containing 1 mg digitoxigenin per gram of seed.

Discussion: Multiple case reports have described cardiotoxic effects after the ingestion of candlenuts advertised as weight loss supplements, suggesting the possibility of cardiac glycosides in these products. Two cases had detectable digoxin concentrations, but this was never associated with the possibility of yellow oleander seeds packaged in the same bag. Cardiac symptoms in these cases were attributed to the phorbol esters that raw candlenuts contain. Animal models suggest that phorbol esters lead to negative inotropic effects as well as arrhythmias, but this has not been noted beyond animal data. One case report, in which yellow oleander seeds were identified in the candlenut package, described a patient who presented very similarly to ours with stomach upset, significant bradycardia and hyperkalemia and died prior to receiving digoxin immune fragments.

Conclusions: Yellow oleander seeds may be confused with candlenuts. Inadvertent ingestion of yellow oleander seeds may result in cardiac glycoside poisoning. Since these products continue to be readily available online, toxicologists and healthcare professionals should be aware of the potential toxicity stemming from "candlenuts."

KEYWORDS Candlenuts; yellow oleander; weight loss supplement

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252. Succession in the line of pennyroyalty: a self-controlled case series

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Background: Pennyroyal, *Mentha pulegium*, a plant native to North America, is historically used as an herbal folk remedy to treat a variety of ailments, is a known abortifacient, and possesses insecticidal properties. Pennyroyal oil contains pulegone, which is metabolized in humans to menthofuran. Menthofuran is thought to deplete glutathione and cause hepatotoxicity. Mint teas containing pulegone have caused inadvertent hepatotoxicity and death.

Case report: A 39 year-old female presented to the emergency department 25 minutes after drinking 10 mL of pennyroyal essential oil that she had purchased from a local essential oils shop with the intent to end her life. She was asymptomatic, so minty-smelling gastric fluid was suctioned. At 1.25 hours post-ingestion, she received activated charcoal. At 2 hours post-ingestion, she was started on a standard dose 21-hour infusion of N-acetylcysteine (NAC). She developed no transaminitis nor any clinical evidence of toxicity. After completion of approximately 48 hours of NAC, she remained asymptomatic and was discharged to a psychiatric facility. Eight months later, the same patient again presented to the emergency department two hours after drinking 60 mL of pennyroyal oil. The pennyroyal product she ingested had been returned to her upon discharge from the inpatient psychiatric facility. She was initially asymptomatic. Aspartate aminotransferase (AST) and alanine transaminase (ALT) remained within normal limits at 3.5 hours post-ingestion, 6.5 hours post-ingestion, and on 2 subsequent blood draws the following day. No treatment was performed during this time. By hospital day 3, the patient developed vomiting and abdominal pain; samples collected 40 hours post-ingestion revealed AST 2787 U/L and ALT > 3300 U/L. The patient received standard-dose 21 hour infusion of NAC followed by two additional maintenance doses of 100 mg/kg infused over 16 hours, totaling 53 hours of NAC. NAC was discontinued once the AST had declined to 681; AST further

declined to 175 before discharge. She developed no further symptoms.
Discussion: The same patient presented with two separate self-harm ingestions of pennyroyal oil. Notably, she was discharged from the psychiatric facility with the very product she had used in the initial attempt to end her life. Overdose data are relatively limited, but indicate significant morbidity and mortality in rare reports. The patient's first ingestion resulted in no clinical effects. This outcome may be attributed to early gastric decontamination, quick administration of NAC, the low volume of the product ingested, or a combination of these factors. The second ingestion caused significant delayed hepatotoxicity. This may be attributed to the larger volume ingested, or the absence of any early treatment, or both.
Conclusions: A reported ingestion of 60 mL pennyroyal oil is sufficient to cause significant hepatotoxicity. Gastric decontamination may be beneficial in preventing toxicity from pennyroyal oil. NAC has an important role in treating pennyroyal oil toxicity via repletion of glutathione. Discharging a patient with the same product used in a self-harm attempt, without any medical necessity, may increase the likelihood of re-exposure or repeat overdose and should be avoided.

KEYWORDS Pennyroyal; pulegone; glutathione

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253. Turmeric-associated acute liver injury: a rarely O-curry-ing phenomenon

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Background: Turmeric is increasingly being used as a supplement in the United States for conditions including arthritis, hyperlipidemia, degenerative eye conditions, and anxiety. Rarely, turmeric has been associated with hepatotoxicity presenting as painless jaundice, bloating, nausea, or right upper quadrant pain. Here we report a case of a 45-year-old female who presented with acute hepatitis in the setting of turmeric supplementation.
Case report: A 45-year-old female patient with history of cholecystectomy presented to the emergency department for three days of progressive jaundice and epigastric abdominal pain, three weeks after starting a supplement containing probiotics, turmeric, moringa leaf, curry leaf, lecithin, and black pepper fruit extract. Her other home medication is amphetamine/dextroamphetamine. She had no recent exposure to acetaminophen. On admission to the hospital, labs were as follows: acetaminophen undetectable, ALT 1,369 U/L, AST 1,157 U/L, alkaline phosphatase 224 U/L, total bilirubin 6.1 μmol/L with direct bilirubin of 4.1 μmol/L, lipase 46 U/L, INR 1.2, with normal complete blood counts and electrolytes. Viral hepatitis panels were negative. Autoantibody testing for autoimmune etiologies was negative. An abdominal ultrasound revealed surgical absence of the gallbladder with mild common bile duct dilation to 9 mm, likely related to post-cholecystectomy changes. Magnetic resonance cholangiopancreatography was performed and found to be negative. The patient was treated with N-acetylcysteine (NAC) for 2 days with improvement in her liver function tests. She was discharged on hospital day 9 with partial resolution of her liver dysfunction. At 50 days post-admission, the patient's liver function testing normalized.
Discussion: Turmeric has been used as both a food additive and a health supplement for thousands of years and the latter is increasingly common in the United States. While rare, a few reports exist of turmeric causing acute liver injury which resolved with cessation of supplementation. Several commercially available combination supplements exist which contain both curcuminoids (isolated from turmeric) as well as piperine (isolated from black pepper). Piperine has been demonstrated to increase absorption and bioavailability of curcuminoids up to 2000% in both rats and humans. These findings are increasingly relevant as turmeric's popularity grows as an anti-inflammatory agent. The use of antidotal therapies for other causes of drug-induced liver injury, such as NAC, in the setting of turmeric-associated hepatotoxicity requires further investigation.
Conclusions: Turmeric extract, especially in combination with black pepper extract, appears to be associated with several reports of acute drug-induced liver injury. Our case emphasizes the need for further investigation into turmeric's rare but significant hepatotoxicity. It additionally reinforces the need for thorough history-taking regarding over-the-counter supplement usage. Further studies are required to determine the efficacy of NAC therapy in turmeric-associated livery injury.

KEYWORDS Turmeric; hepatotoxicity; dietary supplement

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254. Descriptive study of mushroom exposures reported to state poison center, 2003–2022

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Background: Clinical mushroom exposures can be broadly characterized by symptoms or by organ toxicity – loosely based on mushroom species identification or class of mushroom ingested. Most data to date report trends of the lethal cyclopeptide mushroom *Amanita phalloides,* which causes severe liver failure and most often attributed to misidentification of the mushroom. Recently we have seen an increase trend in psychoactive mushroom interest in popular press and an increase in availability of psychoactive mushroom products available for purchase in local dispensaries. Two main psychoactive mushrooms exist in our region: anticholinergic delirium inducing mushrooms such as *Amanita Muscaria* (due to muscimol/ibotenic acid) & psilocybin mushrooms (LSD-like substance psilocybin). This study aimed to characterize all mushroom exposures as a primary objective and secondarily evaluate the trends of psychoactive mushroom exposures reported to state poison center.
Methods: This is a retrospective chart review of exposures reported to State Poison Center from 2003 to 2022. The database was queried for "mushroom" exposures. Age, date, reason for exposure, location of call, management site, type of mushroom (category 1–7, unk, misc), clinical effects and medical outcome were recorded. Medical outcome severities and categories of mushrooms were derived from American Association of Poison Control Centers' coding definition. This study was IRB reviewed and exempt by host institution.
Results: There were 3,072 exposures to mushrooms reported to State Poison Center from 2003 to 2022. The majority of exposures (2,573, 84%) were to an unknown mushroom. The age distribution of mushroom exposures follows expected patterns with a broad range (age 0–96 years) with average age of 18.6 years and median of 16 years; 61.7% of reported exposures were in patients 18 years and under. One death was reported in the two-decade time frame in 64-year-old female with unknown mushroom exposure categorized as misuse. The trend of intentional psychoactive mushroom exposures demonstrates an increase from 2011 to 2022. When the exposures per year are averaged

2011–2013 are compared to 2020–2022 average, there is a 3.3X increase noted. Intents of this psychoactive subgroup demonstrates proportional increases in suicide intent and abuse intent categories. Major limitations of this study include inability to confirm mushroom identification or correct categorization, in addition to inherent limitations of data drawn from elective reporting to poison centers.
Conclusions: Mushroom exposures reported to Poison Centers occur at lower frequencies than other common substances, however this State Poison Center has received increasing reports of all mushroom exposures, especially since 2011. Most notable was the dramatic increase in psychoactive mushroom exposures which have increased threefold. Our findings provide valuable insights into the patterns of mushroom poisoning, and we conclude toxicologists need to be aware of this growing trend. Continued evaluation of the impacts, clinical effects, and outcomes, of these exposures is needed.

KEYWORDS Mushroom; psychoactive; poison center

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255. From green to clean: chelation therapy in a pediatric case of copper chlorophyllin complex overdose

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Background: Copper chlorophyllin is a chlorophyl derivative and widely available supplement used as a deodorizer for ostomies. While current literature clearly identifies other copper compounds as toxic, little is known about the potential for copper chlorophyllin toxicity after ingestion. We present a 20-month-old who ingested copper chlorophyllin resulting in recurrent hypoglycemia and transaminase elevation treated with dimercaprol.
Case report: A previously healthy 20-month-old male presented to an emergency department with obtundation after an exploratory ingestion of an estimated 100 mL of Nature's Way Chlorofresh containing 3 mg/mL copper chlorophyllin. He was noted to have profound hypoglycemia (20 mg/dL) with bradycardia (HR 70 BPM). His family denied any diabetic medications in the house including insulin or sulfonylureas. He had no response to naloxone but had noted improvement in mental status with intravenous dextrose and his vital signs improved to normal. Initial labs demonstrated a mild lactic acidosis (2.7 mmol/L), mildly elevated AST (52 U/L), negative serum ethanol, and improvement of hypoglycemia (263 mg/dL). Patient was transferred to a higher level of care where he was noted to have multiple episodes of green emesis consistent with the color of the agent ingested. He became hypoglycemic again (55 mg/dL) so a dextrose infusion and octreotide were started. Repeat laboratory evaluation demonstrated mild worsening of transaminases with an AST of 98 U/L, elevation in LDH (1533 U/L) and a plasma free hemoglobin of 270 mg/dL. Salicylates, acetaminophen, methemoglobin, and a comprehensive urine drug GC/MS were negative. Serum copper level was requested but was unable to be performed secondary to machine malfunction. The patient experienced clinical improvement in symptoms, however, repeat labs revealed significant increase in transaminases with AST 549 U/L and ALT 259 U/L, an increased LDH 1792 U/L, and normal CK. C-peptide testing was performed and mildly low at 0.4 ng/mL (normal 0.6-6.3). Given the ingestion and clinical signs/symptoms, copper toxicity was suspected and the patient was started on intramuscular dimercaprol 4 mg/kg every 4 hours. He received four doses, had subsequent decrease of transaminases to AST 89 and ALT 152, and was ultimately discharged in stable condition.
Discussion: Toxicity from copper ingestions are well documented in literature, potentially resulting in nausea, vomiting, hepatotoxicity, and in some cases methemoglobinemia, hemolysis, and shock. Treatment involves supportive care and chelation with d-penicillamine or dimercaprol. This case highlights the potential dangers of copper chlorophyllin ingestion in pediatric patients. To our knowledge, there are no previous reports of acute copper chlorophyllin causing toxicity in humans. While our case was limited by the inability to obtain a serum copper concentration, symptoms and laboratory values were consistent with copper toxicity. However, the cause for his hypoglycemia remains unclear. Ultimately, he experienced clinical improvement with supportive care and chelation therapy, the mainstays of treatment for copper toxicity.
Conclusions: Toxicologists should be aware of the effects from large copper chlorophyllin ingestions, including vomiting, hypoglycemia, and transaminase elevation. Supportive care and chelation may be helpful treatments.

KEYWORDS Copper; chelation; hepatotoxicity

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256. Local nasopharyngeal toxicity due to intranasal squirting cucumber exposure (*Ecballium elaterium*)

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Case report: The patient is a 31-year-old healthy female who presented with nasal congestion, palate pain, and otalgia after using an herbal remedy. Patient had been experiencing cold symptoms recently, and a family member mailed her a "squirting cucumber" from Israel. She squeezed the juice out, and dropped around 1 mL of the liquid into each nostril the evening prior. She immediately started to have symptoms including nasal congestion, persistent rhinorrhea, odynophagia, sore throat, difficulty speaking, and had 3 episodes of mucous-appearing emesis which prompted an ED evaluation. She denied any chronic medical problems or allergies. Vital signs: HR 105 bpm, BP 147/66 mmHg, RR 18 bpm, SpO_2 100% on room air. On examination, she was in painful distress but non-toxic appearing. Her uvula was edematous with oropharyngeal erythema. Her ear and nares appeared normal. Her CBC and BMP were unremarkable. She was given IV dexamethasone, diphenhydramine, and famotidine with improvement of symptoms. She was observed in the toxicology unit overnight with supportive care, and discharged in the morning after symptomatic improvement.
Discussion: "Squirting cucumber" or *Ecballium elaterium* is a plant native to the Mediterranean region which contains toxic cucurbitacins, which has been used as a folk remedy for treating sinusitis. Intranasal use of this has been associated with mucosal inflammation, necrosis, angioedema, and in one case renal and cardiac failure. Most patients report edema of pharynx, dyspnea, drooling, dysphagia, and vomiting with full recovery with glucocorticoids and antihistamines. Recovery occurred in a few days. There was one case where a patient developed persistent symptoms as above, then subsequently developed fever and oliguria on day 4, renal failure and progressive severe dyspnea on day 5, and died of cardiac failure on day 6. Our patient did well with supportive care, systemic steroids, antihistamines, and H2 blockers.
Conclusions: *Ecballium elaterium* contains toxic cucurbitacins, which may cause mucosal inflammation when applied in nares or

oropharynx. Our case shows that supportive care with systemic steroids, antihistamines, and H2 blockers may improve symptoms.

KEYWORDS Ecballium elaterium; squirting cucumber; cucurbitacins

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257. Heavy metal toxicity due to Ayurvedic supplements

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Background: Ayurveda is an over 2000-year-old traditional form of Indian medicine. Various herbs are combined with metals, minerals, and gems to attempt to replete essential minerals in the body. We report a case of symptomatic arsenic and lead poisoning due to Ayurvedic supplements. This report adds to the growing body of literature detailing the dangers of unregulated Ayurvedic supplements in the United States.
Case report: A 75-year-old Caucasian female with a past medical history of postural tachycardia syndrome presented to the emergency department with fatigue and decreased sensation in her distal extremities. She was found to have diminished deep tendon reflexes and lack of sensation to light touch in her bilateral distal extremities. Laboratory examination revealed pancytopenia and she was referred for hematology and neurology for evaluation. Bone marrow biopsy demonstrated erythroid dysplasia, reticulocytosis, and small hypolobated megakaryocytes. Electromyography demonstrated small fiber polyneuropathy with distal degeneration of sensory greater than motor axons. Heavy metal testing demonstrated elevated blood lead (26.4 ug/dL) and arsenic (140.6 ug/L) concentrations as well as elevated 24-hour urine arsenic (total 871.3 ug/L; inorganic 1683.8 ug/L, methylated 1730.4 ug/L, and organic $<$ 5 ug/L) and lead (21.2 ug/L) concentrations. The patient stated that she had been prescribed Ayurvedic supplements by a holistic energy healer for anxiety, palpitations, and heartburn. She received her most recent batch of supplements from India six weeks prior to developing symptoms. Repeat blood testing one month after supplement discontinuation demonstrated resolution of her pancytopenia, decreasing blood arsenic (13.6 ug/L) and stable blood lead (27.7 ug/dL) concentrations. Chelation was deferred in favor of close outpatient monitoring and as of follow up at 135 days the patient had undetectable blood arsenic concentrations and unchanged distal extremity sensation loss.
Discussion: All ten Ayurvedic supplements being taken by the patient were tested with inductively coupled plasma mass spectrometry. All tablets contained measurable heavy metals. 8/10 contained arsenic, 9/10 contained mercury, and 7/10 contained lead. Three supplements contained heavy metal concentrations a magnitude higher than the others (1,4,7). Daily heavy metal doses were calculated based on the patient's reported daily supplement consumption and revealed a daily arsenic dose of greater than 650 mg/day and a mercury dose of greater than 300 mg/day. Of note, supplement 1 was labelled to contain 20 mg of "shuddh hartal" which translates to pure arsenic and was composed of 16 mg arsenic per tablet. The patient's urine speciation was consistent with the presence of inorganic arsenic, which is significantly more toxic than the organic form commonly found in seafood. Her findings were consistent with both arsenic neurotoxicity with a peripheral sensory neuropathy and hematotoxicity with pancytopenia and erythroid dysplasia. The rate of absorption of elemental mercury through an intact gastrointestinal tract following oral ingestion is clinically insignificant with regards to causing systemic toxicity.
Conclusions: Clinicians should caution patients about the known risks of ayurvedic supplement heavy metal toxicity and screen patients routinely for use of non-pharmaceutical medications and supplements.

KEYWORDS Ayurveda; supplements; heavy metals

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258. Pediatric ondansetron overdose presenting with depressed level of consciousness and convulsions

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Background: Ondansetron is a 5-HT3 serotonin receptor antagonist extensively prescribed for nausea and vomiting. Acute toxicity of large overdoses in pediatric patients is rarely described.
Case report: A two-year-old previously healthy female presented with decreased level of consciousness after ingesting 272 mg (20.9 mg/kg) of ondansetron in the form of eight mg oral disintegrating tablets. Therapeutic dosing of ondansetron in children is 0.1–0.15 mg/kg. 30–60 minutes after ingestion the patient was "drowsy," with "shallow breathing," and a "deep sounding cry" per her parents. On emergency department arrival, vital signs were notable only for tachycardia to 122 beats per minute. Physical examination demonstrated decreased level of consciousness, normal tone, 2+ bilateral patellar reflexes, no clonus, and no nystagmus. Complete blood count, complete metabolic panel including electrolytes, transaminases, and lactic acid were within normal ranges and not repeated. Acetaminophen, salicylate, and ethanol concentrations were undetectable. Initial electrocardiogram (ECG) demonstrated sinus rhythm without QRS nor QT interval prolongation, and was unchanged eight hours later. Soon after arrival the patient had generalized tonic-clonic convulsions lasting approximately two minutes. She received lorazepam and levetiracetam intravenously and was intubated for airway protection. On pediatric intensive care unit arrival, she had no significant physical exam findings other than mydriasis. Electroencephalography was unremarkable. Urine drugs of abuse by immunoassay was positive for fentanyl, which had been administered post-intubation. Qualitative serum testing performed nine hours following ingestion via gas chromatography-mass spectrometry with a panel of 246 analytes detected ondansetron and levetiracetam. She was extubated twelve hours after ingestion, returned to baseline mental status soon after, and was hemodynamically stable throughout her hospitalization. She was discharged twenty-four hours after arrival without sequelae.
Discussion: Ondansetron is broadly utilized with an excellent safety profile and wide therapeutic index. Although QTc prolongation is well described and the FDA has a boxed warning for it, this effect is rarely consequential in patients without pre-existing cardiac conduction disorders. Generalized convulsions without any other identifiable etiology have rarely been described following the administration of therapeutic ondansetron. Despite how frequently ondansetron is administered and prescribed we are aware of only two published reports of ondansetron overdose involving pediatric patients, neither with qualitative or quantitative testing performed. The first case describes a 12-month-old that ingested 6.4 mg/kg and developed depressed level of consciousness, rash, myoclonus, convulsions, and serotonin toxicity. The second described an eight-year-old who

ingested 1.25 mg/kg and developed hypotension. Our case differs from both previously reported toxic ingestions as our patient ingested a significantly higher dose of ondansetron (20.9 mg/kg), had positive qualitative testing, and did not develop hypotension, a rash, hyperreflexia, or ECG changes. The primary therapeutic anti-emetic mechanism of ondansetron is the antagonism of central and peripheral 5HT-3 receptors. In overdose receptor specificity may be lost, resulting in GABA, glycine, and serotonin antagonism resulting in neurotoxicity and convulsions.
Conclusions: Large acute pediatric ondansetron overdose is rarely described and may result in depressed level of consciousness and convulsions with rapid resolution. Further research is necessary to determine the toxic dose in this age group.

KEYWORDS Ondansetron; pediatric; overdose

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259. Acute withdrawal from opium-containing Indian herbal drug Kamini Vidrawan Ras tablets in Canada

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Background: Kamini Vidrawan Ras (Kamini) is a traditional Ayurvedic medicine primarily marketed to improve men's sexual health concerns, including erectile dysfunction, impotence, premature ejaculation, and low libido. Kamini contains opium poppy and is also used by workers to increase alertness. There have been several case reports and case series of Kamini abuse internationally, however we believe this to be the first reported case in North America.
Case report: A 39-year-old male Indian immigrant truck driver began taking Kamini tablets he purchased illegally in Canada at a Punjabi grocery store to stay awake while driving. The patient was introduced to Kamini in Canada by fellow Indian truck drivers who used the product to sustain longer working hours. Kamini tablets contain *Papver somniferum* (opium poppy) and P*iper betle* (betel leaves) amongst other herbal ingredients. The patient was unaware that Kamini contained opium and believed it was a product similar to caffeine. He developed dependence on Kamini and experienced opioid withdrawal symptoms with cessation. The patient did not use other substances and had no prior history of addictions.
Discussion: Kamini dependency has been well documented with reports predominately from India, Australia, and New Zealand. This case appears to be the first report of a recognized opioid use disorder secondary to Kamini use in North America. A particularly concerning phenomenon is reports of users experiencing a sense of wakefulness while clinically appearing drowsy. One explanation for this presentation is the substance P*iper betle* (betel leaf) which is found in some Kamini preparations. *Piper betle* is a common medicinal plant in Asia used for the treatment of a variety of conditions, including oral, skin, joint, and digestive health concerns. The leaf or flower of P*iper betle* is a key component in betle quid chewing which produces psychostimulant effects. Other ingredients found in Kamini tablets that may be responsible for the sensation of increased alertness are *Myristica fragrans* (nutmeg) and *Crocus sativus* (saffron). As in this case, there have been previous reports of Kamini abuse to sustain longer working hours, particularly in the transportation industry. A case report has also described manic symptoms in the setting of Kamini use.
Conclusions: Kamini is an illegal opioid-containing substance that can readily be obtained in Canada. Clinicians should be aware of the potential deleterious effects of non-allopathic and herbal medications and inquire about their use. The use of Kamini to sustain longer working hours in the transportation industry is of great concern to public safety. We can expect to see more cases of Kamini dependency until there is more awareness of this substance.

KEYWORDS Kamini Vidrawan Ras; ayurvedic; opioid withdrawal

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260. Confirmed envenomation by *Leiurus quinquestriatus* (deathstalker scorpion)

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Background: *Leiurus quinquestriatus* (also known as the Deathstalker or Egyptian scorpion), a member of the family Buthidae, is considered to be among the most lethal scorpions in the world. The Deathstalker is native to the Middle East and Northern Africa; envenomation is rarely reported outside of these regions. We present a case of confirmed envenomation by *Leiurus quinquestriatus* and the subsequent clinical course.
Case report: A 39-year old male presented to the emergency department shortly after being stung on his hand by his pet *Leiurus quinquestriatus*. Prior to arrival, he attempted to suck the venom out of the envenomation site. On presentation, he had some localized redness, pain, and erythema at the site of the sting, and complained of nausea. Vital signs on presentation were: heart rate: 89 beats per minute; blood pressure: 152/97 mmHg; respiratory rate: 16 breaths per minute; and oxygen saturation: 96% on room air. EKG revealed a normal sinus rhythm and intervals within normal limits. Presenting lab work was unremarkable. He developed mild elevations in high sensitivity troponin up to 25 ng/L and creatinine kinase up to 272 units/L. He received antiemetics to manage nausea and acetaminophen to manage pain. 24 hours after presentation, his lab abnormalities returned to within normal limits, all symptoms but localized erythema had resolved, and the patient was discharged to home.
Discussion: The venom produced by *Leiurus quinquestriatus* has been reported to affect the cardiovascular, autonomic, and central nervous systems, though its mechanism is not well understood. Reported symptoms of *Leiurus quinquestriatus* include local and generalized paresthesias, tachycardia, bradycardia, diaphoresis, miosis, mydriasis, hypertension, and hypotension. Ventricular dysrhythmias, respiratory failure, hematemesis, seizures, coma, pulmonary edema, and cardiogenic shock are also reported. In nonfatal cases, symptom resolution is typically seen within 36 hours. While antivenoms are available in the regions where *Leiurus quinquestriatus* is native, clinical utility is equivocal and most patients go on to develop only mild symptoms following envenomation that respond well to symptomatic and supportive care.
Conclusions: *Leiurus quinquestriatus* envenomations are uncommon in the United States, but do carry the risk for significant morbidity and mortality.

KEYWORDS Deathstalker; scorpion; envenomation

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261. Case report: acute toxic encephalopathy due to dermal hydrogen cyanamide toxicity in Sohag government

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Background: Pesticides are used widely all-over the world and is a major cause of occupational, accidental and intentional poisoning. Hydrogen cyanamide which is the active component of Dormex® (commercial product), which is a plant growth regulator with high toxic effects.
Case report: The study represents a case report of a 22 year-old male farmer with accidental occupational dermal exposure to Dormex® resulting in second degree burn in his lower limbs and abdomen and acute toxic encephalopathy. MRI- brain showed multiple widespread cortical and white matter abnormal signal intensity lesions scattered upon both cerebral and cerebellar hemispheres, bilateral lentiform nuclei and vermis. The patient partially recovered after three weeks of effective treatment in ICU and was discharged to follow up with a neurological consultant doctor.
Discussion: In this presented case there was severe contact dermatitis and different degree burns involving large surface area of the patient body as the route of exposure was dermal contact. Dermal toxicity could be attributed to an immunological mechanism, as Dormex® acts as a hapten that initiates an immunological reaction against keratinocytes. This might lead to a severe allergic reaction in the form of erythema multiforme as reported in previous studies. Also, it has been reported that acute cyanamide poisoning affects the cerebral structures with the highest oxygen requirement, such as the basal ganglia, the cerebral cortex, and the sensorimotor cortex. As a result, the anoxic encephalopathy shows hemorrhagic necrosis, mainly in the striatum, and pseudolaminar necrosis in the cortex as shown in MRI of this case.
Conclusions: Acute accidental exposure to Dormex®, either dermally in the workplace or accidental ingestions in those who have this dangerous product in their home present a great threat to human life with many toxic effects like disturbed conscious level, permanent Central Nervous System effects, multiple vesicles in skin, and gastrointestinal effects. There is ignorance among farmers about how hydrogen cyanamide is so dangerous and proper precautions they need when using it. Recommendations: Education training programs and awareness creation on harmful effects of Dormex®, especially among farmers and proper precautions they need to take when they use it. Adequate information about full personal protective equipment should be given to farmers.

KEYWORDS Dormex®; hydrogen cyanamide; toxic encephalopathy

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262. Fatal cyanide poisoning from amygdalin ingestion

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Background: Amygdalin, marketed as "vitamin B17" and sold online as a health supplement, is a cyanogenic compound derived from apricot pits, bitter almonds, and other species of the *Rosaceae* family. Touted as an alternative treatment for cancer, sale of amygdalin and its semi-synthetic derivative laetrile are banned by the US Food and Drug Administration and the European Commission, having been found to be neither safe nor effective in the treatment of any medical condition. When taken orally, amygdalin is enzymatically metabolized in the gastrointestinal tract to hydrogen cyanide. We present a fatal case of amygdalin ingestion leading to lethal cyanide toxicity in a young child.
Case report: A 6-year-old male with autism presented to the emergency department by ambulance after he was found unresponsive at home. CPR was started just prior to arrival for bradycardia. On presentation to the emergency department, he had a GCS of 3 with fixed and dilated pupils. The paramedics produced a photograph of an empty bottle of 500 mg amygdalin capsules that had been found near the patient, along with an open container of Oxiclean powder. His mother reported having found him with the closed bottle of amygdalin several hours beforehand and disclosed that he later had vomited multiple times before becoming unresponsive. He developed PEA and approximately 25 minutes of CPR was performed while he was treated with 70 mg/kg IV hydroxocobalamin and 1.65 mL/kg IV sodium thiosulfate for presumed cyanide toxicity. The patient regained pulses approximately 5 minutes after receiving hydroxocobalamin and was transferred to the intensive care unit, where he was given 25 g of activated charcoal. He was given a second dose of hydroxocobalamin 6 hours after the initial dose, and a second dose of sodium thiosulfate 12 hours after the initial dose. The following day, he had absent brainstem reflexes while off all sedation, and brain imaging demonstrated evidence of severe anoxic brain injury leading to cerebral herniation. Additional testing was consistent with brain death. Whole blood samples obtained 7 hours after administration of the second dose of hydroxocobalamin and one hour after the second dose of sodium thiosulfate revealed a cyanide level of 0.140 mg/L. The medical examiner listed cyanide toxicity as the probable cause of death, with autism as a contributing condition.
Discussion: Based on the available information, we believe the patient ingested a lethal amount of amygdalin, resulting in fatal cyanide toxicity. Though it is unknown how many capsules the child ingested, one 500 mg amygdalin capsule may be metabolized to as much as 30 mg of cyanide. The lethal dose of cyanide is 1.5 mg/kg, which would suggest the fatal dose in this 36-kg child was two 500 mg amygdalin capsules. Additionally, this patient's cyanide level even after treatment was well above the expected level for a non-smoker ($<$ 0.025 mg/L).
Conclusions: Given amygdalin's lack of demonstrable clinical benefit and clear toxic potential, we strongly urge the FDA to enforce strict penalties on distributors of this dangerous compound.

KEYWORDS Amygdalin; pediatric; cyanide

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263. Evaluation of oral dimethyl trisulfide (DMTS) as a prophylactic countermeasure for oral cyanide toxicity in a swine (*Sus scrofa*) model

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Background: Cyanide (CN) has the potential to be weaponized by terrorist groups in deadly chemical attacks, as it can be easily stored and readily accessible to contaminate food and water supplies. Currently, there are no FDA approved antidotes specific to oral CN. Although there are antidotes available for inhaled CN, these are expensive, resource intensive, and time consuming. For example, hydroxocobalamin requires intravenous access and administration in high volumes thus limiting its use in a mass casualty setting. This gap could be filled by administration of a low-volume, orally administered countermeasure. Such a countermeasure would have more practical applicability in mass casualty (MASCAL), prehospital, and warfare settings. Sulfur donors administered orally have been shown to be efficacious in treating cyanide toxicity in animal models. Dimethyl Trisulfide (DMTS) is a sulfur-based molecule that occurs naturally and is used as an additive in food. In this study, we evaluated the efficacy of DMTS when administered orally as a prophylactic countermeasure for acute cyanide toxicity in swine.
Methods: Yorkshire swine weighing 49.8 ± 1 kg were anesthetized and randomized to two groups, prophylactic treatment with DMTS ($n = 8$) or untreated controls (CTR, DMTS diluent) ($n = 4$). Delivery of DMTS (15 mg/kg) or diluent was performed via an orogastric (OG) tube. Ten minutes after administration of DMTS or diluent, animals received potassium CN (8 mg/kg) through the OG tube to induce toxicity. Blood samples and vitals were collected throughout the procedure. Animals were observed for 120 minutes after CN administration. Data shown as mean ± SEM; statistical significance was accepted at $P < 0.05$.
Results: At 120 minutes, the group treated with DMTS had 100% survival compared to 0% survival in the CTR group ($P < 0.0004$). The average time of death was 48 ± 12 minutes and the average time to apnea was 9 ± 1.3 minutes in the CTR group. Differences in lactate concentrations (mM) were identified between the two groups (DMTS: 1.4 ± 0.09 vs. CTR: 6.7 ± 0.21 at 20 minutes, $P < 0.0001$). At 20 minutes post CN, pO_2 levels (mmHg) were different between the two groups (DMTS: 95 ± 4.3 vs. CTR: 40 ± 4.4; $P < 0.0001$). Mean arterial pressure, cardiac output, and venous oxygen saturation (SVO_2) were also improved in DMTS treated animals compared to controls.
Conclusions: Oral prophylactic DMTS improved survival at 120 minutes in a large animal model of severe, acute oral CN toxicity compared to no treatment controls. These data provide preclinical evidence of the efficacy of DMTS as a potential countermeasure against severe CN toxicity.

KEYWORDS Cyanide; dimethyl trisulfide; MASCAL

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Disclosure statement

The views expressed are those of the authors and do not reflect the official views or policy of the Department of Defense or its components. The experiments reported herein were conducted according to the principles set forth in the National Institute of Health Publication No. 80-23, Guide for the Care and Use of Laboratory Animals and the Animal Welfare Act of 1966, as amended. No potential conflict of interest was reported by the author(s).

264. Kernel of truth: a 22-year retrospective review of apricot kernel ingestions at a regional poison control center

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Background: The common apricot, *Prunus armeniaca* is the primary cultivar known for its delectable fruit. Ground seeds are used in the cosmetic industry as an exfoliant, while kernels found inside the seed are used in benzaldehyde and apricot oil production. Many prunus kernels contain the cyanogenic glycoside amygdalin, first isolated from bitter almonds in 1830. Amygdalin, and its semisynthetic derivative laetrile have been touted as cancer cures for over a century. *In vivo*, amygdalin undergoes enzymatic hydrolysis to hydrogen cyanide. Despite lack of scientific evidence to support cancer benefits, apricot kernels continue to be widely available for purchase in health-food stores and online. It remains unclear how many apricot kernels, particularly when masticated, can liberate enough cyanide to inhibit cytochrome C oxidase and cause subsequent cellular anoxia.
Methods: This is a retrospective review of single substance human exposure cases involving apricot kernel ingestion as reported to a single regional poison center (PC) between January 2001 and April 2023. Cases coded with the AAPCC Generic Code for "Plants: Amygdalin and/or cyanogenic Glycosides" were extracted from the PC's internal database (Toxicall®). The case narrative was reviewed to confirm involvement of an apricot kernel and to classify if the kernel was swallowed whole, chewed, or ground up prior to ingestion. Additionally, cases were reviewed to verify coding accuracy and conformance with National Poison Data System (NPDS) coding definitions.
Results: Fifty (50) cases were identified to meet inclusion criteria. The gender distribution was nearly equal and patient age ranged from 15 months to 82 years. Accidental ingestions accounted for 18% ($n = 9$) of exposure cases and were most frequently associated with whole kernel ingestion ($n = 5$) without adverse effect. Unintentional misuse and therapeutic errors accounted for 80% of the exposures ($n = 40$). These exposures often occurred in the context of a purported health benefit and were more likely to involve intentional chewing (78%) or grinding the kernel (20%) over multiple doses. There were no moderate or major outcomes within this patient population and 50% ($n = 20$) had no clinical effects reported. Among symptomatic patients ($n = 20$), 40% of the effects reported were assessed as unrelated to the exposure and 25% were assessed as unknown if related. The most frequently reported symptoms included vomiting ($n = 11$), nausea ($n = 6$), and dizziness ($n = 6$). Hypertension was noted in four (4) cases assessed as an unrelated effect. In each of these cases, the hypertension was described by the physician as 'mild' in the context of anxiety. The most serious case involved a single self-harm exposure involving an unknown number of kernels that resulted in moderate CNS depression, hypertension, muscle weakness, cyanosis, dyspnea, respiratory depression, and increased lactate level. There were no fatalities reported in this data set.
Conclusions: We report the largest case series of chewed apricot seed ingestions reported to one regional PC. Public health messaging should emphasize the lack of scientific evidence for cancer benefits and the potential for harm associated with apricot

kernel consumption. Further research is needed to determine safe consumption levels and the appropriate regulation of apricot kernel products.

KEYWORDS Apricot kernel; amygdalin

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265. Apricot kernels as cause of death in a dog

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Background: Apricot kernels are found inside the apricot pit. The kernel contains amygdalin, a cyanogenic glycoside, in a concentration of 0.05–0.3% by weight. The cyanogenic glycoside functions to protect the plant from predation. Since cyanogenic glycosides are common in plants, mammals have the rhodanese enzyme system that converts cyanide in the body to thiocyanate. When this system is overwhelmed, toxicosis occurs. Cyanide binds with iron in cytochrome a3, preventing electron transport. When cytochrome oxidase is nonfunctional, it stops tissue utilization of oxygen. There is no cellular respiration in the mitochondria, no ATP production, and anoxia occurs. Signs have a rapid onset and death can occur within minutes. Respiration and heart rate are stimulated then depressed. The venous blood may look 'cherry red'. Coma is followed by apnea, seizures, and death.
Case report: An 8.5 y, 34.5 kg, spayed female golden retriever chewed into a bag of apricot kernel meal and ingested an estimated 1/2 pound. The kernels were ground to be used as an exfoliator in homemade soap. The owners were away for 6-8 hours and found the dog symptomatic (already vomited once) when they arrived home. The dog continued to vomit an additional 5 times with apricot kernel meal observed in the vomitus. The dog became lethargic, ataxic, and was breathing heavily. The owner presented the dog to a local veterinary emergency clinic. Upon arrival the dog was unresponsive. The veterinarian was able to intubate without any sedation. On presentation the HR was 140 (normal 60 –120 BPM), BP 138 (normal 120 – 130 systolic), and the patient was hypothermic (95° F, normal 100 – 103° F). The dog was started on intravenous fluid support. Hydroxocobalamin was recommended. In dogs it is administered as a one-time dose of 150 mg/kg IV over 15 minutes. The patient should be monitored for metabolic acidosis, hypotension, dysrhythmias, and seizures when administering hydroxocobalamin. The veterinarian was able to source hydroxocobalamin from a human pharmacy, and it was administered 2 hours after arrival at the veterinary facility. The dog remained comatose, but the BP improved, and apnea resolved. However, the dog developed severe lactic acidosis and arrested five hours after presentation. There was no response to CPR.
Discussion: Apricot kernel meal is an uncommon poisoning in dogs. In humans, ingestion of 20–60 kernels or approximately 0.29–0.85 kernel/kg, has resulted in toxicosis. It is recommended humans consume no more than 1 to 3 kernels in a 24-hour period (0.014–0.04 kernels/kg). The exact fatal dose is not known in dogs but is estimated to be 0.05 kernels/kg or 0.025 g/kg. If hydroxocobalamin is not available, then a cyanide antidote kit (sodium nitrite, sodium thiosulfate) can be used. In this case the large amount ingested plus the delay to get the antidote probably contributed to the death of this patient.
Conclusions: From the human data, coma and lactic acidosis correlate with severe cyanide toxicosis.

KEYWORDS Apricot kernel; cyanide; dogs

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266. Bee, hornet, and wasp stings reported to poison centers

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Background: Bee, hornet, and wasp (yellow jacket) stings can cause adverse effects ranging from relatively mild-moderate effects such as burning pain at the sting site, erythema, and edema to severe allergic reactions (anaphylaxis) such as urticaria, difficulty breathing, swelling of the throat and tongue, weak and rapid pulse, nausea or vomiting, dizziness, syncope, and possibly death. The objective of this study was to describe bee, hornet, and wasp stings reported to United States poison centers.
Methods: Cases were exposures to bee, hornets, and wasps (Generic code 0209241 - Bee, Wasp, or Hornet Stings) reported to the National Poison Data System (NPDS), a database that receives data from all United States poison centers, during 2000-2021 where the route was bite/sting or the exposure reason was unintentional bite/sting. The distribution of total cases was determined for patient demographics and exposure circumstances. The distribution of cases not involving other substances was determined for management and outcome.
Results: A total of 151,281 bee, hornet, and wasp stings were identified. The annual number of cases decreased from a maximum of 13,112 in 2001 to 2,080 in 2021. By three-month period, there were 7,270 (4.8%) stings reported in January–March, 35,212 (23.3%) in April–June, 90,882 (60.1%) in July–September, and 17,917 (11.8%) in October–December. The patient age distribution was 28,089 (18.6%) 0–5 years, 18,151 (12.0%) 6–12 years, 9,124 (6.0%) 13–19 years, 48,566 (32.1%) 20–49 years, 33,362 (22.1%) 50+ years, and 13,989 (9.2%) unknown age; 76,090 (50.3%) of the patients were female, 74,909 (49.5%) male, and 282 (0.2%) unknown gender. The exposure site was 135,028 (90.8%) patient's own residence, 5,822 (3.9%) other residence, 5,051 (3.4%) other residence, and 5,380 (3.6%) other and unknown locations. No other substances were reported in 149,507 (98.8%) of the cases. Of these 149,507 cases, 127,647 (85.4%) were managed on site, 5,055 (3.4%) were already at or en route to a healthcare facility, 14,566 (9.7%) were referred to a healthcare facility by the poison center, and 2,239 (1.5%) were managed at other or unknown locations. The medical outcome was 985 (0.7%) no effect, 48,679 (32.6%) minor effect, 8,483 (5.7%) moderate effect, 322 (0.2%) major effect, 841 (0.6%) not followed-judged nontoxic, 83,010 (55.5%) not followed-minimal clinical effects possible, 6,226 (4.2%) unable to follow-potentially toxic, 924 (0.6%) unrelated effect, and 21 (0.0%) unknown; 16 (0.0%) deaths were reported. A clinical effect was reported in 140,931 (94.3%) of the 149,507 cases not involving other substances. The most frequently reported clinical effects were puncture/wound/sting (n = 107,354, 71.8%), dermal irritation/pain (n = 98,488, 65.9%), edema (n = 65,663, 43.9%), erythema/flushed (n = 48,610, 32.5%), 10,471 (n = 10,471, 7.0%), and hives/welts (n = 6,525, 4.4%). The most frequently reported treatments were dilute/irrigate/wash (n = 96,366, 64.5%), antihistamines (n = 51,385, 34.4%), steroids (n = 9,321, 6.2%), and antibiotics (n = 5,787, 3.9%).
Conclusions: While the majority of cases without other substances were managed on site and most did not have serious outcomes, poison centers referred almost 10% of the patients to a healthcare facility and 10% had serious outcomes, including 16 deaths.

KEYWORDS Sting; bee; hornet

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267. High sensitivity troponin is frequently elevated after carbon monoxide exposure

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Background: Cardiotoxicity from carbon monoxide (CO) exposure is well-described. For CO neurotoxicity, there are several standardized approaches for assessment and recommendations for hyperbaric oxygen therapy (HBO). For CO cardiotoxicity, there are not similar standardized approaches for assessment, nor for treatment. Indications for troponin measurement and prognostic value of troponin in the setting of CO exposure are not well-described nor uniform. This hypothesis-generating study seeks to evaluate the correlation of HS-cTn with carboxyhemoglobin (COHb) levels to determine if any patterns of elevated HS-cTn exist in CO exposed patients. Particularly we seek to determine if there is association or correlation of elevated HS-cTn with elevated carboxyhemoglobin (COHb) levels and secondarily evaluate for other clinical findings associated with elevated HS-cTn.
Methods: Cases of CO toxicity reported to our poison center in one winter period were reviewed. All cases of confirmed CO exposure with COHb $>$ 5% were included. Of these, all patients with measurement HS-cTn were included. Statistical analysis to assess association or correlation between COHb and Hs-cTn were conducted by Pearson correlation, Spearman correlation, Kendall correlation, linear regression, and Chi-squared testing using categorical groups of COHb $>$ 25%, and linear regression.
Results: Of 55 patients with positive COHb levels, (range 4.8–54%, mean 25.28%), 17 had HS-cTn measured, and all had detectable concentrations (range 1.4–8806 ng/L, mean 1073.5 ng/L). Notably, only 2 of these patients had chest pain and the other 15 had screening troponin measurements with no specific concern for ACS or myocardial infarction. Of these, 70.5% (n = 12/17) of the HS-cTn were elevated (range 12.45–8808.6 ng/dL, mean 1519.13 ng/dL). Pearson correlation (−0.284, P = 0.269), Spearman correlation (−0.272, P = 0.29), Kendall correlation (tau = −0.176, P = 0.343) linear regression (P = 0.269), and Chi-squared analysis using categorical grouping of COHb $>$ 25% found no link between higher COHb and higher HS-cTn.
Conclusions: HS-cTn is frequently elevated in patients with CO exposure. In this series, 31% (n = 17/55) of patients had HS-cTn measured after CO exposure, and 70% (n = 12/17) were elevated. Of those positive, 16.7% (n = 2/12) had chest pain. Screening HS-cTn- measurement without chest pain or other usual indications for troponin measurement- was positive in 67% (n = 10/15). Cardiac injury is an understandable and predictable result of CO toxicity. In this series, routine screening of HS-cTn was frequently positive in patients with no specific cardiac symptoms. HS-cTn was elevated in both patients with chest pain. Statistical analysis by multiple methods failed to find correlation between elevated HS-cTn with elevated COHb. This study demonstrates that HS-cTn is frequently elevated in patients with CO exposure, but finds no association between higher HS-cTn and higher COHb levels. Investigation is warranted to better understand the relevance, value, and utility of screening HS-cTn measurement in patients with CO exposure.

KEYWORDS Carbon monoxide; carboxyhemoglobin; troponin

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268. Carbon monoxide poisoning by intentional methylene chloride inhalation as a suicide attempt: a case report

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Background: Methylene chloride ($MeCl_2$ or dichloromethane) exposures may result in significant carbon monoxide (CO) poisoning due to its metabolism in the liver by CYP2E1. In contrast to inhalational CO poisoning from common sources (e.g., house fires), inhalation of $MeCl_2$ is associated with delayed and prolonged CO poisoning. We report a case of intentional inhalation of $MeCl_2$ in a suicide attempt, with serial carboxyhemoglobin levels and a confirmed blood dichloromethane concentration.
Case report: A 57-year-old woman with a past medical history of major depression presented to the hospital via EMS after intentionally inhaling 350 mL of vaporized laboratory grade $MeCl_2$ over three hours. The patient denied ever smoking in the past 30 years. The patient vaporized the liquid with a diffuser and connected a mask to her face to "fall asleep peacefully, painlessly, and not wake up." She also reported ingesting zolpidem and oxycodone. Her initial vital signs were: BP, 88/57 mmHg; HR, 49 beats/minute; RR 10 breaths/minute; T, 93.2°Fahrenheit; O_2 Saturation, 100% room air. Upon presentation to the hospital four hours after the $MeCl_2$ exposure, her physical examination was notable for a depressed mental status and a carboxyhemoglobin level [COHb] of 19%. She was transferred to a hyperbaric oxygen facility by helicopter due to concerns for delayed CO toxicity. Over the next 38 hours, her [COHb] decreased to 3.7%, with an apparent half-life of 16.3 hours. No hyperbaric oxygen treatment was administered. A blood dichloromethane concentration obtained around 10 hours after exposure was found to be 1.7 mcg/mL (reporting limit 0.50 mcg/mL). Her subsequent hospitalization was uneventful, and after 2 days, she was transferred to the inpatient Psychiatry Service.
Discussion: Methylene chloride, a common paint stripper, is absorbed by inhalation and metabolized in the liver to form CO. It is metabolized by CYP2E1 to CO and typically peaks around eight hours after exposure reaching COHb levels between 10 and 50%. The [COHb] after $MeCl_2$ exposure is directly proportional to the concentration and duration of exposure. In our case, the patient's elevated [COHb] was 19% four hours after inhalation, and the subsequent down-trending of [COHb] occurred with an apparent half-life of 16.3 hours. As a reference, the [COHb] half-life on room air, 100% oxygen, and hyperbaric oxygen is estimated to be 320, 85, and 20 minutes, respectively. This prolonged apparent half-life is attributed to the ongoing CO production from $MeCl_2$ in fat stores.
Conclusions: Methylene chloride inhalation can cause significant and persistently elevated [COHb] with an apparent half-life of over 16 hours. Healthcare providers should be aware of this rare cause of significant CO poisoning and the potential need for prolonged monitoring.

KEYWORDS Methylene chloride; dichloromethane; delayed carbon monoxide poisoning

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269. Carbon monoxide poisoning is something to talk a-boat

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Background: Carbon monoxide (CO) poisoning can cause significant morbidity and unintentional deaths. Exposures can occur where the hazardous accumulation of CO emissions from generators or engine exhaust gases is found, including boats. Over 14 million United States (US) households own a recreational boat, and approximately 100 million Americans go boating annually. As a result, CO poisoning during recreational boating has been reported in the literature. This study used a national database to characterize CO poisoning during recreational poisoning.
Methods: Data were obtained from Recreational Boating Statistics annual reports produced by the US Coast Guard (USCG). These reports contain aggregate data on recreational boating accidents, including CO poisoning/exposure. The data in the reports are received from state marine agencies, federal agencies (e.g., USCG, National Park Service, Army Corps of Engineers, Forest Service), the public, and news media. After data are submitted, the USCG reviews and standardizes the data. The annual reports for 2004 - 2020 were reviewed, and the distribution of CO poisonings was determined for various factors.
Results: Two hundred and eighteen CO poisoning accidents were reported, ranging from 6 to 18 per year. The mean annual number of CO poisoning accidents was 15.4 during 2004 - 2010 and 11.0 during 2011 – 2020. CO poisoning was reported as the first event in 206 (94.5%) accidents, second event in 9 (4.1%), and third event in 3 (1.4%). Of the 206 CO poisonings as the first event in an accident, the states with the highest number of such accidents were California 28 (13.6%), Utah 18 (8.7%), Florida 13 (6.3%), New York 12 (5.8%), Georgia 10 (4.9%), and Arizona 9 (4.4%). The distribution by US region was 22 (10.7%) Northeast, 37 (18.0%) Midwest, 65 (31.6%) South, 79 (38.3%) West, and 3 (1.5%) other USCG jurisdiction/unknown. There were 431 total CO poisoning injuries, ranging from 8 to 51 per year. The mean annual CO poisoning injuries were 32.9 during 2004 – 2010 and 20.1 during 2011 – 2020. The distribution of injuries by type of boat was 215 (49.9%) cabin motorboat, 122 (28.3%) houseboat, 86 (20.0%) open motorboat, 3 (0.7%) auxiliary sailboat, 2 (0.5%) personal watercraft, and 3 (0.7%) not reported/unknown. In addition, 95 CO poisoning deaths were reported, ranging from 0 to 12 per year. The mean annual number of CO poisoning deaths was 8.4 during 2004 - 2008, 2.8 during 2009 – 2014, and 6.0 during 2015 – 2020.
Conclusions: CO poisoning accidents and injuries during recreational boating both dropped during the latter part of the study period. Deaths caused by CO poisoning declined by 66% mid-study period and nearly doubled at the end. The US region most often reported CO poisoning during recreational boating was the West, followed by the South. Nearly half of the injuries involved cabin motorboats, followed by houseboats and open motorboats. Limitations of the annual reports include the lack of patient demographics or details on the types of injury and contain aggregate data.

KEYWORDS Boating; carbon monoxide; unintentional deaths

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270. Carbon monoxide poisoning in the emergency department: a retrospective analysis of 10 years in a hospital in Mexico State

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Background: Carbon monoxide (CO) is a colorless, odorless, and tasteless gas, which represents a public health problem throughout the world. The signs and symptoms of this poisoning can be non-specific, delaying the diagnosis and implementation of timely treatment in the emergency department (ED). The objective of this study is to identify the epidemiological factors that occur most frequently in CO poisoned patients who attend the emergency department at a hospital in Mexico State.
Methods: This is a retrospective and descriptive review of the database of a Poison Control Center at a hospital in Mexico State, from January 2013 to March 2023. The variables considered were source of CO exposure, gender, age, clinical picture, carboxyhemoglobin (%), and treatment. Data fields from case records were analyzed using descriptive statistics.
Results: From a database of 1428 patients, a total of 34 records of CO poisoning were retrieved. It was found that the main source of exposure to CO was the water heater, with 15/34 cases (61.8%). The ages ranged from 24 months to 64 years (median 28.3 years), with 10 (29.4%) from 31 to 40 years, followed by 9 (26.4%) from 21 to 30 years. By gender, women represented 64.70% of the population studied. The most commonly reported symptoms were headache (58.82%), nausea (38.25%) unclassified syncope (35.29%), emesis (29.41%) and dizziness (26.47%). Additional reported symptoms included disorientation (11.76%), somnolence (8.82%), chest pain (5.88%), tachycardia (5.88%), tinnitus (5.88%), agitation (2.94%), bradypsychia (2.94%) and bradylalia (2.94%). 14 subjects with recorded carboxyhemoglobin (COHb) levels had values over 30%, 18 from 15% to 29.9% and two were under 14.9% (median 26.7%). 25 patients (73.5%) received hyperbaric oxygen and 9 (26.4%) were treated with supplemental oxygen; no deaths were reported.
Conclusions: In the studied population, it was observed that the water heater predominated as a cause of exposure. CO poisoning was found to be manifested primarily by non-specific cardiovascular and neurological symptoms like headache, unclassified syncope, dizziness, disorientation, somnolence, chest pain, tachycardia, tinnitus, agitation, bradypsychia and bradylalia. However, syncope and loss of alertness were found most frequently in patients with COHb $>$ 30%. In contrast, headache, dizziness and gastrointestinal symptoms like nausea and emesis predominated in the population with COHb $<$ 30%, highlighting the fact that the clinical aspect must be considered when categorizing the severity of the patient poisoned by CO. Finally, epidemiological description of CO exposures will help to create public health measures with the aim of prevention.

KEYWORDS Carbon monoxide poisoning; carboxyhemoglobin; emergency department

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271. Exposures to hydrazine on military bases

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Background: Exposures to hydrazine (HZ) and hydrazine derivatives (HZ-D) vapors occur during routine operations in military and aerospace industries. Hydrazine- and HZ-D-based propellants are utilized within specific components on military aircraft and spacecraft. These chemicals may pose a risk to crews of aircraft and spacecraft as well as ground support personnel. Few human case reports of exposures to HZ and HZ-D are available. This study seeks to better understand common manifestations of HZ and HZ-D exposures on military bases during routine operations.
Methods: A retrospective database review between 1 June 2000 and 31 May 2022, of a regional poison center electronic medical record was performed. All cases originating from, or involving military personnel, when identified, were included. A specific query for exposure to "hydrazine," "monomethylhydrazine," "dimethylhydrazine," "rocket fuel," and "jet fuel" was performed. Exclusion criteria were cases not originating from a military base or involving military personnel, cases not involving an exposure, and cases involving non-HZ or -HZ-D compounds. Following case collection, descriptive statistics were performed to characterize demographics, clinical manifestations, treatments, and outcomes. This study was reviewed and approved by the local Investigational Review Board.
Results: In all, 45 individual cases were identified. Median age of exposure was 32 (range 20–50), and most exposures were inhalational or exposure to vapors ($n = 42$, 94%). Sex was not reported in 10 cases, and in cases where sex was reported, the majority were men ($n = 33$, 94%). All exposures were accidental due to release of fumes from storage containers or operating/malfunctioning components. Most patients were asymptomatic following exposure ($n = 35$, 78%), with most common signs and symptoms being cough ($n = 4$, 9%), dyspnea ($n = 3$, 7%), throat irritation ($n = 3$, 7%), lightheadedness ($n = 2$, 4%), ocular irritation ($n = 2$, 4%), and chest pain ($n = 1$, 2%). Albuterol was given in 2 cases, and oxygen supplementation was utilized in one. Most patients were observed without intervention. Overall, 82% of patients were observed and discharged from an emergency department. Two patients were admitted for observation due to a report of prolonged exposure and discharged after remaining asymptomatic for 14 h. Only one patient was admitted for persistent symptoms and was discharged within 24 h after resolution of symptoms. No significant respiratory compromise or neurologic sequelae were reported in the cases and there were no deaths.
Conclusions: Acute exposure to HZ and HZ-D during routine operations on military bases is often accidental. Most common symptoms were typically mucosal irritation with no reports of significant pulmonary or neurologic sequelae. While limited due to inability to confirm exposure either by environmental or patient laboratory testing, these data suggest that acute management of exposures to presumably low concentrations vapors may focus on supportive care of the mucosal irritant properties of HZ/HZ-D. Better characterizing exposures to these compounds during routine aeronautical and space operations will be important as interest in human space exploration grows and clinical space toxicology plays a greater role. Disclaimer: The views expressed in this material are those of the author(s) and do not necessarily reflect the official policy or position of the Department of the Air Force, the Department of Defense, or the US government.

KEYWORDS Hydrazine; aerospace toxicology; military medicine

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272. (Not so) poison hemlock: a six year retrospective review of regional poison center cases from 2017–2022

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Background: Poison Hemlock (*Conium maculatum*) is an invasive plant that has spread throughout the continental US in recent years. The plant is difficult to eradicate and exposures occur in the spring and summer months when the plant is mown by farmers and landscapers. Though the number of exposures and calls to poison centers has increased over the past few years, research on human mortality and morbidity is limited.
Methods: A retrospective review of data from the National Poison Data System (NPDS), querying for the product code for poison hemlock from 1 January 2017 to 31 December 2022, was performed. Analysis on exposures per year, route of exposures, demographics, health care utilization and clinical effects was undertaken.
Results: The NPDS query returned 77 cases in the RPC region. Codes of routes of exposure included: dermal (54 cases, 70.1%), ingestion (18 cases, 23.4%), and inhalation (5 cases, 6.5%). Age of patients ranged from 10 months to 81 years old. Exposure by gender was equal with 39 males and 38 females in the cohort. The majority of cases (87%) were unintentional exposures and only 5 were coded as intentional, 2 of which were coded as intentional suicidal intent; both SI cases were ingestions. 11 total cases (14.3%) were seen in a healthcare facility and only 1 (1.3%) was admitted (to a psychiatric facility). No patients were admitted for medical reasons. No major effects or deaths were coded, and only 4 moderate effects (5.2%) were coded, all of which were from dermal exposures. The majority of the cases were reported during late spring and early summer with the most common months being May (20 cases, 26%), June (28 cases, 36.4%), and July (11 cases, 14.3%). Only 1 case was reported during winter, and it was an ingestion in January.
Conclusions: Human exposures to poison hemlock are increasing as the geographic distribution of the species increases. Though historically the plant was known to be severely toxic, our results show that this is not true for environmental exposures. Poison Center staff can expect the majority of calls for exposures to occur during the summer months. Exposures are likely to result with a minor or no effect, and if the symptoms are minor then the patient is unlikely to require evaluation in a healthcare facility.

KEYWORDS Poison hemlock

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273. Fasciotomy after North American pit viper envenomation in 2004–2021

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Background: Envenomation by North American pit vipers occurs over 4000 times annually in the United States. Polyvalent Fab antivenom is the mainstay of treatment. Rarely, patients undergo fasciotomy to treat or prevent venom-induced compartment

syndrome despite studies documenting resolution with antivenom alone. The study aim was to describe fasciotomy cases reported to the Texas Poison Center Network.
Methods: The Texas Poison Center Network Toxicall® database was searched for crotaline snakebite exposure calls from 2004 to 2021. From these records, a subset of suspected fasciotomies performed was created by searching for the following keywords fasciotomy, surgery, compartment pressure, and compartment syndrome. Any chart containing at least one of the keywords in the notes was manually reviewed. We defined "fasciotomy" as any surgical procedure performed on a snakebite patient to decompress tissue under pressure, including finger dermotomy. Four toxicologists were trained and performed data abstraction of the charts with each case evaluated by two abstractors. Variables abstracted included snake type, bite site, time to presentation/antivenom, laboratory values, fasciotomy parameters, and hospital course. Descriptive statistics, standard deviations, bivariate analyses, and interrater reliability scores were determined.
Results: Of 17,133 reported snakebite patients, 117 (0.68%) fasciotomies were performed. Males accounted for 95 (81.2%) fasciotomy patients and 10,723 (62.6%) non-fasciotomy patients ($P < 0.0001$). Males were 2.6 times [1.63 – 4.20] more likely to have had a fasciotomy than females. Fasciotomies were performed more commonly in patients aged 20 – 39 years (42; 35.8%). Rattlesnake and copperhead bites accounted for 56 (47.9%) and 19 (16.2%) of fasciotomies, respectively. Rattlesnake bites were 5.8 times [4.03 – 8.39] more likely to have a fasciotomy performed than other snakebites. Sixty-two of the fasciotomy sites (49.6%) were on the hand or finger, and 35 (28.0%) on the lower extremity (excluding the foot). A toxicologist was consulted on 27 (23.1%) fasciotomies either by phone (23) or bedside (4). To assess envenomation progression, physicians used clinical judgement without objective measurements in 86 (73.5%) cases, monitored/measured the leading edge of swelling in 48 (41%), asked the patient about pain in 27 (23.1%), and used the Snakebite Severity Score in one patient. Only 7 (6%) fasciotomy cases had compartment pressure measured. Antivenom was administered to 101 (86.3%) fasciotomy patients, of whom 92 (91.1%) received a mean of 12.4 total vials of Fab antivenom (*Crotalidae* Polyvalent Immune Fab (ovine), CroFab®), 4 (3.9%) received a mean of 20 total vials of $F(ab')_2$ (*Crotalidae* Immune F(ab')2 (equine), Anavip®), and 3 (2.9%) received an average of 16 total vials of both types of antivenom. Annually the number of non-fasciotomy snakebite exposure cases ($n = 17{,}016$) increased, while the fasciotomy snakebite exposure cases decreased by 60%. Fifteen (12.8%) fasciotomies were performed in 2004 ($P < 0.0001$), followed by an average of six per year. The relative risk of receiving a fasciotomy after a snakebite was 3.6 times higher if it occurred in 2004 compared to later years.
Conclusions: In our state fasciotomy for crotaline snakebite was uncommon and has declined since 2004. Concerningly, not all fasciotomy patients received antivenom.

KEYWORDS North American pit viper envenomation; fasciotomy; antivenom

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274. The true "CO"st of red meat

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Background: Carbon monoxide (CO) is a colorless, odorless, and tasteless gas produced by the incomplete combustion of carbon-based fuels. In meat packaging, it is used to preserve color and extend the shelf life by altering the composition of the gas surrounding the meat to slow down spoilage and maintain its visual appeal. This is referred to as modified atmosphere packaging. We describe a series of 16 patients from a workplace carbon monoxide exposure at a meat packaging facility.
Case series: Emergency response was dispatched to a local meat packaging facility at 13:46 after workers were exposed to a "chemical" resulting in multiple syncopal events within 20 minutes. Incident command was established and the first reading of CO at the building's entrance was 123 parts per million (ppm). The production room, where the CO originated, had immeasurable levels of +499 ppm. The building was evacuated, ventilated, and the source identified. The incident was resolved at 16:43 with production room CO reading at 26 ppm. Sixteen patients were transported to an emergency department for treatment of CO poisoning. The poison center was contacted at 14:32 upon arrival of the first patient, and recommendations were made regarding labs, monitoring parameters, and keeping all patients on 100% oxygen via non-rebreather or high-flow nasal cannula. Everyone received 100% oxygen, EKGs and troponins were normal, and only patient #13 had an elevated lactate of 4.3 mmol/L. Eight patients were considered high risk for delayed neurologic sequelae and received HBO. As chambers were limited, two patients needed to be transferred to receive HBO in a timely manner. All patients' symptoms resolved either by discharge or by the end of their first HBO session.
Discussion: Carbon monoxide is responsible for hundreds of deaths and tens of thousands of ED visits each year in the United States. Most occupational exposures to CO occur in proximity to the burning of a carbon-containing fuel; this exposure was in an environment that purposefully utilized CO in operations, one that is rarely considered as source of CO exposure. OSHA's permissible exposure limit is 50 ppm as an 8-hour time-weighted average. In this event, the measured CO exceeded the range of the fire department's detector (maxed at 499 ppm) but considering the workers in the production area developed symptoms rapidly (under 30 minutes), it is likely levels were as high as 2500–3000 ppm. Though it was known CO was being used at this plant, there is no evidence that CO detectors were in place. The resulting mass casualty incident stressed the local hospital's capacity. Specifically, while the accepting facility did have HBO chambers, the large number of patients was more than the hospital could dive within a reasonable window, requiring adequate communication and coordination for transfer.
Conclusions: Carbon monoxide is an important and underappreciated occupational exposure risk for workers in the meat packaging industry that has the potential to cause mass casualty incidents that warrant specific preparation.

KEYWORDS Carbon monoxide; occupational; hyperbaric oxygen

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275. A case of severe lead encephalopathy with cardiac arrest managed during a chelation shortage

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Background: For many years, the standard of care in the United States has been to treat acute lead encephalopathy with a combination of intramuscular (IM) dimercaprol (BAL) and IM or

intravenous (IV) $CaNa_2EDTA$. FDA-approved $CaNa_2EDTA$ remains on long-term shortage, and the sole US manufacturer of BAL ceased operations earlier this year. Few reports offer safe and effective chelation alternatives when circumstances preclude the use of the standard 2-drug chelation. We present a case of a pediatric patient with severe lead encephalopathy, complicated by cardiac arrest, who was treated with an alternative regimen when $CaNa_2EDTA$ was unavailable.

Case report: A 24-month-old male presented to an emergency room (ER) with new onset seizures and depressed mental status. He was intubated on arrival to the ER. During intubation, he sustained a cardiac arrest and required multiple rounds of CPR before achieving ROSC. His post-ROSC vital signs were as follows: BP 92/41 mmHg; HR 104 bpm; T 99.1° F; O2 Sat 100% (on 40% FiO_2). A head CT was unremarkable. A CT of his abdomen noted radiopaque materials in the small bowel. Laboratory analysis was significant for a hemoglobin of 5.7 mcg/dl, iron concentration of 54 mcg/dl, and basophilic stippling on a peripheral smear. The medical toxicology service recommended whole bowel irrigation and empiric chelation with BAL and $CaNa_2EDTA$, pending results of a venous blood lead level. Unfortunately, the hospital was unable to obtain $CaNa_2EDTA$ due to the nationwide shortage. Compounding of $CaNa_2EDTA$ was recommended but it was initially not permitted due to a hospital restriction. For this reason, IM BAL and succimer (via nasogastric tube) was recommended. The initial blood lead concentration returned after several days' delay at 263 mcg/dl with an elevated zinc protoporphyrin. The patient was chelated with BAL IM for twelve days and succimer for 28 days. He received a second five-day course of BAL due to rebounding blood lead concentrations. Permission was eventually received to compound and administer $CaNa_2EDTA$. He remained encephalopathic even after receiving $CaNa_2EDTA$ and he had spastic hypertonia throughout. He was successfully extubated on hospital day 10. An MRI obtained on hospital day 6 was suggestive of anoxic leukoencephalopathy. He was ultimately discharged with a blood lead concentration of 46.2 mcg/dl and was continued on succimer by gastric tube as an outpatient.

Discussion: The combination of succimer and BAL was effective in rapidly decreasing whole blood lead concentrations. Expectedly, rebounding of whole blood lead concentrations were noted in the time periods where succimer was used alone after BAL was discontinued. Our patient had no significant improvement in encephalopathy with this combination therapy but his course was complicated by anoxic brain injury which likely contributed to his encephalopathy.

Conclusions: Drug shortages continue to have significant implications for the management of poisoned patients. This case highlights how shortages of chelating agents dramatically complicate patient care.

KEYWORDS Lead encephalopathy; drug shortages; chelation

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276. Treatment of ocular palytoxin exposure with minimal injury despite high ocular pH

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Background: Palytoxin (PTX) is an extremely potent marine toxin capable of causing severe illness or death in humans. In marine species, the toxin functions as a chemical defense that inhibits the sodium-potassium ATPase thereby disrupting ion gradients, causing profound vasoconstriction, and leading to cell death; corneal epithelium is particularly susceptible to these toxic effects. Ocular exposure to PTX can present with pain and conjunctival irritation and may progress to keratoconjunctivitis, iritis, or corneal perforation.

Case report: An otherwise healthy 27-year-old contact lens wearing male presented to the ED approximately 1 day post ocular exposure to PTX from coral in his home aquarium. He experienced immediate burning eye pain, blurred vision, and progressive conjunctival injection and edema. Following the exposure, the patient dabbed the eye with a damp towel, removed his contact lens, and went to sleep. He presented to the ED the subsequent evening. Ophthalmology was consulted and the patient was found to have 2+ conjunctival injection, visual acuity of 20/50, and a pH of 9 in the affected eye. Intraocular pressure, visual fields, anterior and posterior examinations were normal, and there was no evidence of corneal defect. The patient's eye was irrigated with 5 L of NS using Morgan Lens with improvement in the pH to 7–8. Following irrigation, ocular lubricant drops, prednisolone drops, and erythromycin ointment were applied. The patient was discharged home with prescriptions for each of these medications and a plan to follow up in the cornea clinic in 1–2 days. On patient follow up, he reported completion of the prednisolone and erythromycin drops although he did not follow up with ophthalmology. He endorsed complete symptom resolution and a return to baseline visual acuity by 3 days post discharge.

Discussion: This case details the clinical course and treatment of an ocular PTX exposure with an initial pH that was higher than others previously documented in the literature. It is unclear if this alkalinity represents a higher toxic exposure, or if other factors such as contact lens usage or prolonged time to presentation, could have contributed. Regardless, early irrigation and normalization of ocular pH is crucial to remove as much residual toxin as possible and to prevent further cornea damage. Although topical steroids can contribute to delayed corneal healing, anti-inflammatory effects appear to prevent the progression to corneal perforation. In addition, topical antibiotics are important in cases of PTX exposure in preventing secondary bacterial infections. Despite a delay to presentation and an elevated pH on presentation, this patient obtained a positive clinical outcome with appropriate treatment.

Conclusions: PTX is a toxic compound that can cause severe ocular damage. This toxin can be found in a variety of marine corals, and poses an underrecognized risk to unsuspecting home aquarium enthusiasts. In this case, a delay to care did not lead to poor outcomes once treatment was initiated. Further the degree of alkalinity associated with the exposure does not appear to correlate with the severity of the toxicity.

KEYWORDS Palytoxin; ocular; alkalinity

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277. Stingray injuries treated at emergency departments

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Background: Stingrays are large, flat fish with whip-like tails found in the shallow intertidal areas of tropical to warm temperate oceans. One to two dozen stingray species are found along the United States (US) coast. Stingrays have one or more venomous, serrated barbs on the dorsal aspect of their tails. Stingray injuries typically induce immediate intense pain, edema, discoloration, and bleeding. Systemic clinical effects may include nausea, vomiting, diarrhea, headache, fever, chills, seizures, generalized edema, muscle cramping, tremors, weakness, limb paralysis,

hypotension, bradycardia, convulsions, and syncope. The objective of this study was to describe stingray injuries treated at US hospital emergency departments (EDs).
Methods: Data were obtained from the National Electronic Injury Surveillance System (NEISS), a database of consumer product-related injuries collected from a representative sample of approximately 100 US hospital EDs. National estimates are calculated from database records according to the sample weight assigned to each case based on the inverse probability of the hospital being selected for the NEISS sample. To identify stingray injuries reported during 2000–2021, all records with the letter combinations "sting" and "ray" mentioned in the narrative were reviewed, and those that appeared to be stingray injuries were included in the study. The distribution of estimated stingray injuries was determined for various factors.
Results: A total of 1,009 stingray injuries were reported to a sample of US hospital EDs during 2000 – 2021, resulting in an estimated 66,894 such injuries. The mean estimated annual number of stingray injuries was 8,750 during 2000 – 2005, 1,473 during 2006 – 2011, 517 during 2012 – 2016, and 595 during 2017–2021. There were 3,976 (5.9%) estimated injuries reported during December - February, 17,961 (26.8%) during March – May, 27,403 (41.0%) during June – August, and 17,554 (26.2%) during September – November. The activity associated with the stingray injury was 57,105 (85.4%) swimming, 7,191 (10.8%) fishing, 1,434 (2.1%) surfing and related activities, 616 (0.9%) other, and 548 (0.8%) unknown. Patient age distribution was 1,029 (1.5%) 0 – 5 years, 6,949 (10.4%) 6 – 12 years, 8,657 (12.9%) 13 – 19 years, 9,722 (14.5%) 20 – 29 years, 11,626 (17.4%) 30 – 39 years, 13,408 (20.0%) 40 – 49 years, 8,477 (12.7%) 50 – 59 years, 5,317 (7.9%) 60 – 69 years, 1,573 (2.4%) 70 – 79 years, and 136 (0.2%) 80+ years; 40,929 (61.2%) patients were male and 25,965 (38.8%) were female. The incident location was 52,998 (79.2%) place of recreation or sports, 12,995 (19.4%) other public property, 166 (0.2%) home, 68 (0.1%) street or highway, and 668 (1.0%) not recorded. Patient disposition was 66,305 (99.1%) treated or examined and released, 492 (0.7%) treated and admitted for hospitalization, 6 (0.0%) held for observation, and 91 (0.1%) left without being seen/against medical advice. The most frequently reported diagnoses were 59,814 (89.4%) puncture, 1,924 (2.9%) laceration, and 1,446 (2.2%) foreign body. The affected body part was 59,119 (88.4%) lower extremity, 7,097 (10.6%) upper extremity, 600 (0.9%) trunk, and 78 (0.1%) other/unknown.
Conclusions: Stingray injuries were seasonal, with the highest proportion occurring in June–August. Patients 20–49 years accounted for 52.0% of the estimated injuries, and most patients were male. The majority of patients were treated or evaluated at the ED and released.

KEYWORDS Stingray; swimming; intense pain

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278. Sudsy misadventures: profound metabolic acidosis following intentional ingestion of surfactant-containing products in adults

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Background: Ingestion of surfactant-containing products and detergents are a source of common consultation for toxicologists. While occasionally problematic in children, they are generally benign in adults. This case highlights two presentations of profound metabolic acidosis associated with soap product ingestion.
Case series: Case 1: A 52-year-old male with a remote history of liver transplantations, on immunosupressants presented to the emergency department (ED) three hours after ingesting 16 ounces of Tide™ high-efficiency laundry detergent, whiskey, and one beer in a suicide attempt. Over the next four hours in the ED, he developed a metabolic acidosis with a serum pH of 7.02, bicarbonate of 11 mmol/L, and lactic acid of 11.1 mmol/L. Laboratory testing for toxic alcohols was negative; tacrolimus concentration was within normal limits. Flatulence and eructation with a characteristic laundry detergent smell were present until the patient was ultimately intubated for declining mental status. Computed tomography of the abdomen demonstrated diffuse mucosal small bowel and colonic enhancement consistent with acute, severe inflammation. Despite resuscitation and eventual continuous renal replacement therapy (intermittent dialysis attempted but unable to complete secondary to shock), his acidosis worsened and he ultimately died. Case 2: A 33-year-old woman consumed ⅔ of a gallon of Softsoap™ Advanced Clean hand soap (containing amide oxide surfactants) in search of ethanol, ultimately presenting to the emergency department mottled and ill appearing, with more than thirty episodes of sudsy and frothy soap-scented diarrhea. Exam revealed obtundation, motting, and initial BP of 50/30 mmHg and a patient covered in soapy, frothy emesis. Ethanol and toxic alcohol concentrations were undetectable. Venous pH nadired at 7.09, and laboratory investigations further revealed prerenal azotemia with bicarbonate nadir of 12 mmol/L and creatinine of 2.2 mg/dL. Aggressive administration of isotonic bicarbonate and three liters of lactated ringers with the use of norepinephrine for distributive shock ultimately corrected the acidosis and hemodynamic instability in approximately six hours.
Discussion and conclusions: Ingestion of surfactants including ethoxylated alcohols and amide oxides can result in profound metabolic acidosis from gastrointestinal losses, irritant inflammation leading to third spacing, and various other mechanisms. The optimal resuscitation strategy is not well defined but may include the use of crystalloids, vasopressors, and extracorporeal removal of endogenously produced organic acids. Toxicologists should be vigilant for rapid progression of a metabolic acidosis in these ingestion scenarios.

KEYWORDS Surfactant; detergent; soap

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279. They may be rare, but are they definitely scary? A case series of 5-fluorouracil and capecitabine managed by a regional poison center

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Background: 5-fluorouracil (5-FU) is a fluoropyrimidine anticancer drug that inhibits thymidylate synthase, preventing the production of nucleic acids essential for DNA replication and repair, which ultimately inhibits RNA and DNA synthesis. 5-FU also can be incorporated in place of uracil or thymidine, compromising genomic function. Capecitabine is an orally bioavailable prodrug to 5-FU. Toxicity can develop after overdose (due to therapeutic error, self-harm, or exploratory ingestion) or can occur after therapeutic dosing in patients with a genetic predisposition. Uridine triacetate (UT) is an oral antidote that may improve survival in fluoropyrimidine toxicity. UT is a pyrimidine analog that competitively antagonizes the effects of 5-FU or capecitabine. It was FDA approved in 2016 based on two unpublished open-label studies. The indications for UT are not well-defined, but one group has published a nomogram

based on the total dose (in mg) and the dosage rate (in mg/hr). UT is expensive ($75,000 per course) and has not been compared prospectively to standard of care. The goal of this case series is to describe the 5-FU and capecitabine cases reported to our regional poison center (RPC).
Methods: We queried parenteral 5-FU and all capecitabine cases reported to our RPC from 1 January 2010 through 31 December 2022. Data of interest included demographics, intent, dose, number of pump malfunctions, UT utilization, oncology collaboration, use of the nomogram, and outcome.
Results: Fifteen cases of 5-FU or capecitabine toxicity were reported to the RPC, eight 5-FU & seven capecitabine. Ages ranged from 21 months to 81 years. For 5-FU cases, the majority were therapeutic errors with 3 patients having pump malfunctions. The majority of capecitabine patients (6, 75%) took extra doses inadvertently. One pediatric patient (21 months) potentially ingested up to 15 capecitabine 500 mg tablets belonging to the grandmother. Doses ranged from 1800 to 7240 mg for 5-FU and 500 – 7500 mg for capecitabine. UT was administered 4 times (three 5-FU and once for the pediatric capecitabine patient). Oncology collaboration occurred 11 times and included all patients receiving UT. The published nomogram relating dose and infusion rate to estimate risk was referred to in 50% of 5-FU cases. The nomogram predicted severe toxicity or lethality for all pump malfunction cases. Of the four patients in which the nomogram recommended UT, three received it. The fourth patient suffered minor effects only. No fatalities occurred in this series, although one patient (an inadvertent large 5-FU overdose after pump malfunction who received UT) developed myelosuppression.
Conclusions: 5-FU and capecitabine cases are rarely reported to our RPC. Oncological collaboration was requested in 73% of cases, ranging from requesting follow-up to UT administration. Oncologists may be managing these cases independently, as no oncologist called for medical toxicology input. UT was used selectively in our series. Referencing the published nomogram was useful to determine when UT was recommended. The cases with the highest predicted toxicity occurred as a result of pump malfunctions, generally received UT, and generally had favorable outcomes.

KEYWORDS 5-Fluorouracil; capecitabine; uridine triacetate

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280. Acute respiratory distress syndrome secondary to occupational chlorine gas exposure

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Background: Chlorine gas is an intermediately soluble pulmonary irritant which when inhaled creates a spectrum of upper and lower respiratory tract symptoms depending on the concentration and volume of exposure. We report a severe case of occupational exposure to chlorine gas.
Case report: A previously healthy 48-year-old male was found down at water treatment plant after copious chlorine gas and industrial bleach exposure for an unknown length of time. Per EMS the patient's oxygen saturation was 58% on room air which improved to 86% on 15 L oxygen via non-rebreather mask. He was not decontaminated on scene and was wearing porous garments saturated with the chemical creating ongoing exposure. Upon arrival to a small community emergency department (ED), the patient was in respiratory distress with hypoxia, tachypnea, bilateral coarse breath sounds, crackles, and end expiratory wheezing. Initial need for decontamination was complicated by the patient's simultaneous critical care needs. He was taken to a patient care area to be placed on BiPAP for pre-oxygenation before transport to the decontamination room for garment removal and water irrigation. After decontamination, the patient's oxygen saturation remained in the 80's and the patient was intubated; copious frothy secretions, airway edema, and bronchospasm complicated the procedure. The patient developed acute respiratory distress syndrome (ARDS) requiring 100% FiO2 and PEEP of 16 to maintain oxygen saturation $>$ 90% and vasopressors were needed for post-intubation hypotension. Initial chest radiography demonstrated bilateral interstitial infiltrates. Labs showed a pH of 7.15, lactate of 10.3 mmol/L, and leukocytosis. In the intensive care unit, nebulized sodium bicarbonate therapy was administered every 6 hours for the first 24 hours, in addition to corticosteroids and bronchodilators with worsening bilateral lung infiltrates on chest radiography. Attempts to transfer for VV-ECMO evaluation were unsuccessful. As the patient gradually improved and ventilator settings were being weaned the patient self-extubated on day 7. He was quickly reintubated given inability to tolerate BIPAP. He was successfully extubated on day 9 and continued to receive bronchodilators and supplemental oxygen until discharge to an inpatient rehabilitation facility on day 16.
Discussion: Chlorine gas reacts with water in the respiratory tract to form both hypochlorous and hydrochloric acids as well as reactive oxygen species. Nebulized sodium bicarbonate is proposed as a therapy to neutralize acids formed after inhalation. This therapy is likely futile in high volume and high concentration exposures, as demonstrated in this patient. While decontamination is important in chemical exposures, there can be discord between theories of ideal hospital-based decontamination and practicality at a small community ED, where even a single chemical casualty scenario can overwhelm the hospital. Using an 'as low as reasonably achievable' approach to decontamination techniques is preferred in such scenarios, like simply disrobing the patient prior to entry into patient care areas. It also cannot be assumed that pre-hospital decontamination will be performed.
Conclusions: Severe chlorine gas exposures can lead to rapid development of ARDS where nebulized sodium bicarbonate may be futile in such patients with significant exposures. Decontamination challenges may arise in chemical exposures.

KEYWORDS Chlorine gas; acute respiratory distress syndrome; decontamination

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281. Successful treatment of *Echis carinatus sochureki* envenomation with Inoserp Pan-Africa antivenom

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Background: *Echis carinatus sochureki,* a subspecies of saw scaled viper, is a venomous snake endemic to India. In its native range, envenomations by *E. c. sochureki* are often treated with Indian polyvalent antivenom. However, there have been multiple cases reported in the literature of *E. c. sochureki* envenomations causing venom induced consumptive coagulopathy with poor response to Indian polyvalent antivenom. In this case report, we detail successful treatment of envenomation by *E. c. sochureki* with Inoserp Pan-Africa.
Case report: A 44 year old Caucasian male presented to an outside facility after he was bitten on the left index finger at 1200

by his saw-scaled viper, *Echis carinatus sochureki.* He was transferred to our facility for management. After arrival to our emergency department, the patient reported a hemorrhagic bulla and swelling in the affected finger as well as pain radiating up the left arm. No vials of Inoserp MENA, which specifically treats envenomation by *E. c. sochureki,* were available locally. The decision was made to treat the patient with Inoserp Pan-Africa, which was available locally, and which treats bites by three related species of *Echis.* Notably, this patient had received CroFab® five years prior for another snake bite. After infusion of 2 vials of Inoserp Pan-Africa was initiated, the patient began to experience itching in the armpits and groin, as well as a non-pruritic facial rash and chest pressure. However, he denied shortness of breath or wheezing. The infusion was stopped and the patient was given 50 mg diphenhydramine and 125 methylprednisolone. The infusion was later resumed, and the patient tolerated it well. A second round of 2 vials of antivenom was given at 0300 on hospital day 2 after evaluating the patient's coagulation labs. The morning of hospital day 3, the patient reported complete resolution of all symptoms except for the hemorrhagic bulla on his finger and his labs had displayed improvement. He was subsequently discharged. Labs obtained on day 8 of illness demonstrated further normalization of his coagulation factors.
Discussion: *Echis carinatus sochureki* bites are an important cause of medical morbidity and mortality. Indian polyvalent antivenom, often used for bites by this snake, does not always reverse the consumptive coagulopathy caused by the venom. Though Inoserp Pan-Africa is not specifically approved for treatment of *E. c. sochureki* envenomation, it effectively reversed this patient's coagulopathy. Also of note is that this patient developed an allergic reaction to the antivenom. If this happens, the infusion should be temporarily stopped, and medication for anaphylaxis given if needed. Infusion should then be restarted at a slower rate.
Conclusions: *Echis carinatus sochureki* bites are an important cause of morbidity and mortality in the snake's native habitat. Indian polyvalent antivenom, commonly used for envenomations by this subspecies, does not always reverse the coagulopathy caused by envenomation. In addition to Inoserp MENA, Inoserp Pan-Africa is a potential treatment option.

KEYWORDS Echis carinatus sochureki; saw-scaled viper; Inoserp Pan-Africa

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282. "False death cap" almost becomes "true death cap" - a case demonstrating the importance of species identification in *Amanita* mushroom ingestion

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Background: Mushroom identification of *Amanita* species is critical. For instance, *Amanita citrina* mushrooms contain muscimol and ibotenic acid. Expected toxicity would include hallucinations and seizure, while numerous *Amanita* species contain RNA-polymerase-inhibiting cyclopeptides and may result in hepatotoxicity. *Amanita citrina* shares physical characteristics with cyclopeptide-containing *Amanita* species and is known as the "false death cap." We present a case of severe hepatotoxicity after a mushroom ingestion initially identified as *A. citrina* that was likely misidentified.
Case report: A 65-year-old male ingested an unknown number of foraged mushrooms approximately two days before arrival at the hospital. Nausea, vomiting, and diarrhea started 6.5 hours after ingestion. Shortly after ED arrival, the Poison Center (PC) was consulted and recommended mycologist identification. Law enforcement went to the patient's home to take photos of the mushrooms, and the mycologist later identified the photos preliminarily as *Amanita citrina.* Prior to identification, PC recommended to trend transaminases and INR. Initial labs were: AST = 25 IU/L, ALT = 39 IU/L; acetaminophen was undetectable. Twenty-four hours later transaminases increased: AST = 707 IU/L, ALT = 652 IU/L. Nausea persisted, but he was otherwise feeling well. The patient never described hallucinations. Seizures were not observed. Within the first 24 hours of hospital presentation, he received four doses of multiple-dose activated charcoal, intravenous N-acetylcysteine, and one dose of 100,000 units of penicillin. Given the clinical trajectory, he was transferred to a liver transplant center. On hospital day (HD) 2, transaminases worsened: peak AST = 6,471, ALT = 7,480 IU/L, INR 2.08. Renal function remained normal. N-acetylcysteine was infused until HD4, when transaminases improved (AST = 932, ALT = 4,415 IU/L and INR 1.47). Symptoms resolved and he recovered without sequelae. After case conclusion, the photos were sent to a second mycologist who could not definitively identify the mushrooms. This mycologist thought *A. citrina* was unlikely and that a cyclopeptide-containing *Amanita* species was more likely, with the caveat that definitive identification could not be confirmed without a microscopic examination.
Discussion: *Amanita citrina* shares physical characteristics with cyclopeptide-containing *Amanita* species. Along with the annulus and volva, *A.citrina* is a fleshy-pale yellow (or white) mushroom, similar to *Amanita bisporigera* and *virosa*. Our patient developed signs and symptoms of cyclopeptide poisoning, but not those consistent with ibotenic acid or muscimol poisoning. It is likely that he was poisoned with either *Amanita bisporigera* or *virosa*. This case highlights potential pitfalls of mushroom identification. First, the mushroom identified is often *not* the mushroom consumed by the patient. Secondly, mushrooms are occasionally identified by someone returning to the scene of foraging and either taking a photo or procuring a second mushroom. In both cases this is *not* the mushroom consumed by the patient and could mislead caregivers as multiple species can grow in close proximity. Finally, unlike other medical subspecialties, PC mycologists do not have training per PC accreditation requirements, and interrater reliability among PC mycologists is poorly studied.
Conclusions: Amanita citrina, the "false death cap", may be mistaken for a cyclopeptide-containing Amanita mushroom, such as Amanita bisporigera or virosa. In equivocal cases, a cyclopeptide-containing mushroom should be assumed and treated accordingly.

KEYWORDS Mushrooms; Amanita; mycologist

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283. East Palestine, Ohio train derailment and chemical release disaster, February 2023

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Background: On 3 February 2023, a 149 car Norfolk Southern train derailed in East Palestine, Ohio due to an overheated wheel bearing. Thirty-eight railcars derailed, of which 11 containing hazardous chemicals ignited, damaging 12 non-derailed cars. The derailed cars contained vinyl chloride, ethylene glycol monobutyl

ether acetate, 2-ethylhexyl acrylate, isobutylene, *n*-butyl acrylate, and benzene. A 1-mile evacuation zone was implemented. Rising temperatures in 5 adjacent derailed tank cars carrying 115,580 gallons of vinyl chloride posed an explosion hazard. The evacuation zone was expanded, and a controlled vent and burn of the vinyl chloride occurred on February 6th. The lack of vinyl chloride detection supported safe air quality for residents to return on February 8th. Increased levels of particulate matter and smoke were however confirmed. Regional poison control centers (PCC) in Ohio and Pennsylvania began receiving calls on February 6th from patients and providers. America's Poison Centers (APC) issued an emergent product code to track all train derailment disaster calls on February 14th. Ongoing collaboration was initiated among public health partners to align resources and formulate best practices. Inclusion criteria for analysis was all calls reported to the National Poison Data System (NPDS) coded with the product code 7769528. Data extracted included patient age, gender, reason for exposure, management site, clinical effects, treatment, and medical outcome. In addition, all case narratives were reviewed. Data were analyzed by descriptive statistics.

Case series: A total of 261 documented cases were identified across 14 states of which 191 were exposures between 2/6/23 and 4/26/23. Most exposures reported were in adults (78%) and 58% were female. The primary route of exposure was inhalation (86%) followed by ingestion (19%) and dermal (14%). The majority (75%) were exposed in their own residence. Symptoms reported by order of incidence were headache, throat irritation, cough, ocular irritation, dyspnea, vomiting, nausea, dizziness, mild central nervous system depression, oral irritation, rash, diarrhea, chest pain and dermal irritation. Most exposures were not followed (63%) and of the known outcomes most were minor (14%), or moderate (11%) with 1 major outcome reported. Approximately 68% were seen in a healthcare facility.

Discussion: Callers inquired about symptoms they were experiencing as well as general questions regarding air quality, public water safety, personal well water safety, concerns about pets, livestock and agriculture. Callers often expressed concerns over lack of reliable information and difficulty trusting the various agencies that responded to the disaster. Healthcare providers asked for information on treatment including information on diagnostic tests, lab values and specific testing for chemicals. In addition, public health officials asked the regional Poison Centers to help gather information from callers for the After Chemical Exposure (ACE) survey to help supplement their door-to-door efforts.

Conclusions: Poison control centers play an immediate and vital role in disaster management. The general public and healthcare providers sought treatment recommendations and other information from PCCs following this environmental disaster. In addition to providing treatment recommendations, data collected by regional Poison Control Centers was critical in public health surveillance.

KEYWORDS Derailment; chemical; East Palestine

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284. Seven year analysis of sea surface temperatures and frequency of pelagic cnidarian stings reported to a single poison center

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Background: Deaths associated with *Physalia physalis* (Portuguese Man-O-War), are rare. Stings from *Physalia* generally cause morbidity in the form of irritating, slow-to-heal dermal lesions. Over the last fifteen years, the free-floating *Physalia* has spread widely into new waters. This is thought to be a manifestation of increasing sea surface temperatures. The purpose of this study was to evaluate reports of *Physalia* stings associated with measured sea surface temperatures reported to a regional poison center.

Methods: All cases involving marine animal bites and stings from Hawai'i reported to a single poison center from 2010 to 2022 were identified and evaluated. Cases without a listed species, those coded as terrestrial animals, corals, other non-jellyfish/non-siphonophore animals were excluded. Sea surface temperatures were obtained from the Pacific Islands Ocean Observing System (PacIOOS) Regional Ocean Monitoring System (ROMS), University of Hawai'i. PacIOOS ROM has retrievable water temperature data available from April 2015 – present.

Results: Two hundred thirteen cases were identified in 2010 – 2022 with 120 cases between 2015 and 2022. On average, 13 stings per month were reported with significant monthly variability. Fifty-eight of these cases were specifically coded as *Physalia* species. Annual water temperature in the seven-year study period was 25.9 °C, T_{min} 25.54 °C – T_{max} 26.4 °C. There is a statistically significant ($P = 0.039$) correlation between monthly water surface temperature and occurrence of *Physalia* stings; this correlation does not exist when all stings are considered.

Conclusions: There is a correlation between sea surface temperature and incidence of *Physalia* stings (but not Scyphozoan or Cubozoan stings) as reported to a single PC. On average 17.8 stings are reported per month over the study period with 28% of them associated with *Physalia*. One limitation is underreporting of stings reported as they are minor, daily occurrences for Hawaiian citizens and physicians. Hawai'i has profoundly unique ecology: land and water temperatures around Hawaii remain relatively constant throughout the year thanks to unique oceanographic features. Changes in water and land temperatures alter winds which may blow *Physalia* into new areas. *Physalia* is not the only toxic oceanic organism of concern. Phytoplankton develop into Harmful Algal Blooms (HABs) that have exploded in size and frequency in recent years. Ongoing study of sea temperature changes will be of continued importance to toxicologists.

KEYWORDS Jellyfish; Physalia; climate change

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285. Efficacy and impact of a medical toxicology rotation at a regional poison center: an assessment of virtual and in-person learning curriculums

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Background: Regional poison centers (PCs) are a source of high-quality toxicology education for learners in pharmacy and medical disciplines by offering medical toxicology (MT) rotations. Our PC has had an in-person MT rotation for over 30 years. However, in March 2020, the in-person rotation was stopped to comply

with SARS-CoV-2 pandemic restrictions. The rotation restarted virtually in October 2020, then converted back to an in-person rotation in July 2022. We designed a prospective survey study to assess the efficacy and impact of the virtual and in-person curriculums.
Methods: This prospective survey study of learners at our PC assesses our virtual and in-person MT rotation from October 2020 – June 2022 and July 2022 – present. Both rotations were held daily from 9AM to 3PM, Monday – Friday. Both curriculums included small group teaching by MT fellows, didactics (core lecture series, regional toxicology conference, and journal club), and case-based afternoon faculty teaching. Online surveys were solicited from the learners (via Alchemer®) prior to the rotation start ("PRE") and after the rotation ("POST"). The survey process of soliciting PRE and POST remained consistent between rotations. However, while all learners were asked to complete both surveys, responses were not linked. The PRE and POST surveys included questions with Likert scale, multiple choice, and open-ended responses. A HIPAA-compliant WebEx program was used for virtual teaching. This was an IRB-exempt study as determined by our institution.
Results: A total of 238 PRE responses (186 [virtual], 97 [in-person]); 174 total POST responses (136 [virtual], 38 [in-person]) were collected from 6 different US states, Canada, and the United Arab Emirates. Virtual rotation data collection occurred over 22 months, and in-person rotation occurred over nine months so far. Most survey respondents were emergency medicine residents; other specialties represented included pediatrics, pediatric emergency medicine, and internal medicine. Both PRE and POST participants were asked how competent they feel managing toxicology cases ("not," "somewhat," "competent," or "highly"); PRE rotation 17% (virtual) and 14% (in-person) responded highly or competent; POST rotation, 67% (virtual), 76% (in-person) responded highly or competent. PRE rotation, 20% (virtual) and 19% (in-person) reported they were "not competent"; POST rotation, 3% (virtual) and 0% (in-person) reported this. The highest yield aspects of the rotation for POST respondents were MT faculty teaching (41% virtual, 45% in-person) and fellow interactions (40% virtual, 26% in-person). Based on the POST, 90% (virtual), 100% (in-person) participants rated the rotation as "very effective" or "effective". Only 21% (virtual)/19% (in-person) of PRE respondents reported contacting their regional PC "frequently." In the POST survey, 74% (virtual), 87% (in-person) said they were "highly likely" to contact their regional PC for toxicology cases.
Conclusions: Based on this survey study performed in both the virtual and in-person settings, our MT rotation appears to be efficacious and positively impactful regardless of setting. It improved learners' self-perceived competence in MT and may improve regional PC case reporting. Further study is necessary to determine whether these effects are long-lasting and whether the format of the MT rotation (virtual vs. in-person) matters for these outcomes.

KEYWORDS Education; virtual; curriculum

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286. Acute poisoning from tolfenpyrad-based insecticide

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Background: Tolfenpyrad, a pyrazole-5-carboxamide derivative, is a relatively new class of insecticides developed in Japan and first approved in 2002. To date, it has been available in many countries including the United States of America and Thailand. Tolfenpyrad acts as an inhibitor of Complex I of the mitochondrial respiratory chain in animal models, which makes it effective against a broad range of pests. Data on tolfenpyrad exposure in humans are limited, and there are few reports of tolfenpyrad poisoning only in Japan. Anecdotally, our poison center has noted an increased number of fatalities from this compound over the last several years. The purpose of this study was to better understand the toxicity profile of tolfenpyrad-based insecticide.
Methods: This was a retrospective study that reviewed cases of tolfenpyrad exposure who were referred and consulted to a single poison center between January 2012 and December 2022. The diagnosis of tolfenpyrad poisoning was based on a history of insecticide exposure with information on the brand name and/or the patients brought the product containers with them to the hospital. The demographic and clinical characteristics, treatments, and outcomes were summarized using descriptive statistics. Exclusion criteria were non-human exposures and calls to request information.
Results: A total of 7 patients were identified in the 11-year period. There was no report of tolfenpyrad exposures before 2012. Between 2012 and 2019, there were only four exposures and from 2020 through 2022, three exposures. Most patients (71.4%, 5/7) were male and had ingested tolfenpyrad deliberately (42.9%, 3/7). The median age was 33 years old (range 1 to 46 years). All patients with oral exposure (57.1%, 4/7) developed severe systemic effects at presentation including depression of consciousness ($n = 4$), cardiac arrest ($n = 1$), hypotension ($n = 4$), bradycardia ($n = 2$), and high anion gap metabolic acidosis ($n = 4$). The median time from exposure to presentation at a hospital was 30 minutes (range 15 to 60 minutes). Management mainly included symptomatic and supportive care. However, all patients who ingested tolfenpyrad died eventually. Among the four deaths, one was a 1-year-7-month-old girl who ingested accidentally and presented with cardiac arrest. Three of these patients died within 6 hours after ingestion. The remaining one died on the thirteenth day of hospitalization. Of the three patients exposed to the substance via inhalation and dermal route, all developed only mild clinical effects and were ultimately discharged after supportive care.
Conclusions: Poisoning with tolfenpyrad insecticide is uncommon but is potentially fatal. Significant toxicity of tolfenpyrad can develop rapidly following oral exposure. The mortality from this poisoning was very high. All patients with history of tolfenpyrad ingestion should be closely monitored and aggressively treated. The ability to recognize and identify tolfenpyrad poisoning and manage promptly are crucial to medical providers. Public education is essential to improve poison prevention and minimize toxicity. Moreover, larger scale studies are warranted to identify significant predictors of severity and specific treatment among tolfenpyrad poisoned patients.

KEYWORDS Pyrazole insecticide; insecticide poisoning; fatalities

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287. Prediction of the eight common acute poisoning agents based on clinical features using Deep Neural Network (DNN) derived from the National Poison Data System (NPDS)

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Background: Acute poisoning is a significant global health burden, and the causative agent is often unclear. The primary aim of this pilot study was to develop a deep learning algorithm that predicts the most probable agent a poisoned patient was exposed to from a pre-specified list of drugs.
Methods: Data were queried from the National Poison Data System (NPDS) from 2014 through 2018 for eight single-agent poisonings (acetaminophen, diphenhydramine, aspirin, calcium channel blockers, sulfonylureas, benzodiazepines, bupropion, and lithium). Two Deep Neural Networks (PyTorch and Keras) designed for multi-class classification tasks were applied.
Results: There were 201,031 single-agent poisonings included in the analysis. For distinguishing among selected poisonings, PyTorch model had specificity of 97%, accuracy of 83%, precision of 83%, recall of 83%, and an F1-score of 82%. Keras had specificity of 98%, accuracy of 83%, precision of 84%, recall of 83%, and an F1-score of 83%. The best performance was achieved in the diagnosis of single-agent poisoning in diagnosing poisoning by lithium, sulfonylureas, diphenhydramine, calcium channel blockers, then acetaminophen, in PyTorch (F1-score = 99, 94, 85, 83, and 82%, respectively) and Keras (F1-score = 99, 94, 86, 82, and 82%, respectively).
Conclusions: Deep neural networks can potentially help in distinguishing the causative agent of acute poisoning. This study used a small list of drugs, with polysubstance ingestions excluded. The clinical utility is untested, and with further development, this may become a diagnostic aid for clinicians without a background in toxicology who care for poisoned patients with unreliable histories. Reproducible source code and results can be obtained at https://github.com/ashiskb/npds-workspace.git.

KEYWORDS Poisoning; PyTorch; Keras

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288. Panic at the prison: a case series of correctional facility staff exposed to a mysterious white powder

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Background: Recent news articles and social media videos have depicted police officers and community members displaying non-opioid toxidromes after skin or minor aerosol exposure to presumed fentanyl. These videos often depict hyperventilation with a return to baseline after multiple doses of intranasal naloxone. Given the respiratory depressant effects of opioids, these symptoms are unlikely to be a result of an opioid overdose and more closely resemble psychomotor agitation. We report a case series of multiple correctional facility staff with occupational exposure to a mysterious white powder and the symptoms staff developed.
Case series: A regional poison center received calls from multiple hospitals about a potential mass exposure event at a correctional facility. The report from the correctional facility was that an inmate having a medical incident was noted to have a white powder covering parts of his skin. Shortly after noting the white powder, multiple correctional facility officers responding to the incident, some having touched the patient, began exhibiting inconsistent and varying symptoms including hyperventilation, decreased alertness, headache, tingling in the hands and face, and "out of body experiences." On-site medical staff responded and administered intranasal naloxone which resolved symptoms in about half of the staff. Additional correctional facility staff who responded to the incident, including medical staff, then began exhibiting similar symptoms themselves and further intranasal naloxone was administered. A health alert was placed to send all available intranasal naloxone in the region to the correctional facility. All correctional facility staff with symptoms were sent to local emergency departments for evaluation. Over the course of hours, three hospitals received a total of 20 patients with either no symptoms or previously mentioned symptoms. Vital signs were mostly normal with few having tachycardia or hypertension. No patients were noted to have somnolence, bradypnea, or miosis. Workup in the emergency department was minimal and varied from each hospital. One hospital sent urine drug screen testing from all patients which were negative. One hospital elected to administer intravenous naloxone to all patients with no significant improvement noted. All patients were observed for varying amounts of time until complete resolution of symptoms. State police hazardous materials team investigated the exposure and tested the white powder as well as a liquid in a bottle labeled 'nasal spray' also found at the scene. MX-908 mass spectrometry testing was completed and found no controlled or potentially hazardous materials in the powder (aluminum phosphate) or liquid.
Discussion: Misinformation indicating that skin or minor aerosol exposure to fentanyl can be deadly is common among police officers and other members of the law enforcement community. This misinformation can lead to inappropriate precautions, delayed or inappropriate response to emergencies, and symptoms inconsistent with exposure. In this series, the constellation of inconsistent symptoms, various routes of exposure, and

relatively harmless precipitant are consistent with a mass psychogenic illness.
Conclusions: Concerns over fentanyl exposure can inappropriately lead to the deployment of significant and often inappropriate resources. Education is needed on the routes of opioid absorption, toxidrome recognition, and appropriate use of naloxone.

KEYWORDS Misinformation; toxidrome recognition; education

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289. Assessing perceived workload at a regional poison center – NASA TLX analysis

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Background: AAPCC accreditation standards require a poison center to manage a certain annual case volume of human exposures per CSPI/SPI/PIP FTE. This standard acts as a measure of poison center workload and may influence funding for certain poison centers. Though case volume decreases nationwide, cases become more complex often requiring more time and effort. Perceived workload is a worker's view of the amount of effort required to successfully complete a task. Objective workload measures (case volume) may not comprehensively depict the impact of perceived workload on staff performance and needs. We report the perceived workload of poison call center staff from one regional poison center.
Methods: We utilized the National Aeronautics and Space Administration Task Load Index (NASA TLX) to measure the perceived workload of SPIs and PIPs staffing the 24-hour emergency hotline at one regional poison center. Each participant completed three questionnaires per shift (start, middle, and finish) over 2 weeks in May 2022. All submitted questionnaires were aggregated and analyzed using descriptive statistics. Results are reported as median and interquartile ranges.NASA TLX is validated for high-stress jobs in the healthcare setting. NASA TLX assesses six subjective dimensions (mental demand, physical demand, temporal demand, performance, effort, and frustration) each with a possible score of 0–9 with 0 being the lowest score.
Results: During our 2-week study period, we had a response rate of 90.5%. The median score for each NASA TLX dimension was: mental demand 4.5 (IQR 3 – 6), physical demand 1 (IQR 0 – 3), temporal demand 5 (IQR 3 – 7), performance 7 (IQR 6 – 8), effort 5 (IQR 3 – 7), and frustration 2 (IQR 0.25 – 5).
Conclusions: We successfully used the NASA TLX instrument to characterize the perceived workload of one regional poison call center's staff. Mental demand, temporal demand, and effort were all mid-range. Performance was relatively high and frustration was relatively low. All dimensions except for performance, however, had a range encompassing all possible scores indicating large variability. As there are presently no benchmarks for accep perceived workload, these results do not provide insight into current working conditions; however, when used as a baseline comparator, these results can determine the impact of operational changes (text/chat platform, staffing strategies) or changes in work complexity on staff perceptions. Such information may be beneficial in guiding future operational changes when evaluating staffing needs.

KEYWORDS Perceived workload; poison center

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290. Poison call center occupancy under current AAPCC accreditation standards

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Background: AAPCC accreditation standards require a poison center to manage 2,000–5,500 human exposures per CSPI/SPI/PIP FTE annually. This standard acts as a measure of poison center workload; however, as case volume decreases nationwide, poison call centers remain busy. Occupancy is another measure of workload that describes the proportion of time managing a case either directly or indirectly (case documentation, research). Occupancy is recommended by other call center industries at $\leq$85% to minimize poor work quality and employee burnout. Our study characterizes the occupancy of one regional poison center under current accreditation standards.
Methods: Call center workload was assessed using a self-reported work sample model over 2-weeks in August 2022. Utilizing sampling generation devices, participants were randomly signaled 6–8 times/hour during their shift to document their current activity on a data collection form. Predetermined activities included direct clinical work (initial and follow-up calls), indirect clinical work (case documentation, research, quality assurance), mentoring (SPI-to-PIP consultation), administrative work (work email, scheduling), and breaks/idle time. All SPIs/CSPIs and PIPs staffing the 24-hour emergency hotline were included. PIPs and rotating learners providing longitudinal follow-up were not included. Data collection forms were aggregated and analyzed using descriptive statistics. Minute per case was calculated by dividing the total estimated minutes worked by all participants in a category by the number of relevant cases.
Results: During the 2-week study period, our response rate was 88.1%. Our call center managed 1,829 total cases and 1,602 human exposures equating to an approximate annual rate of 2,415 human exposures per SPI/CSPI/PIP FTE. Our estimated occupancy was 87.5%. The proportion of time spent on each broad category was direct clinical work (37.6%), indirect clinical work (40.1%), mentoring (5.6%), administrative work (4.2%), and breaks/idle time (12.5%).The proportion of time spent on direct clinical work subcategories included initial exposure calls (20.9%), follow-up calls (15.0%), information calls (0.9%), and on-call consultation (0.7%). The proportion of time managing initial calls for unintentional exposures was 17.1% compared to 3.4% for intentional calls. The proportion of time conducting follow-ups however was 6.2% for unintentional exposures compared to 8.7% for intentional exposures. The proportion of time spent on indirect clinical work subcategories included case documentation/coding (31.6%), research (3.9%), and quality assurance (3.3%).
Conclusions: Case volume alone may inadequately represent poison call center workload. Our estimated annual human exposures per CSPI/SPI/PIP FTE was at the lower end of AAPCC accreditation standards (2,415). Meanwhile, our occupancy was greater than recommendations from other call center industries (87.5%). Confining AAPCC call center staffing accreditation standards to case volume alone may limit poison centers' ability to provide quality patient care or produce quality data for NPDS. Such accreditation standards may additionally place indirect restrictions on poison center funding for staffing and result in poison specialist burnout. More research is warranted to determine additional measures that more comprehensively describe poison center workload to support poison center work.

KEYWORDS Occupancy; workload; poison center

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291. First responders' narratives of passive fentanyl exposure: a qualitative analysis and guide for dispelling misinformation from recognized authorities

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Background: One objective of poison centers is to offer vetted poison information to the public. This venture is complicated when poison center messaging must compete with misinformation from other recognized authorities. This discussion proposes that there is value in evaluating misinformation through the lens of urban legend theory. One of the main tenets of urban legend analysis is to look for themes within a collection of narratives. This study will review news articles that report on the incidents of passive fentanyl exposure as told by first responders. Applying qualitative coding and thematic analysis will elucidate social issues that supply fuel to the fire of this misinformation spread.
Methods: A focused search was conducted using the Google search engine. The following search terms were used:police officer + fentanyl, police officer + passive exposure, police officer + powder fentanyl. The results were judged by the following eligibility criteria: *Online news outlets*: local and national media outlets were included, but excluded articles that did not include victim retellings. This also excluded blogs or websites that posted personal opinions not associated with a news organization. *Passive exposure*: included news articles that reported suspected fentanyl overdose based on retellings of exposure involving touching or inhaling fentanyl. *Police officers*: included news articles that involved police officers who experienced a suspected exposure while on duty. *Language*: all articles were in English. This left 40 articles that revolved around 8 major instances of police officers who spoke to media outlets regarding passive fentanyl exposure.
Results: Thematic analysis revealed several important themes. (1)Traffic stops- within these stories there is a heightened danger when performing traffic stops. (2) Protocol effectiveness- the stories mention officers following protocol when handling narcotics (donning surgical gloves). In each scenario protocol did not impede overdose. (3) Performing duties alone- many expressed that death would have occurred if they had performed their duty alone. (4) Narcan (naloxone)- the narratives expressed the need for officers to carry Narcan on their person. In many of these stories several doses of Narcan were administered. (5) Public projection- in all cases bodycam footage was released or a social media live event was held to share the experiences of the victims. The themes above point to safety issues that affect police officers in general. The focus on passive fentanyl exposure seems to be an outlet for these concerns. This observation is an important factor to consider when responding to these narratives.
Conclusions: Not all news stories deserve such scrutiny by poison centers. However, a collection of incidences that show signs of trending in the media deserve more than a cursory glance. The first step towards combating misinformation is using Urban Legend theory (ULT) as a tool to understand the nuances of such narratives. ULT encourages public health workers to link stories to social problems that are occurring outside of the healthcare network. Further analysis and testing are needed to determine the best course of action to begin a response to misinformation initiated by authority figures.

KEYWORDS Fentanyl; passive exposure; police officers

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292. Demographic expansion of a state poison center's instance of the National Poison Data System (NPDS)

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Background: NPDS is a unique data set which provides a breadth of information related to poisonings and exposures across the United States, including data that is not found in any other registries. It can help clarify and answer research questions related to poisonings; however, it has some no limitations, such as a lack of demographic information. NPDS captures age and binary gender (male, female, unknown, pregnant), but does not capture other demographics such as race, ethnicity, the gender spectrum, or sexual orientation. We piloted an initiative to capture more detailed demographic information with the goal of identifying underserved demographic groups and creating targeted outreach and education to promote poison center services.
Methods: We chose a quarter of our team of Specialists in Poison Information (SPIs) at random ($n = 4$) to be the pilot testers for this initiative and provided them with scripted questions ("With which race do you identify?" and "Do you identify as Hispanic or non-Hispanic?") to ask each caller during their regular shifts. SPIs were instructed to ask the questions of each caller as scripted but were given flexibility to add the questions into their workflow however they chose. They were also permitted to use demographic data from hospitalized patients' medical records where available. Answers were documented in the poison center EMR. Data collection began on 14 November 2022, and ended on 17 April 2023. Check-in meetings were held every 30 days to assess progress, provide support, and identify areas for potential improvement.
Results: From 14 November 2022 to 17 April 2023, the four pilot SPIs managed a total of 5,742 cases, obtaining race and ethnicity data in 49.3% ($n = 2,832$) of them. A majority of the cases managed by the pilot SPIs were reported to be white, non-Hispanic (66.8%), followed by Multi-racial/Multiethnic (5.0%), and Hispanic/Latinx (3.9%). Fewer than 1.3% of callers declined to answer, and the SPI was unable to ask the pilot questions in an additional 17%. There were no reports of hostile or aggressive reactions to the pilot questions, and the four SPIs reported feeling comfortable with asking them. Limitations include possible bias introduced by asking the caller to self-report the patient's demographics, as well as potential hospital EMR errors which the SPIs may have unknowingly extrapolated into the poison center EMR.
Conclusions: Improving the capture of demographic data enables targeted outreach and education from poison center teams to underserved groups and promotes more effective, efficient use of poison center resources. Eliciting feedback from SPIs was a high priority and the 30–60–90-day check-in process was instrumental in their success. The success of this pilot initiative demonstrates the feasibility of expanding demographic capture and should serve as a precedent and call to action for America's Poison Centers, NPDS, and individual poison centers to implement this quality initiative nationwide as soon as possible.

KEYWORDS Data collection; demography; epidemiology

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293. A multi-poison center educator collaboration effort to prevent and mitigate hurricane-related poisonings

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Background: Hurricane season is known for countless "near misses" leading to emotional exhaustion known as "hurricane fatigue" that can cause people to make poor decisions in the face of an impending storm. However, hurricanes, no matter the category, can lead to death, damage to infrastructure, and disruption of day-to-day routines, creating a perfect storm for poisonings. Since hurricane season is predictable, and hurricanes provide advance notice of their arrival, Poison Center (PC) educators promote safety messages throughout the year and in response to an incoming hurricane. A group of educators from 3 PCs strategically developed a resilient plan to address hurricane fatigue through consistent messaging and amplifying of messaging through trusted community partners directly related to hurricane preparedness and response which allowed for rapid assistance for poisonings and prevention of the most serious storm-related poison outcomes.
Methods: This coordinated holistic approach began in early 2022, with educators providing 43 training sessions at the local, regional, and statewide level to key stakeholders including community nurses, Community Emergency Response Teams (CERT), paramedics, home visitors, and agencies serving older adults and individuals with disabilities. Topics introduced or reinforced poison safety messaging on carbon monoxide, venomous bites and stings, food safety, cleaning safety and more. During hurricane season (June 1 to November 30), we utilized multiple channels to ramp up delivery of specific hurricane-related poison prevention messaging: three TV programs, six website sliders, one news article, 154 social media posts (Twitter, Facebook, Instagram, and YouTube), and two radio programs. As the storm was passing over and in the immediate aftermath, PC staff continued the intense messaging and shared data with the state Department of Health on specific storm-related poisonings in real time to allow for alignment of PC and public health efforts.
Results: At the start of hurricane season through the weeks leading up to a recent major hurricane, the education program reached over 250,000 people, through presentations, TV and social media. Through existing partnerships, educators received real time feedback from key informants (including a legislator) about the needs of the affected population and quickly pivoted to deliver timely radio messaging to reach individuals who were using battery operated radios due to power outage. Epidemiologists at the Department of Health noted that although 43 cases of carbon monoxide poisoning were identified statewide, there were no fatalities, a very unusual finding for a major hurricane affecting a large state.
Conclusions: No matter how catastrophic the damage caused by a hurricane may be, knowing of their impending arrival provides a unique advantage that PC educators can use to help prevent poisonings and save lives. PC educators are encouraged to use multiple channels, remain flexible, and partner with public safety agencies as well as organizations serving vulnerable populations to raise awareness about hurricanes related poisoning. It is critical to not just focus on hurricane response, but to embrace a pre, during, and post approach that will provide additional layers to local and statewide existing hurricane safety plans and help combat hurricane fatigue and poisonings.

KEYWORDS Hurricane messaging; disaster preparedness and response; poison prevention

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294. Training poison specialists with QPR to improve care for suicidal callers

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Background: Calls to poison centers for poisonings involving self-harm have sharply increased in recent years, and many fatalities seen by poison centers are suicides. Most specialists in poison information (SPIs) have little formal preparation for managing suicide attempts, so their approaches to these calls vary widely. The objective of this initiative was to assess if a single session of suicide prevention "gatekeeper training" could improve specialists' comfort, knowledge and engagement practices regarding self-harm cases. QPR™ (Question, Persuade, Refer) Gatekeeper Training by QPR Institute is one of several evidence-based programs addressing suicide prevention available for training health care providers.
Methods: In 2022, one poison specialist attended a community QPR Training and then worked with the regional instructor (who had worked on the suicide hotline) to develop a version of QPR for poison specialists. On March 30, 2023, 12 SPIs attended a 2-hour QPR session in a scheduled staff meeting. Using an interactive phone-based scenario, the instructor covered topics including understanding suicide, overcoming emotional reactions to talking about suicide, responding to direct and indirect clues about suicidal intent, and local resources for mental health crisis. Pre and post tests were conducted online to assess specialists' knowledge and satisfaction with the training. An active discussion followed the QPR session, and most SPIs participated in the interactive components of the activity. Handouts were provided at the end containing QPR guidelines and local resources.
Results: Overall, 91% of participants indicated they felt the training was "excellent," with the remaining rating it as "good." All participants stated the training met their expectations and that the information was "useful" and "easy to understand." Results did not notably vary by SPI length of service. Prior to the training90% of SPIs stated they referred non-critical self-harm cases to the emergency department, 27% referred the caller to 988, and only 36% stated they made an effort to "engage the patient."36% felt "fearful that they could say the wrong thing" in a call about self-harm.
Results: After the training mean SPI discomfort with calls about self-harm declined from 50 to 8 (out of 100).83% indicated they "would apply the QPR techniques they learned." 58% reported feeling less worried about interacting with these callers and "more understanding of these callers' situations." 42% of SPIs planned to offer self-harm prevention guidance regarding after the training, versus 27% who did before. 75% expressed interest in Mental Health First Aid training as a follow-up to QPR.
Conclusions: A single session on suicide prevention was well received by poison specialists and served as an "appetizer" for more training and discussion on how to best assist callers struggling with self-harm. Poison specialists expressed a desire to also learn from and engage with each other on this topic, since it was clear some had developed helpful strategies that went beyond those discussed in the session. Given the rise in these cases, evidence-based trainings and outside speakers may offer helpful perspectives for SPIs on the front lines of the mental health crisis.

KEYWORDS Suicide; prevention; training

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295. Utilizing economic data as predictors of daily call volumes to a US poison center

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Background: Call volumes to poison centers (PCs) can fluctuate significantly. Previous machine learning work has demonstrated efficacy in predicting daily call volumes with limited features as inputs. However, there remain several outlier days, when predictions can vary by more than 100 calls compared to actual values. Given PCs often cover large areas, it makes the addition of local/regional features impractical and would limit model applicability to other centers. National economic data can theoretically be generalized for any PC. In this study, we sought to determine if the addition of national economic trends, as represented by stock market and jobs data, could improve accuracy and reduce outlier days for call volume forecasting.

Methods: A time-series forecasting model was constructed utilizing Gated Recurrent Units (GRU). Daily call volumes were assembled over the previous five years from a large, regional poison center. Stock market data from the same time frame was collected from the S&P 500. Monthly unemployment data was similarly collected. Features and labels were split into training and validation sets at an 80/20, 90/10, and 95/5 ratios. Hyperparameters were experimentally varied to find the optimal solution. Forecasting was performed for the next 365, 182, and 91 days. Forecasted vs actual values for daily call volume were then compared. Outlier days were also examined and considered to be days when the network predicted a greater than 50 call difference from actual.

Results: Our dataset consisted of 5 years (1,826 days) of daily call volumes, with an average volume of 375.6 calls/day (range 174–813), as well as stock market and unemployment data. Given holidays and weekends would have no stock data, the values from the previous days were copied forward to represent the missed days. Unemployment data is reported month-to-month and linear interpolation was used to generate daily values. After feature engineering, our GRU network was then trained. Across forecasting groups, the average predicted vs actual calls differed by 24.9 calls/day. Outlier days were decreased in all groups, with only three in the last prediction group.

Conclusions: Previous studies have demonstrated that call-volume forecasting is possible with minimal features utilizing neural networks. However, there are often outlier days, when call volume is dramatically different than expected, suggesting that current models may need other features to correctly predict these swings. To maintain generalizability of the model, national economic data was gathered and engineered for daily application. After incorporation into an extant model, the economic data improved average model performance by roughly 5 calls/day. However, more interestingly, the model was able to predict large swings more accurately in call volumes, implying economic data can, directly or indirectly, estimate or influence call volume. While this model outperforms previous generations, prospective application is limited to day-to-day, as stock market data could only be added as it is gathered live. However, this model can be added in concert with others to further increase efficiency. Future research will focus on continuing to develop features to better refine predictive models, including hourly volume prediction.

KEYWORDS Machine learning; time series forecasting; poison center

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296. Pop quiz: a survey of retailers selling alkyl nitrites ("poppers") for recreational use

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Background: Alkyl nitrites ("poppers") are used recreationally for sexual enhancement, muscle relaxation, and euphoria; they are also toxic and can cause methemoglobinemia. While legal for purchase in the United States, they are often sold without instructions for proper use and are deceptively branded as nail polish removers, deodorizers, or video head cleaners; they do not generally offer instructions for use. Although the usual route of self-administration of poppers is via inhalation, ingestions have been reported, which may increase the risk of methemoglobinemia. Our poison center has anecdotally noted increased reports of exposures to alkyl nitrites in our area, many of them ingestions. Given a lack of instructions at the point of sale, we designed a survey study of retailers to assess instructions given to consumers about appropriate popper use and evaluated the proximity and co-sale of poppers with similar-appearing energy drinks.

Methods: This is a cross-sectional convenience sample survey of smoke shops, cannabis dispensaries, and exotics shops in the catchment area of an urban poison center. Investigators (consisting of Emergency Medicine residents and Medical Toxicology fellows and faculty) identified retailers in multiple neighborhoods, with store selection left to investigator discretion. Plainclothes investigators visited retailers and followed a predetermined protocol and script to request information regarding the availability ("Do you have poppers?") and usage of poppers ("How should I be using this?") in the context of making a personal purchase. In addition to documenting vendor responses to survey questions, the investigators attempted to visually determine the proximity of poppers to similar-appearing energy drinks (5-Hour Energy®) during their visit.

Results: Ninety-eight stores were identified and surveyed by our investigator team over a two week period with 86 stores meeting the inclusion criterion of selling alkyl nitrites at the time of the investigation. When the store vendors were asked about the appropriate usage method of poppers, 38 (44%) were unsure or refused to answer, 41 (48%) advised inhalation, and 7 (8%) recommended ingestion. Fifty-one (59%) of these sellers also sold 5-Hour Energy®, and poppers were noted to be in close proximity to these energy drinks (same shelf or cabinet) in 20 stores (23% of the total inclusion cohort).

Conclusions: Many commercial alkyl nitrite retailers did not know or offered potentially inaccurate information about the correct use of poppers. In the absence of explicit instructions alkyl nitrite users could be at increased risk for developing methemoglobinemia. Additionally, poppers were often sold in close proximity to commercial energy drinks, potentially increasing the risk of purchasers unknowingly ingesting them. Further research is necessary to determine the impact of these patterns of sale and misinformation, and health care providers and public health authorities should educate alkyl nitrite sellers and users about the risks of methemoglobinemia.

KEYWORDS Poppers; public health; methemoglobinemia

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297. Empowering health care providers: preliminary evaluation of a toolkit for preventing intentional self-poisoning in youth

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Background: Intentional self-poisoning (ISP) has emerged as a prominent concern nationwide. The increasing trend in poison center calls, particularly among adolescent females, underscores the urgent need for effective interventions. These incidents impose a significant burden on both the healthcare system and affected individuals, who face heightened risks of subsequent suicide attempts and premature death. Identifying at-risk youth and providing timely interventions can be challenging. Previous studies found a need for educational interventions to enhance primary care providers' ability to detect and address ISP risks. A comprehensive toolkit that provides guidance on identifying and managing at-risk patients could play a vital role in mitigating these preventable poisonings.
Methods: In 2021 – 2022, our poison center was awarded two grants from youth-focused organizations. A toolkit was created targeting primary care settings, to effectively identify, manage, and refer young patients at risk for ISP. The toolkit's core materials include a comprehensive guidebook and recorded presentation providing an overview of statistical trends in youth ISP, along with tools that providers can incorporate into their practices. In 2022, the program underwent a rigorous review process and received national accreditation for physicians and nurses to receive continuing education credits. This program is active for three years. Pre/posttests were administered to those receiving credit, and a follow-up survey was sent out a year later to assess program effectiveness. The toolkit is available for downloading on our poison center website.
Results: Continuing education credits have been awarded to 37 individuals who completed the online course. More than 100 hard copies of the manual have been requested with another 70 copies distributed electronically. The recorded presentation was viewed 98 times. The program was promoted to over sixty health care offices and key stakeholders and at conferences. Feedback from those who received credits was overwhelmingly positive, citing the toolkit as a valuable resource. Most were school nurses, indicating its potential for broader adoption in other settings. 56 people took the pretest, and 37 completed the posttest. 89.75% reported an increase in their comfort level with screening and managing patients after taking the course. Post survey results reported 100% commitment to screening all teens for suicidal ideation compared to 44.64% in pretest responses. 95% indicated they were likely to incorporate the toolkit into their practices. The majority stated this resource will have an impact on patient outcomes and on the health care team. The toolkit offered evidence-based practice recommendations for primary care, according to those surveyed in a separate project conducted by a medical student.
Conclusions: This project highlights the pressing need for tools to assist health care providers in effectively managing at-risk patients, particularly those with ISP behaviors. Preliminary findings from the utilization of this toolkit suggest that it is a valuable resource that can support health care providers. Further evaluation is warranted to determine the long-term effectiveness of this resource and in addressing ISP-related challenges in primary care and the overall impact on patient outcomes.

KEYWORDS Toolkit; self-poisoning; prevention

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298. Using poison control center data to guide education about poison suicide and self-harm

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Background: According to the Centers for Disease Control (CDC), poisoning is the third leading means of suicide in the US Twelve percent of suicides nationwide are attributed to poisoning. However, poisoning represents the leading means of suicide for females 45 years of age and older. A retrospective review of intentional suspected suicide exposures reported to the National Poison Data System (NPDS) was undertaken to contextualize national suicide data. The aim of the review was to determine the characteristics of intentional self-poisoning reported to poison control centers (PCC) in an effort to guide suicide prevention education.
Methods: The NPDS was queried for human exposure cases from January 2000 to December 2021. The NPDS contains case data for the nation's 55 PCCs. Researchers identified cases coded as "Intentional–Suspected Suicide," which are defined as an exposure resulting from the inappropriate use of a substance for self-harm or for self-destructive or manipulative reasons. Variables included age, gender, reason for exposure, and medical outcome. A separate age-adjusted analysis was performed to exclude cases involving children five years old and under from total NPDS case volume in order to more precisely benchmark the impact of suspected suicide cases on age groups most affected.
Results: Suspected suicide and self-harm cases represented 14% of overall NPDS case volume in 2021. This is an 80% increase from 2000 (7.52% in 2000, 13.57% in 2021). However, when factoring out human exposure case volume involving children five and under, data show that 23% of cases involve a self-harm or suspected suicide intent. Furthermore, NPDS data show that females attempted suicide and self-harm by poisoning at more than twice the rate of males. In 2021, there were 86,477 reports of males attempting suicide and self-harm while there were 194,467 female reports. Additionally, NPDS data demonstrate that adults 20 and older were responsible for the majority of suspected suicide fatalities (94%) in 2021.
Conclusions: Self-poisoning is a common means of suicide and self-harm attempts, yet suicide prevention education that addresses self-poisoning may be lacking. PCC data identifies populations at-risk for poison suicide and helps anchor education on the topic. These findings from NPDS may be useful for building and supporting education on suicide prevention. Adults 20 and older overwhelmingly make up the leading age group for suspected suicide fatalities. Suspected suicide cases reported to PCCs have increased by 80% in about the last 20 years. Females are more than twice as likely to have a suspected suicide or self-harm exposure than males. PCC suspected suicide exposure data mirrors CDC data on the gender imbalance of female to male poison suicide deaths. PCC data provides an exclusive, authoritative perspective on self-poisonings. The staff at PCCs are uniquely positioned to utilize data on self-poisonings and to deliver means restriction and harm reduction messaging at the community level. PCC data about poisoning self-harm and suspected suicide can also help inform larger public health education efforts intended to prevent suicide.

KEYWORDS Suicide; self-harm; suicide prevention

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299. A mini review of micro-hospitals' response to the poisoned patient

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Background: Micro-hospitals are small-scale healthcare facilities which contain a 24/7 emergency department and typically 6–10 inpatient beds where patients can be observed or admitted. They are typically found in suburban or urban locations. Over the last 5–10 years, there has been a dramatic rise in the number of micro-hospitals, and they can now be found in over 19 states. How these facilities manage poisoned patients and utilize regional poison control centers (PCC) has not been well studied. We sought to better characterize the type of poisonings and resulting outcomes by examining the call records from all micro-hospitals to a regional poison control center for a 5-year period.
Methods: This retrospective chart review used the Toxicall® database of a regional PCC. All cases involving calls from a micro-hospital were identified. There were a total of 7 micro-hospitals active during this time frame, though 2 closed in 2022. All information was de-identified in REDCap and analyzed in Microsoft Excel
Results: 224 cases were identified. The number of calls increased from 11 in 2018 to a peak of 65 in 2021. There were 51 calls in 2022. 138 (61.6%) calls involved females, and the average age was 27.1 years (SD 18.8). 120 (54.6%) cases involved adults. Of the 104 (46.4%) cases that involved patients 19 years or younger, 40 (17.9%) involved children 6 years or younger. Intentional exposure was the reason for the exposure in 48.2% ($n = 108$) case, while unintentional exposures accounted for 45.1% ($n = 101$) cases. In 184 (82.1%) cases the exposure was to a single substance. Household chemicals were encountered in 40 cases (17.8%). The three most common drug groups encountered were non-opioid analgesics (47, 21%), antidepressants ($n = 29$, 12.9%), and antihistamines ($n = 26$, 11.6%). Acetaminophen was the single most common drug encountered ($n = 26$, 11.6%). Opioids were encountered in 3 (1.3%) cases. Nearly all cases arrived via private vehicle ($n = 221$, 98.6%) but 49 cases (22%) were transferred out by EMS. In all, 43 (19.2%) of cases ultimately required admission to a hospital. None of these patients were admitted at the micro-hospital. Clinical outcomes were minor in 30.4% ($n = 68$), moderate in 27.7% ($n = 62$) and major in 1.3% ($n = 3$). No deaths occurred. Seizures occurred in 3 cases, and hypotension was documented in 2 cases. No vasopressors were used. Intubation was performed in 1 case. In 13 cases an antidote was administered: 9 case of NAC administration and 1 case each of fomepizole, *Crotalidae* Polyvalent Immune Fab (Ovine), naloxone and physostigmine.
Conclusions: In this single center study, a wide range of poisoned patients presented to micro-hospitals for care. Adult and intentional exposures were most common and almost 20% required transfer to ultimately be admitted. Acetaminophen was the most common substance encountered, while exposures to opioids were surprisingly rare. No poisoned patient was admitted to a micro-hospital in this study, suggesting that regional poison control centers should be prepared for high rates of transfers from these facilities.

KEYWORDS Micro-hospital; rural; patient disposition

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300. Weathering a latex-finish water spill: a regional poison center's experience

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Background: Prompt dissemination of accurate, trusted information to the public is essential during a public health crisis. On 24 March 2023, approximately 8,000 gallons of water-based latex finishing solution containing butyl acrylate, ethyl acrylate, and methyl methacrylate were spilled into a river upstream from a water treatment plant servicing a large city with a population of over 1.5 million people. In the coming days, local government agencies provided emergent updates to the public related to water safety and potential areas of impact. Due to concerns of a potential 'do not drink' order, city residents started emergently over-buying bottled water from local stores and diminished supplies. Despite continued testing that indicated non-contaminated water supply, calls were made to the regional Poison Control Center related to this chemical spill event. This investigation describes the center's experience following this chemical spill with the intent to highlight its role in public emergency preparedness.
Methods: This was a retrospective cohort study of calls made to a regional poison control center between 24 March and 28 March 2023. Upon recognition of the chemical spill event, the poison control center offered to aid municipal public health response organizations as a response partner, but was only provided with publicly available information. Still, the center developed risk communication messaging and standardized documentation and coding for calls related to the crisis. Calls included those with the case type "environmental exposures" with the subcategory "water purity/contamination" and substance verbatim "water plant chemical spill." Call data were evaluated for patterns in date and time of calls following the initial public notification. Case narratives were evaluated for common themes and questions asked.
Results: A total of 32 calls were made to the center, 81% of which were made in the first 24 hours following the public notification. Of the 32 calls, 16 (50%) of calls were made on the first day, followed by 11 (34%), 4 (13%), 0 (0%), and 1 (3%) on subsequent days. Approximately 1 out of every 3 calls were from zip codes that were not impacted by the event. The most common themes involved questions regarding food preparation/drinking safety (47%), bathing safety (17%), zip code impact (15%), clarification of public health messaging (12%), symptoms (6%), and latex allergies (3%).
Conclusions: As CDC-designated public health authorities, poison control centers can greatly strengthen their region's public health infrastructure when engaged early as partners in responding to environmental health crises. The public's need for information in the first 24 hours likewise justifies that poison control centers must be ready to rapidly standardize messaging and documentation of these calls with very little notice. These data also highlight the concerns of individuals outside of the area of impact. When planning for a crisis response, poison control centers should be ready to address the needs of both the affected and those living outside of the area of impact to ensure that everyone has accurate information.

KEYWORDS Emergency preparedness; chemical spill; poison control centers

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301. Machine modeling to predict hospital antidote stocking needs

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Background: Antidotes can be a life-saving intervention for many poisonings. Best practice suggests that a hospital should ensure all appropriate or life-saving antidotes are readily available to administer immediately. However, significant variability exists in antidote need and use between emergency departments and hospitals. Many antidotes are costly and used infrequently, resulting in financial and product waste if the medication expires prior to use. Predicting stocking needs is left to anticipation of use, which is often loosely assessed based on prior years' total use. This presents a challenge when antidotes are expected to be on shortage, creating a need for hospitals to determine anticipated use. Therefore, the purpose of this study was to determine whether machine learning can be used to predict antidote stocking needs for a large, university hospital using naloxone as an example antidote.
Methods: This study was a single-center, retrospective study evaluating naloxone use between 1 January 2010 and 30 September 2022. All dispenses of naloxone were evaluated, and all dispenses attributed to an administration or waste of product were included to assess total hospital use. The total number of milligrams (mg) per day used or wasted was then calculated. A deep neural network utilizing gated-recurrent units (GRU) was then constructed. Day-of-week, week-of-year, and month-of-year, as well as 100 day time lagged data were used as features for the network. Date features were transformed into cyclical features utilizing sin/cosine transforms. Data was split prior to training into training and validation sets. Hyperparameters were varied experimentally to derive the optimal network.
Results: Splitting of data yielded three separate time periods of prediction: one year, six months, and one month. The model was successfully trained on the remainder of the approximately ten years of data. Over the three validation periods, the model had an average error of 6.07, 4.5, and 3.8 mg per day of prediction. Days in which the model had a difference of greater than 20 mg between prediction and actual use were also tracked and demonstrated a decrease over progressively shorter prediction time frames, from 28 to 11 to 6 days within the aforementioned data splits.
Conclusions: Predicting antidote use can potentially improve patient care, costs, and timely administration. Currently, antidote stocking is based on historical use. We trained a deep learning neural network to accurately predict a proxy antidote at a large, academic hospital. In this case, naloxone was used as the proxy and the model was able to accurately predict daily use to an average of 3.8 mg per day. However, naloxone administration can vary wildly, and our model, while correctly predicting some of these swings, fails to capture others, implying better input features are needed for more accurate predictions. By summing the daily predictions into monthly predictions, the model's accuracy increases, as small perturbations in individual days average out. This model can be applied to various hospital settings and antidotes, potentially reducing waste and financial loss due to unused medication from inaccurate predictions.

KEYWORDS Learning; antidote; prediction

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302. Bupropion poisoning in Taiwan: a poison-center based study

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Background: Bupropion is an antidepressant known to cause seizures and other toxic effects following acute overdose. The purpose of this study was to investigate the demographic and clinical manifestations of cases with bupropion exposure reported to Taiwan Poison Control Center (PCC-Taiwan) and to identify the risk factors that may predict the severity of bupropion overdose.
Methods: This was a retrospective chart review study of all bupropion overdose cases reported to PCC-Taiwan from 1985 to 2022. Cases were divided into non-severe (i.e., asymptomatic, mild, and moderate) and severe poisoning groups; between-group differences in demographic and clinical variables were then compared using Fisher's exact test and Wilcoxon rank sum test. The AUC (area under the ROC curve) was used to determine the optimal estimated ingested dose (mg) associated with the severity of outcome. A multivariable logistic regression was also conducted to identify the potential predictors of having a severe outcome following bupropion overdose.
Results: A total of 114 cases were identified after excluding 18 cases due to incomplete data, missing outcome or duplication. The median age of the 114 patients was 19 years, with a slightly higher proportion of female cases (77, 67.5%) than male cases (37, 32.5%). All cases were of acute poisoning and most of them had (78.1%) an intentional exposure; none of the 114 cases died. The most common manifestations were tachycardia (34.2%), seizures (28.1%), and drowsiness (27.2%). In the non-severe group, the most common neurological manifestations were drowsiness (29.7%), dizziness (26.7%), seizures (21.8%), and agitation (14.9%), Moreover, the non-severe group had a significantly higher proportion of gastrointestinal disturbances (23.8%) than the severe group. By contrast, the severe group was more likely to present with coma and seizures than the non-severe group $P < 0.0001$ and $P = 0.0001$, respectively). In addition, hypotension (38.5%), QRS widening (15.4%), and elevation of creatinine kinase (CK) $>$ 1000 U/L (23.1%) were more frequently observed in the severe group. The median estimated ingested dose was 1500 mg and 6000 mg in the non-severe group and the severe group, respectively ($P = 0.0296$). The AUC for estimated ingested dose resulted in a cutoff point of 5250 mg. In the multivariable analysis, higher estimated ingested dose of bupropion (i.e., $\geq$ 5250 mg) was significantly associated with an increased risk of developing severe outcome (adjusted OR [aOR] 39.6, 95% confidence interval [CI] 3.23 – 477.56). Seizures (aOR 15.7, 95% CI 2.27 – 100.06) and hypotension (aOR 46.9, 95% CI 2.6 – 846.25) were also associated predictive of having a severe outcome.
Conclusions: Higher dosage of ingested bupropion ($\geq$5250 mg), seizures and hypotension may be predictive of having a severe outcome following bupropion overdose.

KEYWORDS Bupropion; poisoning

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303. Teenagers and young adults ingesting desiccants inside home pregnancy tests: a concerning social media rumor

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Background: Dangerous health-related misinformation continues to propagate through various forms of social media. Teenagers and young adults are often targets for these false claims and are at risk for adverse consequences when these claims are assumed as fact. A particularly concerning rumor involving pregnancy tests and emergency contraception has emerged claiming that contained within pregnancy tests is emergency contraception medication, such as levonorgestrel or Plan B One Step®. This misinformation appears to have originated in 2019 via a Facebook post and has continued to spread to other social media channels such as TikTok. A pregnancy test often contains a small, circular desiccant tablet that absorbs moisture in the test before use. Social media posts have falsely claimed that this desiccant tablet is an emergency contraception medication used to prevent pregnancy. Manufacturers of pregnancy tests, such as Clearblue®, have posted statements advising consumers not to consume the desiccant and to seek medical attention if consumed. Despite attempts to clarify this rumor, poison control centers are still receiving calls concerning these desiccants being consumed in an attempt to prevent pregnancy.
Methods: This is a retrospective review of exposures reported to a single regional poison control center. Poison center records were queried for all ingestions from diagnostic agents since 1/1/2019. Only cases that were determined to have been ingestions of desiccants from pregnancy tests were included. Of those, only ingestions of desiccants from pregnancy tests that were consumed with the intent to prevent pregnancy were included. Cases were manually reviewed for this criteria, and demographic data was recorded.
Results: Ninety-three cases were identified. Seven cases met the inclusion criteria. The patients were all female. Patient ages ranged from 15 to 22 years (mean 18.7 years). Six cases were asymptomatic at follow up. One case was lost to follow up. The earliest exposure reported was 02/01/20, and the most recent was 02/02/23. This particular poison control center was notified of two exposures per year since 2020, with the exception of the year 2021. The year 2021 received the fewest exposures, with only one exposure that year. Clearblue® was the most common brand of pregnancy test reported. In all cases, patients were asymptomatic and managed on site with the exception of one patient who presented to a healthcare facility prior to the poison center being contacted and was discharged from the emergency department.
Conclusions: Risky social media trends are nothing new to society; however, this study highlights one that is particularly dangerous. While the substance being ingested is likely non-toxic, it is definitely ineffective at preventing pregnancy. Despite manufacturers, such as Clearblue®, posting statements to not ingest the tablets, poison control centers continue to receive calls concerning these desiccants being ingested.

KEYWORDS Social media; pregnancy test; emergency contraception

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304. Help is a call away: using storytelling to improve awareness of Canada's Poison Centres

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Background: In Canada, poison centres play an important role, providing toxicological expertise, supporting people in times of distress and, in most cases, providing guidance that allows callers to remain at home, diverting unnecessary emergency department visits. Yet, nationally representative surveys conducted in 2021 and 2022 found just 18% of adults and 34% of parents were aware of poison centre resources in their area. As part of a strategy to increase awareness of poison centre services and expertise, we undertook a storytelling project highlighting experiences of the public and poison centre staff.
Methods: We recruited potential participants through referrals from poison centres, partner organizations and hospitals, as well as targeted social media posts in English and French. Members of the public in Canada who had previously contacted a poison centre or were affected by a poisoning incident were eligible. We identified two public and four professional participants to be featured in the project: four participants (public and professional) contributed to English-language videos and two professional participants were featured in French-language videos. The stories were recorded over Zoom and public participants contributed personal photos to be incorporated into the videos. The videos were uploaded to YouTube and embedded on two websites: the Canadian Association of Poison Centres and Clinical Toxicology (www.infopoison.ca) and Parachute (www.parachute.ca), Canada's national injury prevention charity. We began disseminating the storytelling videos during Poison Prevention Week (March 2023) through organic and paid social media (Facebook and YouTube). We tracked video views, social media impressions and infopoison.ca website traffic.
Results: We developed a total of six videos in English and French, featuring stories from members of the public and poison centre staff and driving viewers to infopoison.ca. The videos highlighted a variety of personal experiences, including pediatric unintentional cannabis exposure, medication errors and carbon monoxide exposure. For the period of 20 to 31 March 2023 the videos were viewed 438,972 times and received over 1.2 million impressions on YouTube and over 920,000 social media impressions. The storytelling videos also contributed to increased infopoison.ca website traffic during the campaign, with visits increasing from 23 to 125 per day to 1,136 to 1,649 visits per day.
Conclusions: The use of digital storytelling is a growing area for knowledge translation and for sharing patient and health-related experiences. Despite preferences for short online content, the success of these videos – which vary in length from 46 seconds to 4 minutes long – demonstrate the value of storytelling and interest in poison prevention and resources. Paid campaigns are effective in driving web traffic and enhancing awareness of critical health resources like the poison centres and the national infopoison.ca website.

KEYWORDS Poison centres; awareness; digital storytelling

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305. Implementation of Canada's toll-free number for poison centre service, 1-844-POISON X (1-844-764-7669)

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Background: On average, Canadian Poison Centres process 300,000 calls/year. 60% of exposure calls from the public are managed remotely, without the requirement for a physical interaction with a healthcare facility. Prior to March 2023, there were nine different phone numbers used to access the five poison centres (PC) in Canada. The 2020 Evidence Summary on the Prevention of Poisoning in Canada published by Parachute and Alberta's Injury Prevention Centre recommended the development of the national toll-free number to "simplify public education materials across the country and overall create a seamless poison centre system nationally." An Ipsos survey in 2022 found that 70% of Canadian adults had heard of PCs, but only 18% were aware of the resources available in their area. This confirmed the need for a national approach as Canadians have a general awareness of PCs but may lack clarity on how to contact one.
Methods: In 2013, the CAPCCT identified a pressing need to Health Canada for a Canada-wide toll-free number to facilitate access for PC help.A bilingual, meaningful vanity number, 1-844 POISON-X (1-844-764-7669) was secured to promote recall by the public. To ensure the caller receives services from a poison centre that serves their geographic location, the toll-free service prompts callers to verify their location prior to being transferred to a PC. Decision logic is based on the caller's input and the caller's location is not extracted automatically. The caller receives a suggestion for the province or territory corresponding with their area code, if recognized, to reduce subsequent menu options. In all cases, the caller must confirm the province or territory from which they are calling. Health Canada funded the implementation, maintenance, and use of the toll-free number, at no additional cost to provinces and territories. The telecommunications vendor will provide monthly call data including date, time, caller city and province, call duration and the final PC accepting the call. Existing poison centre numbers remain in-service for health professionals.
Results: Health Canada, in collaboration with PCs and TeleCare New Brunswick, launched the toll-free number during Poison Prevention Week, which took place 19–25 March 2023.With the toll-free number announcement and Parachute's paid ads, website visits to infopoison.ca increased from an average of 40–70 visits per day to 1,136–1,649 visits per day. When combined with a national public awareness campaign, the launch of the national toll-free number in the United States demonstrated an increase in call volumes of 9.9% at one poison centre compared to pre-launch call volumes. We anticipate that annual call volumes to Canadian PCs may increase by a similar amount.
Conclusions: Canada's toll-free number will simplify access, allow for timely call routing to the appropriate poison centre, and facilitate consistent messaging. This initiative will complement the current implementation of the Canadian Surveillance System for Poison Information (CSSPI), a collaboration between Health Canada and PCs to systematically aggregate, analyze and interpret pan-Canadian poison centre information in a timely fashion to inform regulatory, public health and health security interventions.

KEYWORDS Poison centres; public health

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306. Eating horse paste: a retrospective review of intentional ivermectin ingestions reported in the US

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Background: During the COVID-19 pandemic, the public was desperate for a cure for the disease. Misinformation regarding alternative treatments, despite a lack of legitimate peer-reviewed evidence, circulated. One of the most controversial treatments was ivermectin. Early in the pandemic multiple publications including an in vitro study, small studies, as well as meta-analyses concluded that ivermectin was beneficial. A few members of the medical community (e.g. America's Frontline Doctors) and social media influencers touted the drug as a miracle cure. Some individuals who believed in the efficacy of ivermectin and were unable to obtain the prescription formulation, resorted to ingesting equine ivermectin paste. This study looks to quantify the use and effects of equine ivermectin paste exposures in NPDS.
Methods: A retrospective review of National Poison Data System (NPDS) data on intentional ingestions of equine Ivermectin paste from 1 January 2014 to 31 December 2022, was performed. Analysis on exposures per year, demographics, health care utilization and clinical effects was undertaken.
Results: The NPDS query returned 146 cases total. Before 2020 the number of intentional ivermectin ingestions reported to poison centers was minimal, consisting of 8 cases from 2014 to 2019. In the three years spanning the COVID-19 pandemic there were 138 cases. There was a significant spike in cases in August, 2021 with 12 cases, peaking in September, 2021 with 25 cases. Age of patients ranged from 6 years to 89 years old. Exposure by gender was similar with 76 males and 68 females in the cohort. Most cases were coded as minimal clinical effects possible (19.9%) or minor effect (19.9%), with 16.4% of cases coded as potentially having a toxic exposure. 1 death was coded in the entire cohort, and the case was also coded as a viral illness. In the majority of cases no specific symptoms were coded but the 5 most common symptoms included nausea, vomiting, dizziness, and diarrhea. The two states with the most cases were Texas and California, which are also the states with the highest horse census, per data from The American Horse Council. Ivermectin horse paste ingestions reported to poison centers had a significant increase during the COVID-19 pandemic. Admission to the hospital occurred 16.7% of the time (ICU and Non-ICU). The majority of cases (61%) did not present to a healthcare facility or were evaluated and released. Most patients had no specific symptoms, but the most common coded symptoms were gastrointestinal symptoms.
Conclusions: A limitation of the study is that there is only one product code for equine ivermectin paste, however several brands are available; there is likely a large underrepresentation of human equine ivermectin exposures in the data. Human exposures to equine ivermectin paste increased markedly between 2020 and 2021 and then fell again in 2022. Most of the ingestions were non to minimally toxic, however almost 16% of patients required admission to the hospital.

KEYWORDS Ivermectin; horse paste

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307. Ivermectin neurotoxicity successfully treated with lipid emulsion therapy: a case series

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Background: Ivermectin, a macrocyclic lactone used in both human and veterinary medicine, is known to cause neurotoxicity in overdose. During the COVID-19 pandemic, ivermectin toxicity cases increased 5-fold from pre-pandemic baseline, and neurotoxicity was the most common reported feature. Lipid emulsion therapy has been successful in treating ivermectin neurotoxicity in veterinary literature but remains underexplored in human patients. This case series describes two human cases of suspected ivermectin neurotoxicity treated with lipid emulsion therapy.
Case series: A 69-year-old female presented after ingesting ivermectin, zolpidem, and ketorolac in a suicide attempt. She presented with altered mental status and was intubated for airway protection. Initial vital signs were otherwise within normal range. After extubation on hospital day 2, she reported bilateral vision loss with complete loss of peripheral vision and poor central visual acuity. MRI brain showed no abnormalities. She was treated with 20% IV lipid emulsion over 30 minutes, and her vision returned to normal within several hours without regression. On follow-up 5 days after discharge, she reported no issues with visual acuity. In a second case, a 46-year-old male self-medicated with ivermectin, albendazole, and oxytetracycline for a suspected scabies infection for 6–8 weeks. He presented with altered mental status, encephalopathy, and an intention tremor. Laboratory findings were remarkable for an INR of 2.2. A non-contrast CT scan of the head showed no acute abnormalities. The patient received two consecutive doses of 20% IV lipid emulsion therapy at 1.5mL/kg over 18 hours, resulting in marked improvement in mental status and tremor the following morning. His INR gradually declined and he was discharged home on hospital day 5.
Discussion: Ivermectin neurotoxicity is well-described in the veterinary literature, with blindness and other neurological symptoms common in a variety of species. The mechanism of ivermectin neurotoxicity is not entirely clear but may be related to its activity as an agonist at GABA-A receptors. Saturation of P-glycoprotein in overdose may lead to increased CNS penetration, increasing the risk of neurotoxicity. Mutations of the ABCB1 gene, which result in loss of function of P-glycoprotein efflux pumps, may also potentiate the risk of neurotoxicity. Ivermectin is highly lipophilic, supporting a high predicted lipid extraction efficiency and the potential efficacy of lipid emulsion therapy. These two cases demonstrate rapid and sustained reversal of ivermectin-induced neurologic symptoms following lipid emulsion therapy. We know of only one other case of ivermectin neurotoxicity treated with lipid emulsion in a human patient.
Conclusions: This case series highlights the potential effectiveness of lipid emulsion therapy in treating human ivermectin neurotoxicity. Further research is needed to both understand the mechanisms of ivermectin neurotoxicity and to support the use of lipid emulsion therapy in management. A limitation of this series is the lack of serum ivermectin concentrations, which are not routinely available for clinical use. Other limitations include co-ingestion of other xenobiotics and absence of genetic testing for the ABCB1 gene.

KEYWORDS Ivermectin; lipid emulsion; neurotoxicity

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308. Inadvertent hydroxychloroquine exposure presenting as Torsades de Pointes in a patient taking off-label fenbendazole and ivermectin

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Background: Medications obtained without a prescription over the internet may contain unknown dosing or alternative components than those advertised and can result in serious toxicity. We describe a case of QTc prolongation and Torsades de Pointes (TdP) in a patient taking off-label fenbendazole, herbal supplements and "ivermectin" later confirmed by liquid chromatography-mass spectrometry (LC-MS) to be hydroxychloroquine.
Case report: A 75-year-old male with a history of metastatic prostate cancer, hypothyroidism, and CKD stage III presented to the emergency department (ED) with syncope. His family witnessed an episode of vomiting followed by a period of unresponsiveness and abnormal movements lasting several minutes. In the ED, he was disoriented, raising suspicion for post-ictal state. He denied prior seizure history, and endorsed taking 80 to 120 mg of ivermectin daily for six weeks, as well as fenbendazole, bloodroot, cat's claw, nettle, and milk thistle as alternative treatments for prostate cancer. The medications were purchased online. ED workup was significant for a QTc interval of 528 msec, and he developed intermittent episodes of TdP. He was given magnesium sulfate, started on isoproterenol, and transferred to a nearby hospital for higher level of care. The QTc interval continued to lengthen peaking at 640 msec by the end of hospital day 1. On hospital day 2, the QTc improved to 460 msec and isoproterenol was discontinued, with no further episodes of TdP. He was discharged on hospital day 6 in stable condition. LC-MS performed on blood from day of presentation was notable for fenbendazole metabolites as well as hydroxychloroquine, which the patient denied taking. Ivermectin and its metabolites were not detected.
Discussion: Fenbendazole toxicity in humans is poorly documented with only one other described case in the literature. We confirmed a case of self-administered off-label fenbendazole as well as a surprising case of inadvertent hydroxychloroquine exposure. Fenbendazole is a benzimidazole antihelminthic medication approved solely for veterinary use. It binds to the colchicine-sensitive site of beta-tubulin inhibiting microtubule polymerization leading to impaired cell division and motility. Hydroxychloroquine is a commonly used antirheumatic agent with neurotoxic and cardiotoxic effects secondary to sodium and potassium channel blockade. Toxicity may include seizures and QTc prolongation that can progress to TdP. Our patient presented with seizure-like activity, grossly prolonged QTc interval progressing to TdP, and other tachyarrhythmias. LC-MS did not detect ivermectin but did isolate fenbendazole metabolites and hydroxychloroquine. The patient's clinical presentation was most consistent with toxicity related to hydroxychloroquine exposure.
Conclusions: We document a rare exposure to the veterinary antihelminthic fenbendazole, and inadvertent hydroxychloroquine exposure resulting in severe toxicity. LC-MS is an important tool in identifying the specific toxic agents responsible for producing observed clinical effects and can uncover the presence of unexpected medications unaware to the patient or primary treating team. Physicians should be vigilant when taking medication

histories, and pharmaceuticals procured online continue to pose risks to patients.

KEYWORDS Fenbendazole; hydroxychloroquine; off-label

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309. Over-the-counter availability of ivermectin: a trending covid effect

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Background: Ivermectin, an FDA-approved antihelminthic medication for human and veterinary use available in prescription and over-the-counter (OTC) products, was reported early in the Covid pandemic as a potential prophylactic and treatment option as it has documented antiviral activity in vitro. Poison Centers (PCs) reported increased contacts in August 2021 regarding intentional exposures to ivermectin. Our regional PC undertook the current study to evaluate our experience and determine the OTC availability of ivermectin in a seven-county metropolitan area. This study had three objectives. We sought to evaluate our regional PC's ToxiCall® data during the Covid pandemic to assess the volume of calls regarding ivermectin. Concurrently, we evaluated Google Trends data to describe searches made for ivermectin during the same period. Finally, we sought to determine the ease of purchasing OTC ivermectin products in retail establishments in a seven-county metropolitan area in March of 2023.
Methods: PC call data were obtained by searching our regional PC ToxiCall® database for both information-seeking and exposure calls regarding ivermectin from 1/1/2020 to 12/31/2022. We searched Google Trends broadly for "ivermectin" queries over the same period. We identified retail establishments within the same seven counties, utilizing Google Maps queries for "pet supply," "veterinary supply," and "tractor supply" excluding apparel stores, commercial farms, duplication of establishments between searches, grooming/boarding/pet daycares, humane society locations, identification/tags/radio frequency identification placements, retail establishments determined to be outside the inclusion region, stockyards, temporarily closed establishments and veterinarian offices. Chain versus independent establishments was determined by chains having greater than five stores within the seven counties. We identified the availability of OTC ivermectin; when none was identified a study investigator queried store staff to verify its availability.
Results: A total of 139 calls were made to our regional PC over the study period; 125 of these were regarding human exposures to ivermectin, and the remaining were information-only calls. The timeline of these calls was similar to the Google Trends data which showed an uptrend of searches starting in July 2021, peaking in November 2021, and decreasing to pre-pandemic frequencies by December 2021. A total of 300 retail establishments were identified; after exclusion 45 retail establishments were included in the analysis. Ivermectin was found in nine (20%) establishments: zero (0%) establishments categorized as pet supply, zero (0%) establishments categorized as veterinary supply, and nine (20%) establishments categorized as tractor supply establishments in the seven-county area. Of the nine establishments where ivermectin products were found, eight (89%) were categorized as chain establishments.
Conclusions: During the Covid pandemic, exposures to ivermectin products reported to our regional PC increased in a similar fashion to Google searches. This corresponds with the ready availability of OTC ivermectin throughout the studied metropolitan area and provides an opportunity to assess the safety of readily available ivermectin at these sites. Limitations of this study include a small geographic study area compared to the catchment area of our regional PC, and results indicate ivermectin availability at tractor supply establishments which are limited in metropolitan areas.

KEYWORDS Ivermectin; COVID; OTC availability

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310. Ivermectin use patterns & outcomes during COVID-19 in a statewide poison network

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Background: Ivermectin is a broad-spectrum antiparasitic agent that has shown indications in *in vitro* studies that it may possess antiviral activity, particularly to enveloped + ssRNA viruses such as flaviviruses, lentiviruses, and coronaviruses. The previous incidence of ivermectin exposures reported to the statewide poison network was, on average, 20 exposures per year from 2001 to 2020, but increased significantly to 90 exposures per year after ivermectin was touted as a possible intervention for COVID-19 in 2021. While side effects associated with ivermectin are typically mild, severe neurotoxic effects including ataxia, respiratory failure, coma, and death have been associated with overdoses. We conducted an IRB-exempt retrospective chart review using statewide poison center exposures to elucidate the trends underlying ivermectin ingestion in the context of the pandemic and analyze possible associations.
Methods: A retrospective chart review was performed on all statewide exposures related to single substance ivermectin exposure from 2001 to 2021 ($n = 492$). Variables assessed included age, gender, intentionality, management site, and outcomes after exposure. Exposures from 2001 to 2019 were compared to exposures from the COVID era from 2020 to 2021 only. A two-sided *t*-test was used to compare incidences preceding and following the onset of the SARS CoV-2 pandemic, with 20 January 2020, used as the time zero. This study was approved by the local IRB.
Results: There was a 450% increase in exposures to ivermectin reported to our network during the study period. There was no significant difference in the gender distribution between cohorts. We noted the largest increase in exposures in the 25 to 50-year age range. Individuals were more likely to intentionally misuse ivermectin (2.82–42.16% of cases, $P = 0.007$) in 2021 compared to previous years. There were no changes in exposures categorized as either intentional suspected suicide or therapeutic errors. Fewer patients were managed at home (50.95% of all patients in 2021 vs. 80% of patients prior, $P < 0.001$). Finally, there were no statistically significant changes in any medical outcome.
Conclusions: Although the poison network noted an increase in the total number of exposures, increased intentional misuse, and less patients managed at home after ivermectin exposure during COVID compared to the pre-COVID, there were no significant changes in outcome. Poison Centers may be able to manage more ivermectin exposures at home, despite changes in use patterns during a global pandemic.

KEYWORDS Ivermectin; COVID; poison centers

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311. Healthcare facility follow-up call metrics – an analysis of call components and external influences within a single poison center

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Background: Specialists in poison information (SPIs) are responsible for following up exposure cases handled by their poison control centers both for home calls and those managed in a healthcare facility (HCF). Information on the amount of time, components, and barriers with conducting a healthcare facility follow-up call is poorly understood. We sought to describe these challenges faced by SPIs by quantifying the individual components of each call as well as any barriers the SPIs may experience
Methods: We conducted a retrospective observational study by assessing a randomized block of HCF initial follow-up calls between March and May 2022. The initial follow-up call was assessed given it often requires the most effort on behalf of the SPIs. One hundred and thirty outgoing calls (10 from each of 13 SPIs) were randomly selected. Researchers listened to each recorded call and manually recorded observations. We recorded the time for automated menus, time to reach provider, time for provider preparation of data, time for provider to share data (vitals, labs, etc.), time for SPI recommendations, and total time of the call. To assess for differences by time of day, six four-hour time blocks were assessed: 2am–6am, 6am–10am, 10am–2pm, 2pm–6pm, 6pm–10pm, and 10pm–2am. Additionally, days of the week and variability amongst individual SPIs was assessed. Descriptive statistics were calculated and Kruskal Wallis test used to compare timing variables across different groups.
Results: Total time for initial follow-up calls was a mean of 7.75 (+/− 3.66) and median of 7.2 minutes. Most (67%) calls were directed towards patients located in the emergency department. When SPIs were unable to complete the follow-up calls it was due to RN/provider being busy (37%), SPI being placed on terminal hold (30%), no answer at all (19%) and other (14%). We found statistically significant differences in the variability amongst SPIs in the time for providers to share data ($P < 0.0001$), time for SPI recommendations ($P = 0.0076$), and total call time ($P = 0.0003$). There were no statistically significant differences in time for automated menus, time to reach provider, time for provider preparation, time for provider to share data, time for SPI recommendations, or total call time based on day of the week or time of day.
Conclusions: We were able to characterize the total time of initial follow-up calls, the time required for all of the components of initial follow-up calls, and the most common barriers SPIs face. There were no statistically significant differences for any interval based on the day of the week or any specific time block. However, we did find significant differences in call time intervals among the different SPIs at our poison control center. Such differences may suggest a need for an updated methodology to optimize how to obtain relevant information and provide succinct but complete recommendations. Leveraging this information may be helpful to other poison centers in assessing opportunities for improvement.

KEYWORDS Follow-up; SPI; timing

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312. Use of large language models to optimize poison center charting

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Background: Nationally, poison centers (PCs) receive nearly 3 million annual calls with each case requiring extensive documentation. Specialists in poison information (SPIs) contemporaneously or anachronistically document through various software solutions to capture critical case details for patient care, national reporting, and future research. Current charting methods are time consuming and prone to error, having the potential to directly impact time available for patient care. Large language models (LLMs) have improved over the last decade and are increasingly accurate at various complex tasks. In this study, we sought to determine if LLMs could accurately interpret real world calls, summarize case details, and abstract labs, vitals, interventions, and recommendations.
Methods: Audio logs of calls from 2023 were sampled. Ten cases involving human exposures managed in a hospital were selected. Calls were manually transcribed into word documents with protected health information redacted. Vocal disfluencies were faithfully adapted to provide a real-world experience. The transcriptions were fed into ChatGPT 4.0. Each call was given a novel workspace and identical prompt asking the LLM to summarize the call and to specifically abstract laboratory data, vital signs, completed interventions, and recommendations into format separate from the summary. Tables were reviewed for accuracy. A novel rubric was created to grade the summaries based on quality, accuracy, and acceptability to enter into the medical record with scores ranging from 1 to 5. Three board-certified toxicologists independently graded the summaries applying the rubric. Toxicologists had access to tabulated data as well for this process.
Results: Ten calls were selected and ranged in length from 3:13 to 25:10 minutes. Seven of these calls were SPI interactions only, while three were between a provider, SPI, and fellow. Summaries had an average score of 3.6 on the rubric, with only two summaries having an average score less than 3.0, the cutoff for acceptability for entry into the medical record. Tables were compared directly to transcripts, and, across all ten transcripts, there were 182 data points described, with the model successfully abstracting all but 18 of them. Only one data point across all transcripts was confabulated by the model.
Conclusions: SPIs at a large, regional PC have 90 minutes of their 8-hour shift built in for charting, though sometimes must exceed this. This represents a large inefficiency and can negatively impact patient care and SPI wellness. In this study, a LLM demonstrated the ability to swiftly complete documentation. Even with this impressive accuracy, mistakes can still be caught by a quick review of the produced content by a SPI and altered or accepted as is. Further, abstracting information into tables demonstrated excellent accuracy, especially for numerical data, such as labs or vitals, which makes future data mining more feasible for yet to be determined research projects. Future research should be done to in-line this method in a real-world model to further test feasibility, as the implications for efficiency and cost savings are significant.

KEYWORDS Machine learning; ChatGPT; medical documentation

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313. The role of the poison center in emergency response to a nitric acid transport spill

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Background: Over 3.1 billion tons of hazardous materials are transported annually in the United States via truck, rail, and water. In 2022, over 23,000 hazmat incidents occurred, involving roadway transport in the United States. While most of these incidents occurred during loading or unloading at a fixed facility, about a third occurred during transit. These incidents cost tens of millions of dollars, pose an environmental threat, and lead to hospitalizations and fatalities. The majority of hazmat incidents in our area occur on roadways.
Case report: A semi-truck ran off Interstate 10 and rolled into the median, rupturing and releasing an initially unknown liquid and red-orange gas. EMS notified toxicologists at our Poison Control Center (PCC) that the hazmat team was dispatched. Within minutes, our toxicologists reviewed images from social media and officials on scene, and recognized the plume had the classic appearance of nitrogen dioxide. We conveyed this to incident command, which had already determined the wind direction and activated a shelter-in-place order for a one-mile radius. The hazmat team on scene then confirmed the truck's contents as nitric acid via a transportation label with UN number 2031 and the bill of lading. The Department of Public Safety (DPS) closed Interstate 10 and re-routed traffic. Early identification of the toxicant and the action of Fire Department teams, EMS, Department of Health, DPS, and local hospitals allowed for smooth isolation of the affected area, minimizing potential exposures. The day after the incident, the PCC and Department of Health released multiple press releases and an informational pamphlet for the public. In total, our PCC fielded 76 cases related to the incident: 12 who self-referred to healthcare facilities, 5 whom our PCC referred to healthcare facilities due to respiratory or ocular symptoms, and 59 managed at home. EMS transported one individual from a property closest to the incident. No patients required hospital admission or treatment.
Discussion: Our PCC has a long history of working with local hazmat teams and is represented in the local emergency planning committee. Our specialists participate in regional hazmat exercises and our toxicologists train paramedics on prehospital guidelines, including the courses Advanced Hazmat Life Support Provider Course and Advanced Hazmat Life Support for Toxmedics. This close collaboration leads to our PCC's real-time involvement during major hazmat incidents. This collaboration potentially prevented exposure to a deadly toxicant and decreased the burden of patients self-referring to Emergency Departments. Furthermore, our collaboration allows documentation of potential exposures in the PCC database, producing an exposure registry for public health, and allowing for ongoing follow up.
Conclusions: Poison Control Centers can play an important role in hazmat incidents, including identifying toxicants, crafting public information statements in coordination with local emergency management and public health agencies, minimizing self-referrals, and assisting healthcare facilities in evaluation and treatment. Furthermore, this partnership assists the emergency response teams in responding to the dangers of hazardous materials, guides healthcare facilities' preparedness teams, and allows for management and follow-up of exposed individuals in a public health registry.

KEYWORDS Hazmat; nitric acid; nitrogen dioxide

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314. An apple watch a day

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Background: Multiple wearable technology devices including the Apple Watch, Samsung Galaxy Watch, and Fitbit added blood oxygen monitoring features to their devices in 2020, likely in response to a heightened public interest due to COVID-19. These devices use pulse oximetry, a technique in which light of differing wavelengths is shined into perfused tissue and the amount of light emitted through (or reflected back from) tissue during pulsatile flow is used to calculate estimated oxygen saturation. Most medical-grade pulse oximeters emit light at 660 and 940 nanometers (nm), selected based on the ranges of the maximal absorption of deoxyhemoglobin and oxyhemoglobin, respectively. Methemoglobin absorbs light at both these wavelengths, and methemoglobinemia causes inaccurate readings in medical-grade pulse oximeters. We report a case of a patient with methemoglobinemia in which an abnormal reading by a wearable device led to their presentation to the hospital.
Case report: A 42-year-old male with a past medical history of valve surgery, cardiac ablation, HIV on antiretroviral therapy, and anxiety presented to the hospital with a chief complaint of low oxygen saturation. He reported that he had been inhaling isobutyl nitrite ("poppers") for approximately three hours when his Series 7 Apple Watch alerted him to a decreased oxygen saturation of 81%. The patient ceased inhalation and looked in the mirror where he noticed that his skin looked blue. He then noted symptoms of lightheadedness, palpitations, and chest pain and activated EMS. His vital signs on arrival to the emergency department were notable for an oxygen saturation of 90%, which did not change with administration of supplemental oxygen. His exam was notable for cyanosis. A venous blood gas demonstrated 19.2% methemoglobin. In consultation with the poison center, the patient was treated with 1 mg/kg methylene blue. The patient's symptoms and cyanosis resolved, his pulse oximetry reading improved to 96%, and he was discharged home.
Discussion: The Blood Oxygen feature on the Apple Watch uses pulse oximetry with light emitted at wavelengths of 660 and 850 nm onto dorsal wrist tissue. Methemoglobin absorbs light at both wavelengths and is thus expected to interfere with the calculations used by this application similarly to the interference seen with medical-grade pulse oximeters. While the estimated oxygen saturation becomes inaccurate, pulse oximetry remains useful in the diagnosis of methemoglobinemia as the calculations still yield a saturation reading below normal. Excess inhalation of isobutyl nitrite causes methemoglobinemia. In this case, the abnormal oxygen saturation measured by this patient's wearable technology device provided the first indication of methemoglobinemia, preceding the recognition of cyanosis or symptoms, and prompted discontinuation of exposure as well as timely presentation to the hospital for treatment.
Conclusions: Methemoglobinemia is detected as an abnormal oxygen saturation by the pulse oximetry methods used by the Blood Oxygen feature on the Apple Watch. Oxygen saturation features on wearable technology can aid in recognition of methemoglobinemia.

KEYWORDS Methemoglobinemia; pulse oximetry; wearable technology

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315. No need to panic: multidisciplinary response coordinated by regional poison center in a series of reported self-poisonings with ricin extracted from castor beans

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Background: Ricin is a ribosome-inactivating protein considered a category B bioterror agent and weapon of mass destruction. Ricin is naturally produced in seeds of the widely-available castor bean plant (*Ricinus communis*). Ricin extraction recipes are readily available online. For suspected ricin exposures, Poison Centers (PCs) may play an important role. We describe a series of patients who reported deriving ricin from castor beans and the subsequent coordinated responses.
Case series: Case 1: 21-year-old woman in high-density housing insufflated and ingested 7 capsules containing powdered ricin that she extracted from castor beans. On ED presentation, she had nausea, vomiting, diarrhea, abdominal and chest pain and received activated charcoal. Serial urine ricinine levels trended down from 42 ng/ml on hospital day (HD)#1 to 17.6 ng/ml on HD#2, with a slight increase (33.1 ng/ml) on HD#2, coinciding with transient worsening of gastrointestinal symptoms. No laboratory abnormalities occurred; she was transferred to a psychiatric facility on HD#4. The local fire department was first contacted and ordered an immediate building evacuation. Given its weapon of mass destruction classification federal resources were activated. The Federal Bureau of Investigation (FBI) and National Guard (55th Civil Support Team) secured the scene. The PC advised on personal protective equipment guidance and coordinated with the state health department (SHD) for biologic testing of the patient's urine within hours. At least 7 additional calls or presentations to local hospitals were reported and media stories regarding the incident persisted for days. Case 2: 39-year-old man arrived at an ED for mental health evaluation, saying he touched ricin 2 days prior. He described performing ricin extraction from castor beans at his residence. Mental health providers contacted the PC, who recommended isolation and decontamination. He was showered, isolated, and observed for 8 hours; no symptoms developed. The PC contacted the state duty officer who contacted the FBI. Urine ricinine, obtained 4 hours after presentation and again coordinated between the PC and SHD, was negative. The FBI secured the scene and determined no paraphernalia was present. The patient was admitted to a psychiatric bed that evening. No media stories appeared, nor were any additional PC calls received.
Discussion: We present contrasting cases of reported ricin poisoning from castor bean extraction, with one being a true poisoning. In both cases immediate detection of the patient by a PC resulted in a multi-agency coordinated response to minimize public health risk and rapidly identify if poisoning truly occurred. Multi-agency responses are required to quickly and effectively respond to similar future incidents. These cases demonstrate the importance of timely recognition of such cases by PCs, and the importance of having clinical toxicology experts involved in coordinating responses to incidents.
Conclusions: Our PC successfully cooperated with state and federal resources to minimize harm and mass panic during true or purported ricin poisonings. Appropriate decontamination, lab monitoring and observation periods were established due to timely direct communication between clinical toxicology experts, bedside caregivers, and first responders. Our workflow may be useful for future encounters.

KEYWORDS Ricin; weapon of mass destruction; bioterrorism

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316. "What's a CHEMPACK?"– an interdisciplinary effort to educate and train healthcare providers and first responders before a large-scale community event

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Background: CHEMPACK is a national program funded by the Administration for Strategic Preparedness and Response (ASPR) and is an extension of the Strategic National Stockpile (SNS) program. CHEMPACKs are containers of nerve agent antidotes (e.g., atropine, pralidoxime, and diazepam) placed in secure locations in local jurisdictions around the country to allow rapid response to a nerve agent or organophosphate exposure. CHEMPACK is a first responder asset that provides these antidotes for individuals exposed to nerve agent attacks and large-scale organophosphate (pesticide) poisonings. In preparing for a large-scale community event, the poison center's host facility was identified as housing a CHEMPACK hospital container. However, there were no policies or protocols other than monthly pharmacy department Standard Operations Procedure (SOP) for medication inspection. When key staff were asked about the location and contents of the CHEMPACK, and how to activate in the event of an emergency, a gap in knowledge was identified.
Methods: The poison center participated in an 8-hour scenario-based tabletop exercise, attended by local, state and federal disaster relief agencies, hospital-based healthcare providers, and first responders. The scenario described a hypothetical nerve agent release resulting in a mass casualty exposure at a large public gathering. The goal of the scenario was to review current policies and protocols on mobilizing CHEMPACKs and identify any gaps in identifying a nerve agent or organophosphate exposure, communicate with responders and facilitate deployment of CHEMPACK. Education was provided on how to recognize a chemical release and assure rapid delivery of the appropriate treatment. Realtime training was provided by the poison center and department of medical toxicology to the poison center's host facility hospital staff including decontamination process, CHEMPACK location and contents, treatment algorithms, and how to access additional resources. Facility-wide emergency alert methods were tested to ensure communication lines were effective.
Results: An internal healthcare facility protocol for CHEMPACK activation was created, which included the poison center and the department of medical toxicology notification. The protocol lists contact information for all important personnel, treatment algorithms, CHEMPACK location, keys, and a list of contents.
Conclusions: Poison Centers are integral partners in emergency preparedness within the community, healthcare systems, first responders, and health departments. Toxicology education and training should be at the forefront of these response efforts. Poison Centers should create protocols with their local and state emergency preparedness teams to establish themselves as a central information hub to act as advisors about treatment and assist in managing resources.

KEYWORDS CHEMPACK; emergency preparedness; interdisciplinary

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317. Text me your pic: do photos improve poison center case management?

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Background: This poison center has had the capability to receive texted photos from patients and health care providers since 2016. Specialists in Poison Information (SPIs) obtain photos of product labels, plants, foreign bodies, etc. to improve case management, but also anticipate added value in obtaining photos to assess dermal symptoms. Relevant telemedicine studies evaluating photo-texting of skin findings compared to in-person examination were reviewed. In addition, there are a number of practical considerations to accommodate photo-texting legally, competently, and with high patient satisfaction. These include HIPAA constraints, secure text transmission, secure storage, reliable linkage to the patient record, costs of additional storage, accurate clinical interpretation of the photos, and written guidelines to promote consistency in practice among SPIs.
Methods: CINAHL, PubMed, and the Northeast Telehealth Resource Library were searched using the keywords "photographs," "skin assessment," and "telemedicine." Nineteen relevant articles were reviewed. Common themes addressed included diagnostic accuracy, technology, cost, and time spent by providers. Each relevant article was evaluated based on the Johns Hopkins Evidence-Based Practice Model for Nursing and Healthcare Professionals.
Results: Available evidence supports the use of photos in the triage, management, and diagnosis of dermal conditions in telehealth practices. Several studies demonstrate high diagnostic accuracy of photos compared to in-person assessments and a reduced referral rate for in-person evaluation. Additionally, patients who text photos to providers report increased satisfaction with their care. However, no studies have evaluated the use of photos for dermal assessments specifically at poison centers. The full impact on cost for poison centers is unclear. Literature points to cost reduction, but only compared to in-person evaluations. No studies examined the costs of photo utilization in a strictly telecommunication-based service. Moreover, HIPAA-compliant technology to securely receive and document images, data storage limitations, and dedicated technology support impact department costs. The process of obtaining, documenting, assessing, and storing photos may place additional burden on lean staffing patterns. SPIs must be trained in the procedures required for photo utilization and documentation, in addition to having appropriate dermal assessment skills. Furthermore, physician or advance practice provider consultation must be available to validate SPIs' evaluation for accurate diagnosis. It is unclear how this influences case management times. Finally, patients must have access to reliable data or Wi-Fi to send photos and the poison center must have a reliable, secure connection to receive them. This barrier is particularly acute in rural areas. And, while 85% of American adults report owning a smartphone in 2021, this leaves ~15% of the population without the capability to text photos.
Conclusions: Texted photos add value to remote dermal assessments and this poison center has the existing technology to utilize them. Next steps include determining the impact of texted photos for dermal assessment on staffing and case management times, as well as evaluating the photo documentation process for inefficiencies. Creating a guideline for consistent use of these resources would be valuable to this poison center.

KEYWORDS Photo; poison center; telehealth

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318. Lye-ability

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Background: Lye or sodium hydroxide (NaOH) is an alkaline corrosive found in household cleaners, drain openers, hair relaxers, and even automobile air bags. It triggers liquefactive necrosis by a process called saponification which impacts the fats in the cell membrane. We discuss a pediatric case where just a taste of 99% sodium hydroxide caused grade IIb circumferential burns to the esophagus necessitating placement of a nasogastric tube.
Case report: A seven-year-old female was inadvertently exposed to a taste ingestion of lye beads (sodium hydroxide 99%, pH 13.0–14.0). A parent had used a spoon to stir the sodium hydroxide then rinsed it with water. The child placed the utensil in her mouth and immediately experienced discomfort and sialorrhea. Her lips and tongue became erythematous. Due to her symptoms, the patient was evaluated in the emergency department. Esophagogastroduodenoscopy completed the following day showed grade IIb caustic esophagitis and circumferential burns in the proximal and medial esophagus; no damage to the stomach or duodenum was noted. Due to the risk of esophageal perforation, a nasogastric tube was inserted and enteral feeding initiated. The patient was discharged on day five with prescriptions for omeprazole and sucralfate and instructions to follow a clear liquid diet. Follow up barium swallow study eight days later revealed no definite stricture, spasm, or mucosal irregularities at which time diet was advanced to thick liquids. The patient was seen in gastroenterology clinic 12 days post-discharge where the nasogastric tube was removed and sucralfate discontinued. Continued follow up was planned to assess long-term effects of caustic ingestion and monitor for stricture formation.
Discussion: Lye is a strong alkali with the potential to cause significant burns to the gastrointestinal tract when ingested. Previous studies of caustic ingestions report cases of severe sequelae in pediatric patients ingesting the product. These exposures also have the potential for long-term effects; in one recent case report, a 53-year-old adult female who ingested lye as a child developed complications including progressive dysphagia well into adulthood. The case presented here is notable for the inadvertent seemingly negligible exposure to lye residue on a previously rinsed spoon that nonetheless led to significant esophageal injury.
Conclusions: This report adds necessary evidence to the body of literature indicating that even in very small amounts, when ingested, lye can be extremely harmful. Not only are children at a greater risk of accidental ingestion, but complications from the exposure may last a lifetime. While it is likely that the incidence of lye ingestions have decreased since the Poison Prevention Packaging Act was put into place in 1970, it is imperative that these cases are treated as potentially serious and monitored diligently.

KEYWORDS Lye; caustic; EGD

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319. Barriers to the performance of hemodialysis when recommended by one poison center

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Background: Hemodialysis is an extracorporeal treatment used to enhance elimination of select toxins. In our experience,

hemodialysis is often not performed despite recommendation from the poison center (PC). A pilot study that sought to identify factors and barriers to the performance of hemodialysis indicated that the odds of receiving hemodialysis were lower when recommended outside of regular business hours (nighttime and weekends). We updated and improved this analysis by expanding the dataset and manually reviewing charts to address the limitations of coding documentation.

Methods: This was a retrospective chart review from a single PC from 1/1/2000 to 12/31/2019. A keyword search of the PC database identified all patients for whom hemodialysis was recommended or performed. Charts were manually reviewed by a co-investigator. All cases of adults aged 18 years or older for whom hemodialysis for toxin removal was recommended were included. Cases were excluded if: hemodialysis was initiated or completed prior to PC involvement; the decision for hemodialysis was made independent of or against PC recommendations; hemodialysis was performed for purposes other than toxin removal; the patient or their proxy refused hemodialysis; or charts were incomplete with respect to the outcome or covariates. Univariate logistic regressions were performed, with receiving hemodialysis within 12 hours of PC recommendation as the outcome on each of the following covariates: age group, gender, hour of day of recommendation, day of week of recommendation, year of recommendation, hospital location, and toxin category. Multivariate logistic regression was then performed on the outcome, adjusting for the previous covariates.

Results: There were 1302 cases identified in the database. After exclusion criteria, 535 cases remained in the analysis. 48% had hemodialysis recommended during the "daytime" (6:00AM – 5:59 PM) and 71% had hemodialysis recommended on "weekdays" (Monday 6:00AM – Friday 11:59 PM). The univariate analyses showed that the odds of receiving recommended hemodialysis within 12 hours were significantly lower when recommended during the nighttime (OR = 0.641, $P = 0.0250$) compared to daytime, during the weekend (OR = 0.573, $P = 0.0076$) compared to weekdays, and to urban hospitals in the PC catchment area (OR = 0.588, $P = 0.0351$) compared to non-urban hospitals. There were no statistically significant differences in odds among the most common toxins for which HD was recommended (aspirin, lithium, metformin, toxic alcohols, and other). After controlling for covariates, nighttime (OR = 0.660, $P = 0.0428$) and weekend (OR = 0.605, $P = 0.0183$) remained significant factors; hospital location was no longer significant after adjustment (OR = 0.594, $P = 0.0507$).

Conclusions: This study suggests that when recommended by the PC, the actual performance of hemodialysis within 12 hours is associated with the time of day and day of week that the recommendation is made. Patients who require hemodialysis during non-weekday times have lower odds of receiving timely hemodialysis. Hospital administrators and health care providers should be aware of this treatment obstacle for poisoned patients and facilitate timely hemodialysis.

KEYWORDS Hemodialysis; poison center; recommendation

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320. Pediatric opioid exposures in the United States (2012–2022)

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Background: The significant impact of opioid use on morbidity and mortality rates among adults in the United States has been widely studied and acknowledged. The detrimental effects on children have received considerably less attention. This study aims to explore patterns in the prevalence and related health consequences of opioid exposures among the pediatric population in the US.

Methods: We conducted a retrospective review of the US National Poison Data System (NPDS) between 2012 and 2022. We assessed trends in exposures among children aged 0 to 5 years and children aged 6–9 years. Type of substance exposure, medical outcome, and the level of care are reported. Poisson regression was used to identify trends in counts and rates (per 100 pediatric opioid exposures) over the study period.

Results: In 2022 there were 4,009 reported opioid exposures to NPDS in children aged 0–9 years, a decrease from 10,883 exposures in 2012. However, among children aged 5 years and younger, the rate of admissions to critical care units (CCUs) steadily increased from 6.5% in 2012 to 16.1% in 2022 ($P < 0.001$). Similarly, the rate of admissions to CCUs among children aged 6–9 years increased from 1.9% in 2012 to 7.6% in 2022 ($P = 0.0031$). The number of exposures resulting in a major effect in children aged 0 to 5 increased from 1.1% in 2022 to 10% in 2022 ($P < 0.001$), and from 0.05% in 2012 to 5.4% in 2022 ($P = 0.001$) among children aged 6–9 years. Analysis of substances revealed an increase in buprenorphine exposures among children aged 0–5 from 11% in 2012 to 26.8% in 2022 ($P < 0.001$), and children aged 6–9, (3.7% in 2012 to 11.3% in 2022; $P = 0.008$). Methadone exposures among both age groups did not change significantly during the study period. Prescription fentanyl-related exposures steadily increased among children aged 0 to 5 from 0.42% in 2012 to 5.2% in 2022 ($P < 0.001$), and from 0.05% in 2012 to 3.7% in 2022 ($P = 0.003$) among children aged 6 to 9. Exposures to illicitly manufactured fentanyl, first captured in NPDS in 2019, reached 6.4% in 2022 among the 0–5 age group. Other prescription opioids in this study, including tramadol, acetaminophen-oxycodone, and acetaminophen-hydrocodone all steadily decreased in exposure percentage over the study period in both age groups.

Conclusions: Despite a decrease in the total number of opioid exposures in the 0-9-year-old age group reported to US poison centers during the study period, the percentage of pediatric patients requiring CCU care steadily increased during the study period. The percentage of opioid exposures due to prescription fentanyl markedly increased and the percentage of buprenorphine-related exposures more than doubled. Exposures to most other pain relief formulations have decreased, indicating a change in the profile of opioid exposures among pediatric patients. As major effect outcomes are increasing, action is needed to further limit pediatric exposures to these substances.

KEYWORDS Opioids; pediatric; unintentional exposures

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321. Pediatric exposures to nicotine devices and nicotine solutions reported to United States poison centers: a summary of NPDS cases from 2010–2022

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Background: Nicotine is an addictive substance commonly used recreationally. Though cigarette use has declined, it has been partially replaced by handheld vaping devices. An unintended consequence is increased pediatric access and exploratory exposures to nicotine devices and solutions. Nicotine exposures tend to be self-limiting due to the low amount of nicotine in

traditional individual products. However, solutions are concerning because of their accessibility and high concentration. In contrast, nicotine devices have small reservoirs and children struggle to inhale from the device properly. Our objective was to describe nicotine exposure in pediatric patients with nicotine devices compared to nicotine solutions.

Methods: Data were acquired from the National Poison Data System from 2010 to 2022. Inclusion criteria were children 5 years of age and younger with acute, unintentional exposure to nicotine devices or liquids. Exposures to other sources of nicotine were excluded. The primary outcomes were admission rates and clinical effects among children with an exposure to nicotine device or liquid exposure. Descriptive statistics were used along with Fisher's exact test.

Results: In total, 17,789 device exposures and 8,463 liquid exposures met criteria from 2010 to 2022. The mean age and weight were 1.7 years and 12 kilograms. Exposures to nicotine devices (12,778, 71.8%) and nicotine liquids (5,365, 63.4%) were mostly managed at home. For cases originating from a health care facility (HCF) or requiring a HCF referral, 4,848 (27.3%) were from devices and 3,000 (35.4%) were from liquids; 3,552 (73.3%) device exposures and 2,268 (75.6%) liquid exposures were evaluated, treated, and released; 138 (2.8%) device exposures and 68 (2.3%) liquid exposures were admitted. Hospital admission rates were statistically similar between nicotine devices and liquid exposures. Among cases followed to a known outcome, 10,005 (62.0%) experienced no effect, 5,726 (36.0%) a minor effect, 304 (1.9%) a moderate effect, and 12 (0.1%) a major effect. One death occurred in each group. Clinical effect duration was mostly less than 2 hrs. (4,759, 78.8%). Clinical effects for nicotine devices and liquids included fussiness (195, 1.1% and 89, 1.1%), gait disturbances (56, 0.3% and 23, 0.3%), CNS depression (363, 2.0% and 174, 2.1%), cough/choke (3,044, 17.1% and 1,175, 13.9%), nausea/vomiting (2,503, 14.1% and 1,248, 14.7%), oral/throat irritation (201, 1.1% and 84, 1.0%), tremor (35, 0.2% and 22, 0.3%), and tachycardia (182, 1.0% and 80, 0.9%); there was no statistically significant difference in clinical effects between the groups. Home interventions included hydration (15,468, 58.9%) and food (4,714, 18%). For children managed in a hospital, the most common interventions were intravenous fluids (236, 3.0%), antiemetics (138, 1.8%), activated charcoal (170, 2.1%), and benzodiazepines ($n = 53$, 0.6%). Seven children were intubated (0.01%).

Conclusions: Clinical effects and admission rates were similar for pediatric exposures to nicotine devices and liquids. Poison centers should continue to assess nicotine exposures based on the suspected nicotine amount ingested, time of exposure, and the child's symptoms when making a referral decision. Any assumption about severity based on the exposure being from a nicotine device or liquid appears misguided.

KEYWORDS Nicotine; pediatric

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322. Pediatric meclizine exposures reported to US poison centers nationwide

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Background: Meclizine is a first-generation antihistamine with anticholinergic properties that is available over-the-counter. Common brand names include Bonine®, Antivert®, and Dramamine Less Drowsy®, which are available as flavored chewable tablets that may be enticing to young children. To mitigate accidental exposures, these products are often packed in child-resistant bottles or blister packs. Current available oral dosage strengths include 12.5, 25, and 50 mg. Meclizine is approved therapeutically for ages > 12 years for motion sickness and vertigo with a starting dose of 25 mg. Literature on safe triage doses in younger children is limited to one case series from 1988 involving 12 children. This study describes pediatric meclizine exposures reported to US poison control centers over a five-year period.

Methods: A retrospective review of pediatric meclizine exposures reported to the National Poison Data System (NPDS) from 2017 to 2021 was performed. Inclusion criteria was limited to single substance human ingestions involving children (aged < = 6 years) with an exposure reason of unintentional general or unintentional therapeutic error. Confirmed non-exposures were excluded. Meclizine products were isolated using Micromedex® product identification codes. Trend analysis and descriptive statistics were performed using absolute case counts and relative proportions.

Results: A total of 4,076 cases were identified to meet inclusion criteria. Of these, most cases (94%) were coded as Unintentional General, and the gender distribution was nearly equal. The majority of exposures (87%) involved children aged 1-3 years. The dose ingested was listed as a quantity of tablets in 44% ($n = 1,781$) of cases and a quantity of milligrams (mg) in 35% ($n = 1,411$). Among cases with an "exact" dose ingested ($n = 733$), 84% of cases involved a total dose ingested < = 50 mg and 66% involved < = 25 mg. Overall, there were no clinical effects reported in 90% of reported cases and among patients followed to a known medical outcome ($n = 2,029$), 84% were asymptomatic. No fatalities or major effect medical outcomes were reported. The most frequent clinical effects included mild central nervous system (CNS) depression ($n = 135$, 3.3%), drowsiness/lethargy ($n = 129$, 3.2%), agitation ($n = 44$, 1.1%), tachycardia ($n = 35$, 0.9%) and vomiting ($n = 30$, 0.7%). Among cases that were initially triaged by the poison center ($n = 3600$), 17% of patients ($n = 606$) were referred to a healthcare facility (HCF) for further observation and/or treatment. Of these, 84% ($n = 509$) had no symptoms and 1.5% ($n = 9$) resulted in a moderate effect outcome. Among all patients treated in a healthcare facility ($n = 995$), 14 (1.4%) received intravenous fluids, 4 received benzodiazepines, and 1 received oxygen. None of the patients who received care in a HCF required advanced airway, CNS, or cardiovascular support.

Conclusions: Over 4,000 pediatric meclizine exposures were reported to US poison centers from 2017-2021 and the vast majority (> 99%) of patients experienced no more than minor effect outcomes. This retrospective case series highlights that most patients can be managed safely in the home setting with poison center follow-up.

KEYWORDS Meclizine; pediatric; toxicity

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323. TikTox – impact of social media challenges on pediatric single use detergent sacs and diphenhydramine ingestions reported to United States poison control centers

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Background: Social media platforms have become ubiquitous in the lives of children and adolescents. TikTok™ has risen quickly

in global popularity, with over 1.6 billion users worldwide, most of whom are under 24 years of age. TikTok™ challenges are short viral videos imploring viewers to recreate tasks, some of which involve performing risky behaviors. The Tide Pod® and Benadryl® challenges encouraged viewers to ingest these substances, with the former resembling Jell-O® and the latter producing hallucinogenic effects. The impact of these challenges on cases reported to United States (US) Poison Control Centers (PCC) has not been comprehensively evaluated. Our objective was to characterize the impact and outcomes of single use detergent sacs (SUDS) and diphenhydramine challenges in pediatric cases reported to US PCCs.

Methods: A retrospective review of pediatric exposures reported to US PCCs using data abstracted from the National Poison Data System (NPDS) was performed. Inclusion criteria encompassed intentional single-substance ingestions of both brand name and generic forms of SUDS and diphenhydramine in children ≤19 years old. We evaluated, using comparative analyses, the incidence, clinical effects, disposition, and management associated with SUDS and diphenhydramine ingestions during the year the respective TikTok™ challenge was introduced compared to the previous year's data. The Tide Pod® challenge was introduced in January 2018, while the Benadryl® challenge was introduced in September 2020. A Chi-square test was used to compare the differences in categorical variables between the two time periods. A significance level of < 0.05 was used.

Results: A total of 469 ingestions of SUDS and 5732 ingestions of diphenhydramine were reported during the study time frame. An increase in the number of SUDS (pre: 82 vs. post: 387; 287% increase) and diphenhydramine ingestions (pre: 974 vs. post: 4758; 388% increase) was noted during the pre-and post-TikTok™ periods. There was a significant increase in SUDS ingestions among the 13–19-year-old age group with school exposures increasing post-TikTok™ challenge. There were also significant increases among females and suicidal intention in diphenhydramine ingestions post-TikTok™ challenge. The use of benzodiazepines, cathartics, and irrigation in SUDS ingestions increased by 100, 100, and 247%, respectively. Benzodiazepine, anticonvulsant, sodium bicarbonate, and physostigmine use increased by 470, 733, 480, and 350%, respectively, in diphenhydramine ingestions. Significant interventions such as endotracheal intubation, vasopressors, and cardiopulmonary resuscitation increased by 269, 133, and 300%, respectively, in diphenhydramine ingestions. There were four deaths associated with diphenhydramine ingestions post-TikTok™ challenge.

Conclusions: This study demonstrated an increase in pediatric ingestions reported to US PCCs coinciding with Tide Pod® and Benadryl® TikTok™ challenges. Though these results do not infer causality, this study highlights the need for parents, health professionals, and public health officials to exercise oversight and report dangerous social media challenges to mitigate serious adverse events. Sustained vigilance of online activity can help inform the public of potential risks associated with social media challenges, promote healthy and responsible Internet use, and support further content moderation efforts.

KEYWORDS Pediatric; TikTok challenges; intentional ingestions

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324. 70 Years of use without pediatric data: triprolidine

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Background: Triprolidine is an alkylamine, first generation H_1-antihistamine that was first developed in the 1950s. It is used to treat allergy and cold symptoms in pediatrics and adults. Despite 70 years of clinical use, there are little pharmacology data because it was approved before regulatory agencies required extensive studies. Usual oral doses for pediatrics, at maximum 4 doses per day, are 0.313 mg for 4 months to 2 years old, 0.625 mg for 2–4 years old, and 0.938 mg for 4–6 years old. Currently, there is no studied toxic dose in pediatric patients. The objective of this study is to evaluate unintentional triprolidine ingestions in patients ≤6 years old and to establish a triage dose for referral to a healthcare facility (HCF).

Methods: 10-Year (2011–2021) retrospective review of pediatric triprolidine ingestions reported to the Texas Control Poison Network (TPCN) was performed. Inclusion criteria were ≤6 years old and verbatim of triprolidine or Histex™. Polydrug ingestions and multidrug formulations were excluded. Severity of symptoms were ranked using the Toxicall® outcome scale.

Results: 900 Cases were identified, most occurring in children 2 years old (M 26.1 months, SEM 0.45). The mean ingested dose was 9.0 mg (SEM 0.31) and mean weight-based dose 0.68 mg/kg (SEM 0.03). Most cases were managed at home ($n = 640$, 71.1%), with 164 cases (18.2%) already in or enroute to a HCF while 95 cases were referred in by a poison center (10.6%). Therapies performed included dilute/irrigate/wash ($n = 366$, 40.9%), food/snack ($n = 178$, 19.9%), intravenous fluids ($n = 7$, 0.8%), other emetic ($n = 6$, 0.7%), and single-dose activated charcoal ($n = 5$, 0.6%). No therapies were recommended in 336 cases (37.5%).285 cases were followed to a known outcome. Of the followed cases, 228 children had no effect (80.0%), 51 minor effects (17.9%), 6 moderate effects (2.1%), and no major effects. 615 cases were not followed to a known outcome. Reasons cases were not followed included minimal clinical effects expected ($n = 581$) or unable to follow ($n = 34$). The lowest reported dose with moderate effects was 14.07 mg. Of the 57 patients with clinical effects, most resolved within 8 hours or less ($n = 56$, 98.2%). Primary effects were neurological or gastrointestinal: mild CNS depression ($n = 70$, 7.8%), vomiting ($n = 8$, 0.9%), agitation ($n = 8$, 0.9%), cough/choke ($n = 5$, 0.6%), ataxia ($n = 4$, 0.4%), tachycardia ($n = 4$, 0.4%), dizziness/vertigo ($n = 2$, 0.2%), abdominal pain ($n = 2$, 0.2%), confusion ($n = 1$, 0.1%), hypertension ($n = 1$, 0.1%), and nausea ($n = 1$, 0.1%).

Conclusions: This study suggests inadvertent pediatric triprolidine ingestions may not require a referral to a HCF as most cases were already successfully managed at home without any effects. Of the patients with clinical effects, 14.07 mg was the lowest dose associated with a moderate effect. Therefore, this dose may be used to assist specialists in determining if a child can be safely monitored at home with appropriate follow up. Limitations of the study include its retrospective nature, coding differences between specialists, and the lack of a standard triprolidine referral dose used in the TPCN.

KEYWORDS Triprolidine; pediatric; ingestion

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325. Trends in pediatric opioid exposures reported to US poison centers from 2016 to 2022

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Background: The opioid crisis has led to increased opioid-related overdoses and negative outcomes across the United States. Less is known about the repercussions it has on children six years old and younger, who are often affected unintentionally.

Methods: This retrospective study investigated the year-to-year trends in opioid exposures from January 2016 to December 2022 reported by US poison centers to the National Poison Data

System. Cases analyzed involved children aged one month to six years with exposure to one or more pharmaceutical or illegal opioid agents, which were identified by 68 generic drug codes. Cases resulting in fatalities were linked to the drug with higher risk of causing death, and the order of risk as follows: fentanyl > heroin > other/unknown > pharmaceutical drugs. Analysis of fentanyl exposure did not differentiate between prescription and illicit forms. Descriptive statistics included 95% confidence intervals (CI) for proportions with no continuity correction. Shapiro-Wilk's test was used to test data normality. Pearson's correlation (PC) or Spearman's rho were used to test trends for significance.

Results: We analyzed 37,117 exposure cases, which included 37,755 opioid agents. Among the cases in the dataset, exposures were classified as follows: 98.3% unintentional (n = 36,480, CI:[98.1,98.4]), 0.3% adverse reaction (n = 124, CI:[0.28,0.39]), 0.2% intentional or malicious (n = 85, CI:[0.19,0.28]), and 1.2% had other or unknown classifications (n = 428, CI:[1.1,1.3]). Site of initial exposure was 91.7% at the child's residence (n = 34,036, CI:[91.3,92.0]), 5.5% at other residences (n = 2,050, CI:[5.3,5.8]), and 2.8% other or unknown sites (n = 1,031, CI:[0.26,0.29]). Children under two were implicated in 74.5% of cases (n = 27,637, CI:[74.0,74.9]); the median age of all exposures was two years. At least 67.3% of reported exposures resulted in admission at a healthcare facility (n = 24,975, CI:[66.8,67.8]). Healthcare facility admission increased at an average rate of 2.9% per year, with an absolute increase of 18.5% overall (PC: 0.987, $P < 0.001$). The most implicated agents were 7,840 exposures to buprenorphine (20.8%, CI:[20.4,21.1]), 6,307 to acetaminophen with hydrocodone (16.7%, CI:[16.3, 17.1]), 5,682 to tramadol (15.0%, CI:[14.7, 15.4]), and 1116 to fentanyl (3.0%, CI:[2.8,3.2]). Exposures decreased an average of 11.8% per year, an absolute decrease of 53.1% (n = 7,750 to n = 3,636); however, rates of death, death by indirect report or major effects, increased at an average rate of 41.0% per year, with an absolute change of 618% overall (PC: 0.942, P = 0.001). Between 2016 and 2022, the count of CPR administration increased by 199.4% (Spearman's rho:0.929, P = 0.003), intubation increased by 181.4% (PC: 0.904, P = 0.005), and naloxone administration increased by 131.4% (PC: 0.973, $P < 0.001$). There were 68 deaths or deaths by indirect report from 2016 to 2018 (0.18%, CI:[0.14,0.23]). Fentanyl was the most implicated opioid in deaths or deaths by indirect report (n = 31, 45.6%, CI:[34.3,57.4]), followed by methadone (n = 14; 20.6%, CI:[12.7,31.6]).

Conclusions: While the incidence of opioid exposure among children has shown no decline, the severity of effects due to exposures have worsened. This concerning trend is likely attributed to the increased prevalence of fentanyl and other potent opioids.

KEYWORDS US poison centers; pediatric opioid exposures; pediatric poisoning

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326. High-dose insulin for calcium channel blocker and beta-blocker poisoning in children: 20 years of experience from a regional poison center

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Background: The use of high-dose insulin (HDI) is a standard therapy for cardiogenic shock secondary to beta-blocker (BB) and calcium channel-blocker (CCB) poisonings. Although the clinical characteristics and adverse events of HDI have been well-described in the adult population, there are no such analyses in children. We sought to examine a cohort of pediatric patients with BB and/or CCB poisonings who received HDI therapy, with the objective to describe clinical characteristics associated with these poisonings and its treatment modalities in children.

Methods: We performed a single-center retrospective chart review of children who had been treated with HDI for BB and/or CCB poisonings between the years 2000 and 2022. The setting of this study is an American Association of Poison Control Centers (AAPCC) accredited regional poison center (PC) covering 3 US states. Patients 18 years of age or younger were identified by querying our PC's electronic database (Toxicall®), which contains categorical fields containing nominal (e.g., gender, exposure route) and ordinal (e.g., age) data as well as free text case notes that describe each case in a manner similar to traditional hospital records. Patients were included if both the record confirmed exposure to a BB or CCB, and the patient received HDI.

Results: A total of 34 patients met inclusion criteria. The median patient age was 16 years (range 7mo–18yr); 61% were female. 13 patients (38%) were poisoned with BBs alone, 16 patients (47%) by CCBs alone, and 5 (15%) by both. Of the CCB poisonings, 8 patients (38%) were exposed to non-dihydropyridine CCBs (verapamil or diltiazem). The median peak insulin infusion was 1 unit/kg/hr (range 0.5–11), with a median insulin infusion duration of 22 hours (range 1–136 hrs). Concentrated dextrose solutions were typically required to maintain normoglycemia, the mean dextrose concentration was 35% (range D5–D70). The median duration of vasopressor use was 29 hours (range 1–199 hrs). Intubation was required in 44% of patients (n = 15). Cardiac arrest occurred in 8.8% of patients (n = 3). Neither ECMO nor any other mechanical circulatory support was required for any patient in this cohort. None of the patients required hemodialysis. Death occurred in 5.9% of patients (n = 2).

Conclusions: The management of shock from beta-blocker and calcium channel-blocker poisonings can be challenging, especially in pediatric patients. Common complications of HDI included hypokalemia, hypoglycemia, and volume overload. There were no significant adverse events that required discontinuation of HDI prior to resolution of the toxicity. Of the deaths that occurred, none were attributed to the use of HDI. The data from this cohort suggest that HDI use in the pediatric population is feasible and safe with appropriate clinical monitoring.

KEYWORDS High dose insulin; beta blocker; calcium channel blocker

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327. Severe toxicity from accidental childhood ingestion of ondansetron orally disintegrating (ODT) formulation

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Background: Ondansetron, a selective antagonist of serotonin sub-type 3 receptor concentrated in the chemoreceptor trigger zone, is commonly used for chemotherapy-induced nausea and vomiting prophylaxis in pediatric patients. It is generally safe at therapeutic doses of 0.15 mg/kg at 4-to-8-hour intervals. However, overdose can cause QT prolongation, hypotension, and serotonergic toxicity. Pediatric overdose literature is scarce. This case report presents a severe toxicity incident resulting from accidental childhood ingestion of ondansetron orally disintegrating tablets (ODT).

Case report: A two-year-old girl ingested a maximum of 20 ondansetron ODT, equating to a dose of 6.4 mg/kg. She was

brought to the emergency department (ED) 1.5 hours post-ingestion and was noted to be drowsy (Glasgow Coma Scale of 14) with stable vital signs, but with borderline QTc prolongation (466 milliseconds) on electrocardiogram. Initial lab work was unremarkable except for a slightly elevated aspartate aminotransferase. At around 2.5 hours post-ingestion, her QTc had become more prolonged (497 milliseconds) and she began to seize. Her initial seizure activity, which responded to lorazepam, recurred 5 minutes later prompting another dose. Her oxygen saturation dropped, and she was emergently intubated. Around 6 hours post-ingestion her QTc interval narrowed (430 milliseconds) but she had become hypotensive and hypothermic and received warming, epinephrine, and norepinephrine. With these supportive measures, her heart rate was 127 beats per minute, blood pressure 97/66 millimeters mercury, respiratory rate 24 breaths per minute, oxygen saturation 97%, and body temperature of 35.6° Celsius. By approximately 10.5 hours post-ingestion, she remained intubated and sedated but was noted to be somewhat more awake. Vitals stabilized except for an elevated body temperature of 38.8° Celsius requiring acetaminophen and her pressor support had been discontinued. Her electroencephalogram monitoring confirmed no further seizure activity. She was extubated the following day, at approximately 22 hours post-ingestion, and remained drowsy but arousable for several hours. She was discharged home 48 hours post-ingestion.

Discussion: Our patient developed severe toxicity involving drowsiness, QTc prolongation, seizure activity, and respiratory depression with rapid symptom onset prior to 90 minutes post-ingestion of 6.4 mg/kg ondansetron. Previously published case reports of accidental acute childhood exposure to ondansetron are limited to two: a 12-month-old who ingested 6.4 mg/kg ondansetron resulting in coma, tachycardia, hyperreflexia, fever, clonus, seizure, mydriasis, diaphoresis, nystagmus, stridor, rash, transient elevated liver enzymes, and QTc prolongation and a 21-month-old who ingested 16 mg/kg resulting in lethargy, ataxia, vomiting, tachycardia, and QTc prolongation. It is noteworthy that all three cases involve the ODT formulation of ondansetron. This raises concern that ondansetron ODT's added sweetener phenylalanine, a component of the artificial sweetener aspartame, and rapid dissolution in the mouth increase the likelihood of a toxic accidental childhood ingestion of this formulation over a regular oral tablet form.

Conclusions: This case report substantiates concerns for significant toxicity with rapid symptom onset, particularly with the ODT formulation of ondansetron in the pediatric population.

KEYWORDS Ondansetron; toxicity; pediatric

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328. Pediatric exposures to expandable water beads reported to US poison centers

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Background: In recent years there has been increasing popularity of expandable water beads as a children's toy. There are recent case reports and media stories highlighting the potential dangers of these toys due to bowel obstruction with subsequent surgical intervention. There is, however, little information on the overall number of these exposures on an annual basis or what percent of unintentional ingestions end up having a surgical intervention.

Methods: A retrospective review of the National Poison Data System (NPDS) 1 January 2019 to 31 December 2022 for exposures to the generic and product NPDS codes for water bead toys in children < 6 years old was conducted. Industrial or water beads used for plants/nurseries were not included in the search.

Results: A total of 5,805 cases were identified; there were 135 (2.3%) exposures in 2019, 1,191 (20.5%) in 2020, 1,681 (29%) in 2021, and 2,798 (48.2%) by the year 2022. There were a total of 3,009 (51.8%) male patients, 2,769 (47.7%) female, and 27 (0.5%) patient's gender was unknown. There were 16 cases (0.27%) that were coded as having a surgical intervention – about 1 in 370 exposures. The most common symptoms coded were vomiting 223, abdominal pain 89, cough/choke 61, diarrhea 59, constipation 50, and fever/hyperthermia 40.

Discussion: In a 4-year retrospective review of pediatric exposures to water beads in NPDS showed a marked increase each year – there was a 2073% increase from 2019 to 2022. The majority of cases (83.5%) were managed on site of the exposure without referral to a HCF. Only 62 cases (1.1%) of cases were admitted to the hospital. Based on coding, 16 of these had a surgical intervention, presumably for removal of the water bead foreign bodies. The number of true exposures is likely greater than what is reported as NDPS as the database is created from voluntary reporting by the general public and health care practitioners. There is also a limitation as this study is based on aggregate data; the poison center narratives were not reviewed and analyzed.

Conclusions: Pediatric exposures to expandable water bead toys are increasing at a rapid rate. While rare, about 1 in 370 exposures are coded to have received a surgical intervention after an exposure. More research is needed to determine which patients are at the greatest risk of requiring surgical intervention after this foreign body exposure.

KEYWORDS Water beads; pediatric; poison center

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329. Oral ingestion of an iron-containing hand warmer in a pediatric patient

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Background: Hand warmer packets are poor heat sources that produce heat by the exothermic oxidation of reduced iron filings. Ingesting the contents is reported in adults with limited toxicity. However, to our knowledge, no pediatric cases have been reported. Consequently, pediatric toxicity remains uncharacterized.

Case report: A two-year and eleven-month-old male with autism spectrum disorder presented to the emergency department after being found with a HOTHANDS® hand warmer packet in his mouth. Half of the contents were reportedly missing. His mouth, face, and hands were covered in black powder and were washed with water prior to arrival. Initial vital signs were within normal limits for his age. Physical examination revealed no significant abnormalities. The patient remained well appearing throughout his emergency department stay and had no vomiting or diarrhea. The initial serum iron concentration four hours post-ingestion was 335 ug/dL (50–120 ug/dL). The remaining laboratory tests were within normal limits except for elevated serum creatinine to 0.71 mg/dL (0.20–0.43 mg/dL). An abdominal radiograph demonstrated radiopaque material in the stomach. Endoscopy performed approximately five hours after ingestion showed Grade IIa gastric and esophageal injury and adherent black powder with underlying mucosal ulcerations. The powder was removed

with irrigation. Intravenous pantoprazole and famotidine as well as whole bowel irrigation with polyethylene glycol via nasogastric tube were initiated post-procedure. Iron measurements subsequently fell rapidly: 213 ug/dL ten hours post-ingestion, 73 ug/dL at 14 hours, and 8 ug/dL at discharge on hospital day five. Consequently, chelation was deferred. Whole bowel irrigation was discontinued once clear rectal effluent was noted. His course was complicated by lavage-induced hyponatremia and blood loss anemia. At two months follow up after discharge, he remains asymptomatic without clinical evidence of gastrointestinal stricture formation or other sequelae.

Discussion: This case demonstrates that ingestion of less than a single hand warmer packet could potentially harm a young child. Based on the large amount of contamination noted on endoscopy, we suspect that iron absorption would have continued if not for prompt aggressive intervention and source control. The mechanism of toxicity for reduced iron is poorly characterized. A hypothesized mechanism is formation of free iron ions and iron chloride in stomach acid. Direct thermal mucosal injury also likely contributes. Management of this type of ingestion may require different considerations than iron salt ingestions. Ingestion of water can terminate the exothermic reaction, possibly reducing thermal injury. Additionally, gastric acid reducing medications may diminish ongoing release of free ions and formation of more toxic iron chloride salts. It remains unclear why the patient was asymptomatic following this ingestion. Clinically significant iron ingestions typically produce gastrointestinal symptoms such as vomiting. It is possible some of the additive ingredients limit these symptoms.

Conclusions: Pediatric ingestion of iron containing hand warmers appears to result in both meaningful iron absorption and clinically significant gastrointestinal injury. Although aggressive gastrointestinal decontamination was beneficial in this case due to retained gastrointestinal iron, further research is necessary to determine the best treatment strategies.

KEYWORDS Iron; pediatric; hand warmer

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330. CHANTER syndrome in a toddler after accidental overdose

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Background: CHANTER (Cerebellar Hippocampal and Basal Nuclei Transient Edema with Restricted Diffusion) syndrome is a rare clinicoradiological phenomenon reported in adults to occur after substance toxicity leading to unconsciousness and hypoxia. A similar pathophysiologic entity POUNCE (Pediatric Opioid-use associated Neurotoxicity with Cerebellar Edema) has been described in children, but hippocampal involvement is usually absent.

Case report: Previously healthy 2-year-old female was found unresponsive at home, last known responsive 2 hours prior. On presentation, the patient was apneic, unresponsive, cyanotic and hypotensive. She was intubated, started on norepinephrine infusion, and received fentanyl for sedation. Department of Child Services reported seeing a relative "flushing drugs down the toilet" when visiting patient's house. Patient's initial lab was notable for positive cocaine on urine drug screen and combined respiratory and metabolic acidosis on venous blood gas. CT brain showed symmetric hypodensity in the bilateral cerebellar hemispheres extending into cerebellar peduncles. MRI revealed confluent diffusion restriction in the bilateral cerebellar hemispheres with additional diffusion restriction in the bilateral hippocampi, posterior right putamen, and scattered foci in bilateral cerebral cortexes. An ICP bolt placed revealed ICP intermittently over 20 mmHg requiring hypertonic saline and hyperventilation. She remained unresponsive with pinpoint fixed pupils. Repeat CT 12 hours after presentation was concerning for worsening cerebellar edema with development of hydrocephalus. Patient was taken to OR for decompressive craniectomy and ventriculostomy. Following the decompression, patient remained GCS 3T until hospital day 3, where she started showing return of brain stem reflexes and withdrew to pain. She was extubated on hospital day 11. Her ICU course was complicated by bacterial pneumonia, volume overload and delirium. She had persistent hydrocephalus requiring VP-shunt placement. She manifested motor, swallowing and speech deficits, all improved significantly following intense physical and speech therapy. By hospital day 27, the patient was able to stand with assistance and crawl independently. She was discharged in care of an aunt with outpatient PT/OT.

Discussion: Both POUNCE and CHANTER likely fall within the same pathophysiologic spectrum. POUNCE has been reported in pediatric patients exclusively after opioid toxicity and with edema of the cerebellum with occasional limited basal ganglia and supraventricular involvement. However, CHANTER is reported in adults, and cocaine, amphetamines, benzodiazepines or ethanol have been implicated in addition to opioids. The added hippocampal lesion increases the risk for opioid-associated amnestic syndrome (OAS), although we would not know its exact effect on this patient until longer term follow-up. A limitation in our case is that while we suspected opioid co-ingestion, the patient received fentanyl within a few minutes of presentation, making determination of co-ingestion difficult. Prognosis in CHANTER syndrome is variable, but often better than expected for the severity of imaging findings. Continuing aggressive supportive care is important despite the initial poor neurological exam. It is particularly important to timely address the posterior fossa edema, which can be difficult to detect with supratentorial ICP monitors.

Conclusions: Substance overdose causing unconsciousness and anoxia could lead to CHANTER syndrome in children as well as adults.

KEYWORDS CHANTER; POUNCE; anoxic injury

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331. Pediatric gummy-formulated product ingestions treated at hospital emergency department

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Background: A variety of medications (e.g., multivitamins, melatonin) or other products (e.g., cannabis and its ingredients, including cannabidiol) are available in a gummy (chewy-gelatinous substance) formulation. Due to their similarity to gummy candy, young children may ingest these gummy-formulated products. Such ingestions by young children may result in adverse effects and/or result in emergency department (ED) visits. The objective of this study was to characterize gummy-formulated product ingestions treated at United States (US) hospital EDs.

Methods: Data were obtained from the National Electronic Injury Surveillance System (NEISS), a database of consumer product-related injuries (including all poisonings to children under age 5 years) collected from a representative sample of approximately 100 US hospital EDs. National estimates are calculated from database records according to the sample weight assigned to each case based on the inverse probability of the hospital being selected for the NEISS sample. To identify gummy formulated product ingestions involving patients age 0–4 years reported

during 2000–2021, all records with the letter groups "gummy," "gummi," "gumy," or "gumi" in the Narrative text field were reviewed, and those that appeared to be gummy formulated product ingestions were included in the study. The distribution of gummy-formulated product ingestions was determined for various factors related to patient demographics, exposure circumstances, and disposition. Due to the relatively small number of cases, national estimates were not calculated.

Results: A total of 193 gummy-formulated product ingestions by patients age 0-4 years were identified at a sample of US hospital EDs. The type of product was 98 (50.3%) melatonin, 47 (24.1%) multivitamins, 42 (21.5%) cannabis (including cannabidiol), 7 (3.6%) other dietary supplements, and 1 (0.5%) unknown. Eight (4.1%) ingestions were reported in 2000-2018, 35 (18.1%) in 2019, 55 (28.5%) in 2020, and 95 (49.2%) in 2021. Patient age distribution was 3 (1.6%) < 1 year, 27 (14.0%) 1 year, 72 (37.3%) 2 years, 58 (30.1%) 3 years, and 33 (17.1%%) 4 years; 106 (54.9%) patients were male and 87 (45.1%) were female. The patient race was 62 (32.1%) White, 47 (24.4%) Black/African American, 2 (1.0%) Asian, 9 (4.7%) Other, and 73 (37.8%) not stated in the ED record. The location of the incident was 137 (71.0%) home, 1 (0.5%) street or highway, and 55 (28.5%) not recorded. The patient disposition was treated or examined and released [142 (94.0%) not cannabis ingestions, 16 (38.1%) cannabis ingestions], treated and admitted for hospitalization [3 (2.0%) not cannabis ingestions, 25 (59.5%) cannabis ingestions], held for observation [1 (0.7%) not cannabis ingestions, 1 (2.4%) cannabis ingestions], and left without being seen/against medical advice [5 (3.3%) not cannabis ingestions, 0 (0.0%) cannabis ingestions].

Conclusions: Gummy-formulated product ingestions reported to a sample of US hospital EDs were relatively rare with the majority reported only in the last few years. This may be due to the coders increasingly mentioning the product was a gummy formulation in the Narrative in recent years. Cannabis gummy-formulated product ingestions were more likely to be admitted or held for observation at the hospital.

KEYWORDS Gummy-formulated; ingestions; emergency department

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332. Characterization of unintentional pediatric exposures with novel psychiatric medications approved by the FDA since 2011: one poison center's experience

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Background: Eight novel prescription medications have received FDA-approval for various psychiatric indications since 2011. Therapeutic categories for these drugs include atypical antipsychotics (olanzapine/samidorphan, aripiprazole lauroxil, cariprazine, brexpiprazole, lumateperone), serotonin-norepinephrine reuptake inhibitors (viloxazine), and selective serotonin reuptake inhibitors (vortioxetine, vilazodone). A search of the medical literature for these medications reveals a paucity of information regarding the clinical effects observed as a result of unintentional and/or intentional exposures in the pediatric population. We sought to review a single poison center's data on pediatric cases involving these drugs to provide better descriptive characterization of the clinical effects, therapeutic interventions recommended and/or provided, and outcomes observed in this select cohort.

Methods: A retrospective search was performed in the National Poison Data System for human exposure cases in patient's aged 0–13 years from 1 January 2011 to 31 December 2022 involving the following medications: Aristada® (aripiprazole lauroxil), Rexulti® (brexpiprazole), Vraylar® (cariprazine), Caplyta® (lumateperone), Lybalvi® (olanzapine/samidorphan), Viibryd® (vilazodone), Qelbree® (viloxazine), Brintellix® (vortioxetine). All cases were abstracted to report patient demographics, drug and dose ingested, exposure reason, management site, level of care, outcome associated with and duration of clinical effects, and therapies performed.

Results: A total of 14 cases (brexpipraozle $n = 3$, cariprazine $n = 1$, vilazodone $n = 7$, viloxazine $n = 1$, vortioxetine $n = 2$) were identified that fit our inclusion criteria. No cases regarding aripiprazole lauroxil, lumateperone, olanzapine/samidorphan were reported to our Center. 12 cases were identified as Unintentional General, one as Unintentional Therapeutic Error, and one as Intentional Suspected Suicide. Age range was 8 months to 12 years. Observed and related symptoms included agitation, confusion, dizziness, mydriasis, nausea, sedation, tachycardia, tremor, and vomiting. No reports of extrapyramidal symptoms, serotonin syndrome, or seizures were documented. 6 patients were managed at home and 8 cases were managed in a healthcare facility. 3 patients were admitted to an intensive care unit, 2 admitted to a noncritical care unit, and 3 were treated/evaluated and released from an emergency department. One patient was intubated for progressive sedation but made a full recovery within 72 hours without sequelae. All other patients had either no, minor, or moderate clinical effects for a duration of no more than 72 hours. All patients recovered without sequelae.

Conclusions: Clinical effects observed in unintentional and intentional pediatric ingestions of novel psychiatric medications FDA-approved since 2011 are similar to other medications in related drug classes. Management involves observation for onset and progression of neurologic effects with supportive care, and the potential for hospitalization. All patients recovered without any observed or reported sequelae.

KEYWORDS Pediatric; antipsychotics; antidepressants

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333. Pediatric poisonings: a 10-year-experience of the Ramathibodi Poison Center

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Background: Acute poisoning in young children is an important public health worldwide. The data of this poisoning is very limited in Asia, especially in Southeast Asia. This study was performed to evaluate the clinical characteristics and consequences of pediatric poisoning patients (< 6 years of age).

Methods: We performed a 10-year retrospective cohort study (January 2011–December 2020) by analyzing data from the Poison Center database.

Results: In total, 37,589 patients were included in the study. Most patients were male (57.1%). Their median age was 1.2 years (range, newborn – < 6 years). More than half (57.85%) of all patients were toddlers (1-3 years old). Most (94.6%) were accidental exposure. Interestingly, some were due to medication errors (594 cases), criminal/malicious exposure (58 cases). Ingestion was the main route of exposure in most patients (94.7%). Some patients (2.0%) exposed more than 1 route.

Household products (29.7%) were the most common substances that caused poisoning in our patients. The other common causes of poisoning included medical drugs (27.3%), pesticides (18.8%), technical and occupational products (16.4%), poisonous plants (2.3%) and venomous animals (1.2%). Almost all (95.2%) had excellent outcomes including no effect or minor effect. However, 182 patients (0.5%) had major effect and 115 patients (0.3%) died from poisoning. Among 115 deaths, 67 patients were male and 48 patients were female. The mean age of them was 1.3 years. Pesticides were the most common cause of deaths (32/115, 27.8%), mostly from paraquat (29/32, 90.6%) followed by organophosphate/carbamate (3/32, 9.4%). The other categories were technical and occupational products (21/115, 18.3%), medical drugs (20/115, 17.4%), venomous animals' envenomation (10/115, 8.7%) and poisonous plants (8/115, 7.0%).
Conclusions: This study determined the clinical characteristics of acute poisoning occurred in young children and highlighted that this poisoning caused health problems including deaths in Thailand. Our findings might be different from other regions' findings. Most were accidental exposure and occurred in the toddler age group. Paraquat was the most common cause of deaths. Therefore, preventive and safety interventions should be emphasized and implemented to prevent and/or decrease the occurrence of this poisoning and might help decrease fatalities.

KEYWORDS Children; poisoning; outcome

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334. Pediatric eye injuries from single use laundry detergent packets reported to PA poison centers

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Background: Due to the popularity of liquid laundry detergent packets (LLDPs) with consumers, children are at high-risk for exploratory exposure to LLDP contents and ocular exposure has been noted to be an important injury pattern. The aim of this study was to describe the epidemiology of pediatric ocular injuries sustained from exposure to LLDPs as reported to two regional poison control centers (PCCs).
Methods: In this retrospective cohort, the National Poison Data System (NPDS) of America's Poison Centers was queried for cases of ocular exposures to LLDPs (NPDS generic codes 0201182, 0201183) among children $< = 5$ years old, reported to Pennsylvania's Poison Control Centers (PCCs, for the five-year period January 2018 through December 2022. These PCCs are designated for service to the entirety of Pennsylvania and to Delaware.
Results: Database query identified 467 potential subjects, all of which were included in the study. The majority of cases (81%) were from Pennsylvania, with 44 cases (9%) from Delaware and 46 cases from other states/countries. Annual reported cases remained consistent for each year studied, ranging from 86 to 101, with an average of 93 cases per year. Nearly half (47%) of cases involved children $< = 2$ years of age and nearly all (96%) exposures occurred in subjects' own residences. 305 case calls originated from a residence and 185 (40%) were managed onsite without healthcare facility (HCF) referral. Of the 282 cases originating from, or referred to, a HCF, seven families declined HCF referral and 47 were lost to follow-up or left against medical advice. Of the remainder, 2 were hospitalized and the other 226 were treated and released. Medical outcomes varied among children with ocular exposure to LLDPs. 149 reports were judged as non-toxic or weren't followed to known outcome; 264 had minor clinical effects; 33 were coded by NPDS conventions as having moderate/major effects; and 21 patients were unable to be followed but deemed as 'potentially toxic.' Corneal abrasions were a frequent cause of moderate/major effects, with 32 such cases reported over the study period. A higher proportion (OR 2.6, 95%CI 1.2–6.0) of children < 2 years were found to have corneal abrasions (14%) compared to those 2-years-old and above (6%). These data are limited by the voluntary nature of PCC reporting, potential for miscoding, loss to follow-up, and the inability to verify the association between ocular exposure to LLDPs and reported clinical effects.
Conclusions: Children with ocular injuries due to LLDP exposure are frequently reported to PCCs, and 7% were found to have moderate-to-major clinical effects. Children under 2-years-old appear particularly susceptible to more substantial clinical effects after ocular exposure compared to older toddlers, especially with regard to corneal abrasions. Public policy should consider these risks to young children.

KEYWORDS Laundry detergent; corneal abrasion

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335. Fatality from levamisole ingestion

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Case report: 64yo M with no history of coronary artery disease, heart failure, venous thromboembolic disease; and not on any medication per family was transported to the ED with active CPR in progress after an accidental drug ingestion. The patient was in his usual state of health, without any shortness of breath, chest pain or any other symptoms prior to the ingestion. He accidentally drank approximately 3–4 oz of a clear liquid in an unlabeled water bottle in his refrigerator. The bottle, which had been in the fridge for several years, contained Prohibit™ powder (46.8 g of Levamisole Hydrochloride per packet; one packet dissolved in 20 oz water) intended for use on his pets. About 20 minutes later, the patient felt unwell and was experiencing nausea, vomiting, tremors, and visual changes. He was taken to a nearby fire station where he was profoundly bradycardic. First responders gave 1 mg atropine without significant response and the patient quickly became unresponsive and went into cardiac arrest. Intubation was attempted without success, and he ultimately received a supraglottic airway prior to being intubated once in the ER. He received 3 rounds of epinephrine for out of hospital CPR without ROSC. He was in PEA upon arrival to the ER with a moment of ROSC after arrival. He then went into ventricular fibrillation and then pulseless ventricular activity despite multiple shocks, bicarbonate, and calcium gluconate. The patient ultimately expired after persistent asystole. A post-mortem levamisole concentration of 19 mcg/mL was obtained.
Discussion: This is a unique case of severe systemic toxicity after accidental ingestion of levamisole hydrochloride. There are reports of levamisole toxicity mainly from adulterated illicit substances. The most reported toxicities include hematologic signs such as agranulocytosis, leukopenia, and dermatologic signs such as skin necrosis due to the drug's effect on immunologic cells. Two case reports of deaths related to cocaine adulterated with levamisole reported post-mortem levamisole concentrations of 49997 and 1606 ng/mL, obtained from cardiac blood samples. These concentrations within adulterated cocaine are compared to the 19 mcg/mL found in our patient, without the presence of co-founding substances such as cocaine. Such a large post-mortem concentration suggests a large ingestion, which can also be inferred from the total 46,800mg of levamisole present in the bottle. In

comparison, when used in humans as an antihelminth, single doses of 50–150 mg were used. Levamisole is a nicotinic agonist in animals, stimulating acetylcholine receptors. Cholinergic toxicity would explain the patient's sudden profound bradycardia leading to arrest, persistent hypoxia despite adequate ventilation and ultimately his death. Aminorex, a levamisole metabolite, also has amphetamine-like properties such as the ability to cause pulmonary vasoconstriction leading to pulmonary hypertension. Lastly, levamisole is a weak reuptake inhibitor of norepinephrine and dopamine, but in massive ingestion could contribute to catecholamine surge. These plausible mechanisms, the patient's rapid clinical deterioration along with the large post-mortem concentration strongly suggest levamisole as cause of death.
Conclusions: Large ingestion of levamisole can cause severe systemic toxicity, leading to acute decompensation and death in previously healthy patient.

KEYWORDS Levamisole; prohibit; dewormer ingestion

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336. Diphenhydramine overdose and antimuscarinic toxicity in a 36-week pregnant mother and neonate

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Background: Limited data exists on the transplacental distribution of diphenhydramine and its potential effects on the fetus.
Case report: A newborn baby girl, born at 36 weeks via primary C-section under general anesthesia for fetal distress, was admitted to the NICU for respiratory failure requiring CPAP support. Toxicology was consulted due to maternal diphenhydramine overdose and potential anticholinergic toxicity in the neonate. The mother, a 38-year-old female with a history of alcohol and benzodiazepine use, was directly admitted to labor and delivery for non-reassuring fetal heart tracing (NRFHT). She reported taking diazepam 10 mg four times per day and venlafaxine 150 mg every morning and 75 mg every evening. After admission, the patient revealed she had ingested approximately 50–60 tablets of diphenhydramine of unknown dose within the last 24 hours, with her most recent dose around 12 hours ago. She experienced abdominal pain, nausea, anxiety, and urinary retention but denied co-ingestants. Her vital signs were normal, and on examination showed agitation and mydriasis. Initial recommendations included benzodiazepine as needed for agitation, catheterization for urinary retention, core temperature monitoring, and toxicology labs. Overnight, she became extremely agitated despite lorazepam 2 mg, leading the OB team to proceed with a C-section under anesthesia for maternal comfort. The baby was born with APGARs of 2 and 7 at 1 and 5 minutes, respectively. She was found apneic, requiring CPAP for 1.5 days. The baby had no urinary retention and showed no apparent antimuscarinic toxidrome. She experienced mild neonatal abstinence syndrome, which resolved on day of life 3. The baby's serum diphenhydramine levels were 1366 ng/ml.
Discussion: Diphenhydramine's high lipophilicity allows it to penetrate the blood-brain barrier well, suggesting transplacental transport. This has been demonstrated in sheep models. One previous case report showed transplacental distribution. Although there was no obvious peripheral antimuscarinic toxicity in the neonate, serum diphenhydramine levels were elevated to 1366 ng/ml. A few studies suggest diphenhydramine may have tocolytic and cervical dilating effects. Due to multiple confounding factors, it is unclear whether the diphenhydramine overdose contributed to the NRFHT or preterm labor.
Conclusions: Diphenhydramine demonstrates transplacental redistribution and may contribute to premature labor in pregnancy.

KEYWORDS Neonatal diphenhydramine overdose; transplacental diphenhydramine; diphenhydramine overdose in pregnancy

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337. Clinical outcomes of unintentional double doses of dofetilide and sotalol reported to a single US poison center

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Background: Dofetilide and sotalol are potassium channel-blocking anti-arrhythmic drugs used for the treatment of tachyarrhythmias. Both medications can cause QTc prolongation and are associated with risk for Torsade de Pointes. The narrow therapeutic index of these drugs is a concern when a patient unintentionally takes a double dose of their medication. This study aims to describe any adverse effects from unintentional double dosing of either dofetilide or sotalol.
Methods: This was a retrospective chart review of unintentional overdose of dofetilide or sotalol reported to a single poison center from 1/1/2002–12/31/2021. Included records had an acute unintentional ingestion of one or more doses of either dofetilide or sotalol. Intentional overdoses were excluded. Data was manually extracted from the electronic medical record in a predefined data sheet. Assessment of other QT-prolonging medications was performed using crediblemeds.org.
Results: 185 dofetilide or sotalol exposures were screened, and 125 met inclusion criteria. The majority of exposures were to sotalol (88%). There were 63 exposures in females (50.4%) and the median age was 71 years (5 months-99 years). In total 95 exposures (76%) were managed at home. Of 15 dofetilide patients, nine (60%) were seen in a healthcare facility. Two of the nine patients were taking other medications known to prolong QT. An ECG was assessed in all nine patients and none had a QTc recorded over 500ms. Of 110 sotalol patients, 21 (19.1%) were seen at a healthcare facility. Of these 21, 10 (47.6%) had ECGs obtained. Five of these 10 patients were taking other medications known to prolong QT. Only one sotalol exposure had a QTc above 500 ms (515 ms). Of cases followed to a known outcome the majority had no or minor effects ($n = 31$). Moderate effects occurred in 8 exposures. Bradycardia was the most common clinical effect (dofetilide n = 2, sotalol $n = 6$). Other clinical effects include dizziness/vertigo ($n = 5$), hypotension (n = 4), QTc prolongation ($n = 3$), or others ($n = 11$). Eleven patients did not have reported clinical effects. No patients experienced major effects and there were no deaths. Of patients seen in a healthcare facility, four (13.3%) were admitted. Of the patients who experienced bradycardia ($n = 8$, 26%), it is unclear if it was a new finding or baseline for the patients.
Conclusions: Our evaluation of patients with a double dose of dofetilide or sotalol revealed a single patient with a recorded QTc over 500 ms. This study revealed double doses of dofetilide or sotalol do not result in significant QTc prolongation.

KEYWORDS QTc prolongation; unintentional ingestion

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338. A tale of two horsewomen: a case series of equine pergolide toxicity

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Background: Veterinary medication exposure may result in human toxicity with approximately 7,000 cases reported to poison centers in 2021. There is a paucity of literature on the management of the poisoned patient secondary to pharmaceuticals intended for equine use. Pergolide is a dopamine and serotonin receptor agonist and is currently approved to treat equine Cushing's disease. It was previously approved in the US to treat Parkinson's disease in humans; however, it was withdrawn from the market in 2007 due to association with valvular heart disease. We report two cases of pergolide toxicity in horse owners following unintentional ingestions.
Case series: A 67-year-old woman presented to the emergency department (ED) via emergency medical services (EMS) following an unintentional ingestion of her horse's 5 mg pergolide. Within 15 minutes of ingestion she developed nausea, vomiting, chills, diaphoresis, lightheadedness and sedation. Her blood pressure (BP) for EMS was 84/46 mm Hg, and she was administered 1.2 L of intravenous (IV) fluids. BP in the ED improved to 102/63 mm Hg. An electrocardiogram (ECG) demonstrated sinus rhythm with first degree atrioventricular (AV) block, similar to previous. Routine laboratory testing demonstrated mild hypokalemia and mild hyperchloremia. Point-of-care cardiac ultrasound was unremarkable. She was treated with aggressive IV fluids and antiemetics, and was subsequently observed in the hospital due to persistent sedation and nausea. The patient was asymptomatic the following day. Comprehensive urine drug testing (LC/MS) was sent to identify any additional co-ingestions and only detected caffeine. Pergolide is not included on this assay and serum concentration was not available. A 75-year-old woman with history of anxiety on citalopram presented to the ED after unintentional ingestion of her horse's 0.5 mg pergolide. Shortly after ingestion, she had an acute episode of neuromuscular rigidity without loss of consciousness. She also developed vomiting, dizziness, and sedation. BP on arrival to the ED was 117/63 mm Hg. She experienced orthostatic hypotension with a precipitous drop in BP to 80/50 mm Hg which resolved with 1 L IV fluid. ECG was remarkable for sinus rhythm with first degree AV block. Routine laboratory testing was unremarkable. She was administered antiemetics and her symptoms resolved after 9 hours, at which point she was discharged. Comprehensive urine drug testing (LC/MS) detected caffeine and citalopram.
Discussion: Both of our patients experienced similar clinical presentations resulting from their unintentional pergolide ingestions. Toxicity resulted in hypotension responsive to intravenous fluids, sedation, and intractable nausea and vomiting for several hours. Previously recommended human dosing started at 0.05 mg and was titrated to reach an average total daily dose of 3 mg. Our patients received doses 10x and 100x of the recommended starting dose, with the latter having symptoms for an additional 15 hours. Clinical presentation was similar to toxicity resulting from other dopamine agonists.
Conclusions: Veterinary medication ingestion presents a unique challenge to clinicians as the drug may have limited human toxicity data and/or recommended animal dosing may differ greatly from human dosing. Case reports of human toxicity may assist with anticipating the clinical course and guiding medical decision making.

KEYWORDS Pergolide; dopamine agonist; veterinary medication

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339. Severe electrolyte abnormalities in a pediatric patient secondary to sodium phosphate enema administration treated with hemodialysis

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Background: Phosphate-containing enemas (PCEs) are widely used to treat constipation. Occasionally, their use is associated with severe adverse effects, including dehydration, electrolyte abnormalities, arrhythmias, seizure, and death. Young children and elderly individuals with impaired kidney function have increased risk of adverse effects from using PCEs. We report a case of a child who developed marked electrolyte abnormalities, severe dehydration, and hypothermia after the administration of two adult PCEs.
Case report: A 3-year-old female with a history of caudal regression syndrome and neurogenic bowel and bladder presented to the emergency department with lethargy, vomiting, diarrhea, and weakness 30 minutes after administration of two adult enemas, each containing 19 grams monobasic sodium phosphate and 7 grams dibasic sodium phosphate, through her MACE (Malone antegrade colonic enema) channel to treat constipation. She was previously prescribed pediatric enemas containing 9.5 and 3.5 grams of monobasic and dibasic sodium phosphate, respectively. On arrival, she was found to have a heart rate of 150 bpm, respiratory rate of 40 bpm, and temperature of 34.3 °C; remaining vitals were stable. She was lethargic with poor muscle tone, and her capillary refill was greater than three seconds. She had facial twitching, positive Trousseau sign, and a distended, non-tender abdomen. Her remaining physical exam was unremarkable. Laboratory testing revealed: WBC 19,500 cells/L, hematocrit 44.5%, sodium 162 mmol/L, potassium 6.5 mmol/L, chloride 94 mmol/L, bicarbonate 6 mmol/L, calcium 5.7 mg/dl, phosphate $>$ 26 mg/dl, pH 6.9, pCO_2 40 mmHg, and lactate 9 mmol/L. Acetaminophen, aspirin and alcohol were negative. An electrocardiogram revealed sinus tachycardia, ST depression in inferior leads and a prolonged QTc. Imaging was unremarkable apart from severe constipation. Resuscitation consisted of normal saline boluses (40 ml/kg total), a sodium bicarbonate bolus and infusion, magnesium sulfate, and calcium gluconate. She was transferred to the pediatric intensive care unit where a manual fecal disimpaction and one session of hemodialysis corrected her severe metabolic acidosis, hypernatremia, hyperphosphatemia and hypocalcemia. She continued to improve and was discharged three days later.
Discussion: Although PCEs are generally well tolerated, toxicity can occur in adults with comorbidities and in pediatric patients secondary to dosing errors. Pediatric PCEs typically contain half the dose of sodium phosphate found in adult enemas, and most cases of pediatric toxicity result from using adult formulations; as such, it is crucial for healthcare professionals to educate caregivers on the differences between these enemas to avoid potentially life-threatening sequelae. Adverse effects include severe dehydration from fluid loss, electrolyte imbalance, altered mental status, and arrhythmias. Hyperphosphatemia and hypocalcemia usually respond to supportive care with fluid administration and

calcium replacement. In severe cases, hemodialysis might be necessary to correct the acid-base and electrolyte abnormalities. The criteria to initiate hemodialysis are not well established and often need a discussion between nephrologists and toxicologists.
Conclusions: Clinicians should be aware of differences between phosphate content of adul versus pediatric PCEs. Supportive care, electrolyte replacement, and potentially hemodialysis are the cornerstones of managing PCE toxicity.

KEYWORDS Phosphate-containing enema; hyperphosphatemia; hypocalcemia
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340. Tenfold overdose of risdiplam in a neonate with spinal muscular atrophy: a case report

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Background: Spinal muscular atrophy (SMA) is an autosomal recessive neurologic disease caused by deficiency in production of SMN protein from the survival of motor neuron 1 (SMN1) gene resulting in muscular weakness and reduced life expectancy. Survival motor neuron 2 (SMN2) is a closely related gene that can produce low concentrations of functional SMN protein. Risdiplam (Evrysdi®) received FDA approval in August of 2020 as an orally administered medication targeting SMN2-directed RNA slicing modifier resulting in increased concentrations of functional SMN protein. No human toxicologic data are available. Animal studies show developmental, reproductive, and retinal toxicity with chronic administration.
Case report: A 16-day-old female was born via induction at 39 weeks due to intrauterine growth restriction and concern for arterial insufficiency with preliminary newborn screen positive for spinal muscular ataxia. She was brought into the emergency department for evaluation following risdiplam overdose. Her mother reported administering patient's first dose of risdiplam that morning. Patient was prescribed 0.45 mg daily, but she received 4.5 mg in first dose. Mom stated the pharmacy had provided 10 mL syringes and she drew up 6 mL of 0.75 mg/mL solution rather than with prescribed 0.6 mL. She noticed the error following administration. She notified the neurologist who referred patient to the ED. Mom reported patient remained in her usual state of health without fevers, emesis, diarrhea, coughing, rashes, or inconsolable crying. Physical exam showed a well appearing neonate with vital signs within appropriate range for age (BP 92/55, HR 159, RR 48, Temp 36.7 Deg C, SpO_2 96% on room air). Laboratory evaluation with CBC, CMP, and EKG were normal. Toxicology and neurology services were consulted. Her parents declined admission for observation. Neurology discussed with manufacturer representative who recommended holding dose for 2 days. She appeared at her baseline at a follow-up Neurology clinic visit one week later. Patient's confirmatory testing for SMA showed 0 copies of SMN1 and 2 copies of SMN2 suggesting severe type 1 SMA phenotype. The patient's mother gave consent for the case report at time of initial presentation.
Discussion: Risdiplam is approved for use in patients less than 2-months of age for SMA. Clinical trials for infantile onset SMA showed increased SMN protein at all ages of treatment. Reported adverse effects include fever, diarrhea, rash, aphthous ulcers, arthralgias, and increase frequency of upper respiratory tract and urinary tract infections. Recommended dosing for patients under 2 months of age is 0.15 mg/kg/d. Human clinical toxicology data are limited. Juvenile rats showed decreased weight gain and tibial length with risdiplam from 4 through 20 days of life. Monkeys had irreversible retinal toxicity on electroretinography after 20 weeks of daily risdiplam at 3, 5, and 7.5 mg/kg/d but with no effect at 1.5 mg/kg/d. This case illustrates a tenfold dosing error, which remains common in pediatric patients.
Conclusions: Risdiplam, a novel medication for treatment of SMA, had no apparent toxicity in acute 10-fold dosing error in neonatal patient.

KEYWORDS Risdiplam; pediatric; medication error
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341. Beyond one pill can kill: a decade of deaths reported to America's Poison Centers

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Background: Poisoning represents a significant but preventable cause of death among children under 6 years of age. One Pill Can Kill has been an effective tagline used for poison prevention efforts in pediatrics and toxicology for decades. This study looks at National Poison Data System data to better understand current national trends in pediatric fatal poisonings reported to poison centers.
Methods: We reviewed pediatric fatality abstracts in the 0-5 age group submitted to poison control centers for the ten-year period 2012–2021. Cases that were coded as Undoubtedly Responsible and Probably Responsible were reviewed; cases coded as Contributory, Probably Not Responsible, Not Responsible, and Unknown were excluded from analysis. There were 290 pediatric fatality abstracts submitted during the study period; 187 cases were coded as Undoubtedly Responsible or Probably Responsible for death. Data on these 187 cases were abstracted and analyzed using descriptive statistics for demographics, substances, and reason for exposure.
Results: The majority of deaths occurred in males (55%) and children 12 to 35 months of age (52%). Most exposures were coded as unintentional (56%) or environmental (26%), while a smaller but alarming number were deemed due to malicious intent (12%). Opioids (26%) were the most common cause of death in this study, followed by fire-related smoke inhalation (21%) and button battery ingestions (7%). Notably, fentanyl exposures increased from zero during the first half of the study period (2012–2016) to eleven during the second half of the study period (2017–2021).
Conclusions: Poisoning continues to be a tragic cause of pediatric death. This study serves as an update and expansion on previous One Pill Can Kill publications as some of the top causes of pediatric death in this study do not involve OTC or prescription pills. Opioids were the most common substances leading to fatal poisoning in children under 6 years of age. Public health officials combating the opioid epidemic should consider targeted interventions to protect this vulnerable group.

KEYWORDS Pediatric
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342. A re-evaluation of pediatric poisoning fatalities using NPDS data

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Background: Toddlers and young children are occasionally exposed to dangerous medications and toxins through

exploratory ingestions. Several frequently referenced papers have described a list of medications or toxins that are potentially fatal in small or single dose exposures. These lists may not reflect the actual frequency of contemporary fatalities. Our aim was to determine which drug and toxin exposures resulted in death in children < 6 years of age reported by US poison centers.
Methods: We performed a retrospective study of pediatric deaths using National Poison Data System (NPDS) and fatality abstract data from 1 January 2011 to 31 December 2021. Inclusion criteria included all cases in children < 6 years old coded with medical outcome of death or indirect death. Cases were excluded if the fatality abstract adjudicated the death as unknown relationship, unrelated, or probably unrelated. For cases with more than one substance, a single author reviewed each fatality abstract to determine the substance most likely responsible for the death. If a primary substance could not be determined the case was categorized as a poly-substance etiology. Case fatality rate was estimated by dividing the number of fatalities for each substance category by the total number of single substance exposures reported during the same time using the generic code name. The primary endpoint was to identify the agents associated with pediatric fatalities over 10 years. Secondary outcomes included describing case fatality rate for each substance over the 10-year period.
Results: The search identified 343 individual cases and after exclusions, 220 individual cases remained with 282 total substances. Of the 220 cases, 81% were single substance exposures. Mean age was 2.1 (SD 1.3) years old with 42% female, 56% male, and 2% unknown. The majority (76.8%) of calls originated from healthcare facilities. Most fatalities over the 10-year period were due to smoke inhalation (22.3%) and opioids (22.3%). For substances with at least 500 exposures, the highest fatality rate (1.3%) was attributed to fentanyl.
Conclusions: There are several potential limitations to this study. NPDS data is generated from discussion between healthcare professionals and regional poison centers which can result in inaccurate acquisition and/or recording of information. Confirmatory drug testing for cases is not available, however, fatality abstracts were utilized to enhance accuracy of causality. Prior literature frequently omits common household substances such as hydrocarbons and batteries, which together made up 14% of fatalities over the last decade. In summary, opioids and smoke inhalation had the highest number of fatalities while drugs such as quinine, camphor, methyl salicylate, and podophyllin, historically cited as "pill can kill" agents, had no fatal cases reported in the last decade.

KEYWORDS One pill can kill; pediatric fatality; NPDS

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343. 10-Year retrospective review of angiotensin-converting enzyme (ACE) inhibitors and angiotensin II receptor blockers (ARB) toxic doses in children < 6 years old

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Background: The objective of this 10-year retrospective study is to evaluate toxic doses of angiotensin-converting enzymes (ACEs) and angiontensin II receptor blockers (ARBs) in pediatrics. A 2013 study observed hypotension in eight cases at lisinopril dose > 4 mg/kg. Another retrospective study set a minimum ARB dose where serious outcomes were likely to be seen for adults at valsartan dose > 320 mg. Therefore, toxic doses for ACEs and ARBs are not well-established in children.
Methods: Followed-up cases of accidental ingestions of known doses of either an ACE or ARB in children < 6-years-old were selected from the 2011 to 2021 Texas Poison Control Network database. Polydrug ingestions were excluded. Each case was assigned a severity score based on adverse effects (0 = no effect, 1 = mild, 2 = moderate, 3 = severe). Primary endpoint for hypotension was defined per PALS guidelines. Relative risks with 95% CI, χ^2 tests, and linear regression models (ingested doses plotted against lowest systolic blood pressure [SBP] recorded) with R^2 were utilized to analyze results comparing ingestions of > 4 mg/kg lisinopril equivalent dose (EQD) and > 200 mg losartan EQD to doses of < 4 mg/kg and < 200 mg, respectively.
Results: 390 ACE ingestion cases were selected. 382 cases had severity scores of 0 and 7 had scores of 1 (emesis [$n = 2$], bradycardia [$n = 1$], facial flushing [$n = 1$], and mild transient hypotension [$n = 3$]). All symptoms resolved spontaneously without interventions. One had a score of 2 with a dose 5.22 mg/kg of lisinopril (dopamine used after blood pressure dropped to 86/42 mm Hg). Children ingesting > 4 mg/kg lisinopril EQD was not shown to have higher risk of developing adverse events than those ingesting < 4 mg/kg, but results were not statistically significant (RR 0.86, 95% CI 0.108–6.844, $P = 0.89$). Lisinopril EQD did not have a statistically significant effect on severity scores ($\chi 2$ statistic 0.20, $P = 0.89$). Linear regression model showed no significant relationship between lisinopril EQD (mg/kg) and SBP ($R^2 = 0.0004$).49 ARB ingestion cases were selected. 46 cases had severity scores of 0 and 3 with scores of 1. The mild effects were described as "a little tachycardic" ($n = 1$) and emesis ($n = 2$). All symptoms resolved without treatments. Children ingesting > 200 mg losartan EQD were at higher risk of developing adverse events than those ingesting < 200 mg, and results were statistically significant (RR 23.5, 95% CI 2.68-206.36, $P = 0.0044$). Losartan EQD had a statistically significant effect on severity scores ($\chi 2$ statistic 15.26, $P = 0.000094$). Linear regression model showed no significant relationship between losartan EQD and SBP ($R^2 = 1^{E-5}$).
Conclusions: In children, inadvertent ingestions of ACEs and ARBs may not necessitate a referral to a health care facility. However, lisinopril EQD > 4 mg/kg and losartan EQD > 200 mg should receive diligent home follow-ups. We cannot confidently conclude if ACE ingestions were the contributing factor for the transient hypotension, as results were not statistically significant ($P = 0.89$). We cannot conclude the minimum losartan EQD for referral due to no reports of inadvertent ingestions beyond 300 mg during the collection period sampled in this research project.

KEYWORDS ACE; ARB

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344. Increase in fentanyl exposures in children 0–5 years old: a 4 year NPDS analysis

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Background: The United States has been plagued by a historic opioid epidemic. This epidemic has worsened with the widespread use of synthetic non-methadone opioids - including fentanyl and fentanyl analogs. According to the CDC, it is estimated that synthetic opioids killed over 71,000 Americans out of 107,000 opioid-related deaths in 2022. The majority of opioid

deaths have been in the adult cohort; however, with increased use and distribution of synthetic opioids there is increased risk of exposure amongst the pediatric cohort ≤5 years old.
Methods: We performed a retrospective review of the National Poison Data System (NPDS) January 2019 –31 December 2022 for exposures with the generic NPDS code for non-prescription fentanyl in ages 5 years and younger.
Results: Pediatric non-prescription fentanyl intoxications for 2019-2022 are described. From 2019 to 2022, the percentage male was 50, 48.8, 47.1, and 53.9%, respectively. In 2020–2022, the majority of exposures occurred in the child's own residence (75.6% in 2020, 79.8% in 2021, and 80.9% in 2022); 2019 was an outlier with 0/2 exposures occurring in the child's own residence. There is a trend of increasing severity of exposure (coded as "major effect" or "death" within the NPDS dataset) across the study period with 0, 19, 68, and 96 cases for 2019, 2020, 2021, and 2022, respectively. In 2021 and 2022, the largest number of severe exposures were seen in 1-year-olds. This age range also accounted for the largest number of total exposures in 2020 and 2021.
Conclusions: In this retrospective analysis, we demonstrate an increasing trend of exposure with non-prescription fentanyl among the pediatric cohort ≤5 years with an increasing number of cases requiring critical care level of treatment. Fentanyl intoxications increased over the study period and an associated rise in the number requiring critical care and invasive management such as intubation is concerning for increasing rates of severe illness (as opposed to increases in testing). The sickest age group appears to be 1-year-olds. An increasing proportion of exposures occurring in the patient's residence may be associated with increased household availability of fentanyl. A limitation of this study is that it relies on NPDS data which often is reliant on history provided by the caller and may lack analytical confirmation and this study may represent a spectrum of non-fentanyl synthetic opioids. A further limitation is that from this data it is unclear if the increase in exposure severity is due to increasing exposure doses or just increasing exposure rates, and this warrants further study.

KEYWORDS Fentanyl; opioid epidemic; pediatric exposure

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345. Pediatric perampanel ingestion leading to prolonged toxicity

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Background: Perampanel is a third generation antiepileptic medication approved for the treatment of partial epilepsy in adults as well as an adjunctive treatment for primary generalized tonic clonic seizures in children. The mechanism of action is unique among antiepileptics and functions as a noncompetitive antagonist of the alpha-amino-3-hydroxy-5-methyl-4-isoxazole-propionic acid (AMPA) glutamate receptor on postsynaptic neurons. Prolonged coma has been reported in adult overdoses. Other reported clinical effects include central nervous system depression, agitation, ataxia, and bradycardia. There is limited information on the clinical effects of perampanel in children, with only a few unintentional ingestions reported. We report a case of a pediatric perampanel ingestion leading to prolonged alteration in consciousness.
Case report: An otherwise healthy 21-month-old male (11.1 kg) ingested up to 48 mg (4.3 mg/kg) of his older sibling's perampanel. Within 30 minutes of ingestion, he became somnolent. On arrival to the emergency department, he had one episode of emesis and remained lethargic with minimal response to stimuli and intermittent irritability. He had mild central hypotonia with a head lag, he was unable to sit independently, and had gait instability, where he previously had been able to walk independently. His vital signs were: heart rate, 108 beats per minute; blood pressure, 99/61 mm Hg; temperature, 98 °F (36.8 °C); respiratory rate, 30 breaths per minute. A serum perampanel concentration obtained on the first day of admission was 580 ng/mL (therapeutic range 100–800 ng/mL). The patient had ongoing episodes of somnolence and intermittent irritability that slowly improved during hospital admission. He also had slow improvements in tone and gait and was subsequently discharged home after 3 days with normal vital signs, mental status and baseline gait.
Discussion: After ingestion, perampanel peaks in 0.5–2.5 hours and has a prolonged half-life of 105 hours. The onset of clinical manifestations in our patient occurred within 30 minutes and did not resolve until post-admission day 3. Pediatric case reports of acute toxicity have described varying resolution times, ranging from a few hours to several days. Consistent with prior case reports of pediatric perampanel ingestions, our patient developed central nervous system toxicity including ataxia, sedation and irritability. Despite previous reports of bradycardia with lower ingested doses, our patient had no cardiovascular effects and remained hemodynamically stable throughout his clinical course. There were no metabolic derangements observed in our case, despite reports of hyponatremia in other previously reported perampanel overdoses.
Conclusions: Perampanel is a newer antiepileptic with a novel mechanism of action. Toxicity in patients, particularly pediatric patients, is not well understood but involves significant central nervous system effects in overdose, as well as other reported cardiovascular abnormalities including bradycardia and hypotension. Additional studies are needed to determine the toxic dose in pediatric populations and to determine whether serum perampanel concentrations correlate with clinical effects. Further research is also required to determine whether there is an association between ingested dose, predicted clinical effects, and duration of effects.

KEYWORDS Perampanel; pediatric

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346. Systemic lidocaine toxicity secondary to topical application in a pediatric patient

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Background: Lidocaine is a commonly used topical anesthetic. Traditionally, over-the-counter lidocaine spray preparations consist of 4% lidocaine. Under physiologic conditions, routine topical lidocaine administration does not result in systemic toxicity. However, when utilized on highly vascularized areas or areas with violated dermal integrity, lidocaine may be excessively absorbed and cause severe systemic toxicity. We present a rarely encountered case of local lidocaine administration resulting in severe systemic toxicity, including altered mental status and multiple seizures.
Case report: A 4-year-old female with no prior seizure history presented to the hospital with new onset seizures shortly after sustaining multiple burns. Prior to hospital arrival, the patient had been inadvertently placed in a shower with scalding water and subsequently sustained burns to her face, chest, abdomen, and right upper extremity (approximately 15% total body surface area). Immediately after noting the burns, her mother applied

aloe vera ointment. Approximately three hours later, the patient was in extreme pain and her mother wiped off the ointment and noticed skin erythema, peeling and areas of bleeding. Topical burn cream containing lidocaine and lidocaine spray were applied to help with the pain. A few minutes after lidocaine application, the patient became lethargic and apneic. Chest compressions were started, and she then developed multiple generalized tonic-clonic seizures. EMS arrived, administered midazolam, and the seizures abated. The patient arrived at the hospital, gradually returned to baseline, and was placed on a dexmedetomidine infusion and given ketamine and midazolam for sedation and burn dressing changes. The patient's laboratory studies, including the basic metabolic panel, were within normal limits. Telemetry showed no abnormalities. The patient was transferred to the Pediatric Intensive Care Unit for airway management, burn debridement, and further medical workup. Continuous EEG monitoring was performed and no further seizures were noted. Neurology evaluated the patient and felt her seizures were provoked by lidocaine toxicity after ruling out other causes. She had no further seizures during her hospitalization. A comprehensive toxicology panel was ordered and returned with a serum lidocaine level of 0.11 mg/L.

Discussion: This case represents an uncommonly seen scenario of systemic lidocaine toxicity secondary to topical lidocaine administration to an injured dermis. The likelihood of systemic toxicity may be higher in pediatric patients compared to adults for several reasons, including increased relative body surface area and dermal anatomy. Although significant neurologic effects were noted from the lidocaine toxicity, fortunately no cardiac effects were noted. The patient did not receive fat emulsion therapy as systemic lidocaine toxicity was not considered until later in the patient's hospitalization course. Her elevated serum lidocaine level and absence of subsequent seizures since the event suggest systemic lidocaine toxicity as the source of her symptoms.

Conclusions: The application of topical lidocaine to an impaired dermis may cause systemic lidocaine toxicity, particularly in pediatric patients. This should be considered in an undifferentiated patient with altered mentation and seizures who is receiving topical lidocaine with an impaired integumentary system.

KEYWORDS Lidocaine; seizure; pediatrics

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347. Plumbus still among us: a case report of lead encephalopathy presenting as status epilepticus in a pediatric patient

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Background: Regulatory bans on the use of leaded household paint and gasoline have significantly reduced the incidence of severe lead poisoning and lead encephalopathy in the United States. Given the rarity of these presentations, challenges arise in their recognition and management.

Case report: This is a single patient case report. A four-year-old-girl with a history of speech delay and no primary care since 2 months of age presented with afebrile status epilepticus prompting intubation, sedation, and admission to the Pediatric ICU. She had a hemoglobin of 4.7 mg/dL with an MCV of 68 fL, and was transfused a total of 30 cc/kg pRBCs on hospital day (HD) 2. A blood lead level (BLL) obtained on HD2 and resulted on HD4 was 116.2 mcg/dL. An abdominal film revealed no radiopaque foreign bodies, and the patient was started on succimer 350 mg/m^2 TID via nasogastric tube (NGT) on HD4. The patient was transitioned to a continuous infusion of $CaNa_2EDTA$ 1500 mg/m^2 q24h, and BAL 75 mg/m^2 q4h, once procured on HD5 and HD6, respectively. On HD9, the BLL was 40.8 mcg/dL, and the patient was transitioned to succimer 350mg/m^2 TID via NGT on HD10. Her PICU course was complicated by ongoing vEEG-confirmed epileptiform activity requiring titration of multiple sedatives for burst suppression, hypertension likely secondary to sedation withdrawal, and neuroimaging reflective of frontal lobar cortical and subcortical vasogenic edema treated with mannitol. She was ultimately extubated and transitioned to high-flow oxygen on HD10, and subsequently to room air and the general pediatric floor on HD13. Home inspection revealed the presence of lead on window sills with chipped paint and bite marks, with $>$ 10,000 ppm of lead within the surrounding dust.

Discussion: Lead encephalopathy was suspected based on the co-occurence of refractory status epilepticus and severe microcytic anemia. Once the diagnosis was established, therapy was focused on expedient and aggressive chelation. Given the need to procure chelators from neighboring hospital pharmacies, therapy was initiated with oral succimer, transitioned to 5-day courses of intravenous CaNa2EDTA and intramuscular BAL once obtained, and followed by oral succimer. The patient's BLL did not rebound significantly after transition to oral succimer, suggesting efficacy with this treatment protocol in preventing such spikes. By HD20, the patient was felt to be near her pre-morbid neuropsychiatric baseline per her mother. BLL was 33 mcg/dL on HD26; Succimer was discontinued on HD28 after a full 19-day course.

Conclusions: Lead encephalopathy remains a critical diagnosis in pediatric patients who present with altered mentation or refractory new-onset seizures. A history of pica, developmental delay, recent immigration, or poor access to routine healthcare should be explored. Our case highlights this and key aspects of management, including the importance of timely diagnosis, a flexible approach to chelation in the face of drug shortages, and a novel strategy of bridging to succimer after the completion of 5 days of parenteral therapy.

KEYWORDS Lead encephalopathy; pediatric poisoning; chelation

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348. Argh! scurvy in a child from extreme food avoidance

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Background: Historically, scurvy was considered a disease affecting sailors because fruits (rich in vitamin C) were not available on long sea voyages, and human stores of vitamin C become depleted in 1–3 months. Today, scurvy is most common in developing countries where malnutrition is endemic but may occur in developed countries. Predisposing risk factors include following a restrictive diet low in vitamin C, dialysis, having an eating disorder, living with dementia or mental illness that interferes with diet, alcoholism, smoking, gastric bypass surgery, malabsorptive syndromes, and poverty.

Case report: A 5-year-old with a history of nonverbal autism presented to an ED with 2 weeks of progressive difficulty walking. She primarily communicates by gesturing and had localized pain via sign to family as in her knees. Over 2 weeks, she had progressed from having difficulty walking, to not walking at all, to not being able to even roll over in bed. She had no known

trauma, and no signs of illness other than a mild cough. She had subjective fever 2 weeks prior and on the night before presentation. No rash, no medications. Wt 56%ile and Ht 97%ile. She was difficult to assess given her lack of cooperation, but there was no appreciable joint swelling, warmth, deformity, erythema, or localizable tenderness. She was noted to keep B lower extremities flexed at the hips and knees and resisted attempts to fully extend them. Initial laboratories showed a mildly elevated CRP of 2.5 mg/dL (0–0.7), ESR of 49 mm/hr (0–12), and CK was normal 143 u/L (0–238). CBC revealed only a mild microcytic anemia with Hgb 11.3 g/dL (11.5–15.5), Hct 34.3% (35–45), MCV 70.9 fL (77–95). X-ray imaging revealed concern for a non-displaced L femur fracture, effusions in bilateral ankles, and edema over the R tibial metaphysis. Follow up MRI imaging revealed a pattern of bone marrow edema, periostitis, and myositis highly suggestive of scurvy. Vitamin C level was checked and was < 5 mcmol/L (23–114). Treatment was started with vitamin C 300 mg IV for 5 days and then 100 mg vitamin C daily for 3 months.
Discussion: Scurvy (vitamin C deficiency) is very uncommon in the US but can develop in cases of extreme dietary restriction. The symptoms of scurvy tend to start out slowly and worsen over time and may be vague. Common symptoms of scurvy include: muscle pain; fatigue; loss of appetite; stiff and swollen joints; spontaneous bleeding and bruising; petechiae; gingivitis, ulceration of gums, and gum enlargement; loss of teeth; irritability and/or mood changes. Vitamin C deficiency in this child was caused by her extreme restrictive eating patterns. Treatment was with IV then oral supplementation of vitamin C.
Conclusions: A thorough dietary history can reveal sources of both under and overdose of essential dietary nutrients. This atypical case was ultimately diagnosed by MRI findings as history and exam were very challenging. This case describes the consequences of unintentional restricting of vitamin C resulting in a clinical case of scurvy in a child.

KEYWORDS Vitamin deficiency; scurvy; pediatrics

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349. Cardiogenic shock in an adolescent ingesting fentanyl adulterated with bupivacaine: a case report

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Background: Para-intoxicants are pharmacologically active agents added to illicit substances for either bulking or synergistic effects. A syringe surveillance program in our area previously documented that 68% of voluntarily submitted samples contained complex combinations of illicit substances, para-intoxicants, and inactive adulterants. The median number of substances per pill was 10 (maximum of 33). Lidocaine and xylazine were present in 41 and 36% of samples, respectively. Lidocaine overdose may produce agitation, seizures, and cardiac dysrhythmias. Bupivacaine is a long-acting amide anesthetic similar to lidocaine and has known cardiac toxicity. The oral bioavailability of bupivacaine is unknown.
Case report: A previously healthy 14-year-old male was brought into a regional hospital after being found unresponsive in his room. EMS reported patient was unresponsive to noxious stimuli, had miotic pupils, and shallow respirations that improved with naloxone. In the ED, patient was unstable (HR 167, BP 88/61) and hypoxic (SpO2 67% on room air requiring bag-valve mask ventilation). He required vasopressors and intubation. Laboratory studies demonstrated an elevated anion gap (AG 21 mEq/L) with metabolic acidosis (pH 7.01), acute kidney injury (Cr 2.6 mg/dL), elevated troponin T (522 ng/L), and elevated lactate (7.9 mmol/L). Patient remained hypotensive despite vasopressor therapy and was transferred to tertiary pediatric hospital for management of cardiogenic shock with VA ECMO. Post-ECMO cannulation, he remained on multiple inotropic and vasopressor medications for hemodynamic support and transthoracic echocardiograph revealed severely decreased biventricular systolic function. Patient's family accessed his phone to find a video of him ingesting a pill immediately prior to symptom onset. They later found a second blue pill stamped with "M30" in his bedroom. Qualitative analysis using liquid chromatography quadrupole time of flight mass spectroscopy (LC-QToF-MS) detected norfentanyl, butyryl fentanyl, acetyl fentanyl, cocaine, BEG, venlafaxine, naltrexone, acetaminophen, and bupivacaine. Sample of patient's urine under LC-QToF-MS analysis detected 2,6–pipecolylxylidine (primary bupivacaine metabolite), fentanyl, and fentanyl metabolites. Insufficient blood volume remained from ED collection for quantitative analysis of bupivacaine concentration. Patient improved hemodynamically with ECMO decannulation and extubation occurring on hospital day 4. He had full neurologic recovery at time of decannulation. Subsequent echocardiography showed return of normal cardiac function. Patient and patient's mother gave consent for this case report.
Discussion: Pediatric exposures to illicit substances including opioids continues to increase. Convenience sampling of voluntarily submitted drug samples demonstrates an increasing number of illicit compounds in single sample and increasing frequency of para-intoxicants. Although patient's myocardial dysfunction and cardiogenic shock are most likely poly-factorial in setting of opioid overdose, we suspect oral bupivacaine toxicity may have led to prolonged cardiac depression as indicated by persistent need of vasopressors, inotropic, and ECMO support across four days. However, this case highlights the clear need for an increasingly broad differential in management of acutely ill patients following substance use and the importance of knowledge of local mixtures of illicit substances.
Conclusions: Orally ingested fentanyl adulterated with bupivacaine produced sustained severe cardiovascular toxicity requiring ECMO support in an adolescent patient.

KEYWORDS Bupivacaine; pediatric; cardiogenic shock

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350. Effect of whole bowel irrigation for ingested lead-containing foreign bodies: a case series

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Background: Foreign body (FB) ingestions commonly cause lead toxicity in pediatric patients. These ingestions result in continued lead absorption until passage or removal from the gastrointestinal (GI) tract. Whole-bowel irrigation (WBI) is frequently recommended to aid in removal of these FBs. However, effectiveness of WBI is not clear. Additionally, children often do not tolerate the recommended dosing of polyethylene glycol 3350 (PEG) used for WBI (25 mL/kg/h or 0.5 L/h). As a result, they often receive lower flow rates. In the setting of failed WBI, patients may require endoscopic removal of ingested FBs. We sought to describe the effectiveness of WBI to remove lead FBs in children with lead toxicity.
Case series: We identified patients admitted for treatment of lead toxicity by our service from 01/01/2017 to 04/25/2023 by query of a local database. We identified and screened 23 cases

by directed chart review for treatment of pediatric patients (< 18 years old) with WBI. Seven cases with radio-opaque FBs underwent further review. For each case we abstracted patient age, identity of ingested FB, initial and follow-up lead concentrations, duration of WBI (in hours), maximum flow rate of PEG used for WBI, success (partial or complete) or failure of FB passage assessed by daily abdominal radiography, performance of endoscopy, results of endoscopy if performed, administration of chelation, and duration of hospital stay (in days). We defined partial success when abdominal radiographs showed interval decrease in radio-opaque FB burden without complete resolution All 7 patients underwent WBI for at least 24 hours. Flow rates varied with a mean and median of 9.7 and 10 mL/kg/h, respectively (range 5–18 mL/kg/h). Only one case resulted in complete expulsion of the ingested FB with WBI alone at 5 mL/kg/h for 35.5 h. Four patients underwent endoscopic removal after WBI after mean and median of 50.6 h and 47.5 h, respectively (range 27–80.5 h) with radiographic confirmation of FB removal. One patient had partial success after 24 h of WBI. One patient failed to clear despite 168.5 h of WBI during a 10-day admission. Lead concentrations on admission had mean and median of 33.5 and 25.1 mcg/dL, respectively (range 16.3–65.9 mcg/dL).
Discussion: Most cases in this series failed to achieve clearance of intestinal FBs with WBI alone. This likely prolonged hospitalization in most cases. No patient received the recommended flow rate for WBI of 25 mL/kg/h. One 16-year-old received 0.5 L/h, but this flow rate is generally reserved for smaller children. Endoscopy was not performed in cases of loose ingested material such as soil and drywall powder. For cases not amenable by endoscopic removal, a trial of WBI may still aid in partial decrease of FB burden.
Conclusions: WBI failed to achieve FB removal in most cases. Prolonged WBI appears unlikely to increase removal of ingested lead containing FBs. Early consultation for endoscopy may decrease duration of hospitalization. Higher PEG flow rates might be more effective.

KEYWORDS Whole bowel irrigation; lead; foreign body ingestion

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351. Refractory hypoglycemia due to sulfonylurea contamination of illicit opioid medication

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Background: Sulfonylurea medications are widely used in the treatment of diabetes mellitus (DM) and work by stimulating insulin release from pancreatic beta cells. Unintentional or intentional overdose of sulfonylureas can cause refractory hypoglycemia. There have been previous case reports describing contamination of street drugs with sulfonylureas leading to hypoglycemia.
Case report: A 67-year-old male patient with past medical history of chronic back pain presented to the emergency department (ED) after being found lying on the ground with abrasions to his face and extremities. Upon arrival of emergency medical services, the patient was difficult to rouse and was confused. The patient's initial blood glucose was 30 mg/dL, and the patient was given 125 mg of dextrose 10% (D10) en route to the hospital. His mental status improved, and he was no longer confused upon arrival at the ED, although he was still amnestic as to how he ended up on the ground. Trauma workup was negative for acute injury. The patient's history and medications were reviewed, and he denied a history of diabetes, use of insulin, or known ingestion of any glucose-lowering medications. The patient's initial blood glucose level upon arrival at the ED was 73 mg/dL. This was checked one hour later and was found to be 34 mg/dL. Additional boluses of D10 and provision of several high-calorie meals did not substantially improve serum glucose levels. He was then started on a D10 infusion at 150 mL/hr. While his glucose initially normalized, the patient became hypoglycemic again once the rate of the D10 infusion was reduced. No infectious, neoplastic, or dietary source could be identified. The patient did admit to buying what he thought was oxycodone from a seller on the street and noticed that the pill shape and color was different from his usual supply. On the night prior to the patient's ED presentation, he had consumed several of these pills. A serum sulfonylurea detection assay was ordered, and the patient was empirically treated with octreotide 100 mg subcutaneously with resolution of his hypoglycemia. His testing returned with a serum glipizide concentration of 240 ng/mL, six times the reporting range.
Discussion: This case represents a likely inadvertent ingestion of glipizide, a type of sulfonylurea, resulting in hypoglycemia refractory to intravenous dextrose and oral nutrition. In addition to dextrose and oral nutrition, patients presenting with hypoglycemia induced by unintentional sulfonylurea ingestion can be treated with octreotide (50–100 mcg, subcutaneously, every 6 hours), which decreases insulin release from pancreatic beta cells. Octreotide reversed this patient's hypoglycemia.
Conclusion: Refractory hypoglycemia may be due to inadvertent or intentional consumption of sulfonylurea medications. Ingestion of street drugs may present a potential source of sulfonylurea exposure.

KEYWORDS Sulfonylurea; overdose; hypoglycemia

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352. Pediatric bupropion fatality despite removal of intact pills and pharmacobezoar

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Background: Modified-release bupropion is a potentially life-threatening ingestion in young children. We present a child who had severe neurologic and cardiovascular effects and died despite an invasive but delayed gastrointestinal (GI) decontamination procedure followed by veno-arterial extracorporeal membrane oxygenation (VA-ECMO).
Case report: A healthy 3-year-old female appeared stiff and tremulous after family found her with a bottle of modified-release bupropion 300 mg tablets. Family described these as "Wellbutrin XL," but the specific formulation could not be confirmed as the original container was unavailable. They brought the child to a local emergency department (ED) where she was noted to be nonverbal with a heart rate of 122 beats/minute, blood pressure 89/69 mm Hg, respiratory rate 20 breaths/minute, temperature 97.7 °F, and oxygen saturation 98% on room air. Lab results included a normal CBC and metabolic panel that was unremarkable except for potassium 3.1 mmol/L and AST 48 U/L. ECG showed sinus rhythm at 144 beats/minute, with QRSd 102 ms and QTc 523. The child had a generalized seizure. She was given lorazepam, intubated, and transferred to a regional medical center (RMC) but GI decontamination was not performed. At the RMC she was initially bradycardic (low 50s) and was started on an epinephrine infusion. The child then developed ventricular tachycardia with cardiac arrest. Resuscitation

included epinephrine boluses, defibrillation, amiodarone, sodium bicarbonate, and intravenous lipid emulsion. Return of spontaneous circulation was achieved on multiple vasopressors. Acetaminophen, salicylate, and ethanol were undetectable at the RMC. Social work interviewed family members and found no evidence that bupropion had been administered to the child. Because ultrasound showed an echogenic structure within the stomach suggestive of a bezoar, gastroenterology performed endoscopy on day 2 that revealed a whitish mass. They broke this up, removing 30 intact pills and 10 partially intact pills. The child was placed on VA-ECMO in the PICU. She was treated with stress dose steroids, antibiotics for presumed aspiration, and continuous renal replacement therapy due to acidosis and oliguria. Providers were able to discontinue ECMO on day 7. The child remained unresponsive, and on day 8 MRI showed evidence of hypoxic brain injury. Subsequent brain CT showed diffuse cerebral edema, and family changed the child's status to comfort care. She was extubated and died on day 14. Serum bupropion and hydroxybupropion concentrations obtained shortly after arrival at the RMC were 42,000 and 8900 ng/mL, respectively, then declined.

Discussion: It's unclear whether activated charcoal or whole bowel irrigation, if administered at the initial ED, could have changed the outcome in this case. These options should be considered in patients with seizures or other neurologic effects after modified-release bupropion ingestion once the airway has been secured, despite uncertain ingestion time.

Conclusions: Due to prolonged absorption, the onset of serious effects following modified-release bupropion ingestion may be delayed. The risks and benefits of GI decontamination should be assessed even if the patient may be more than 1–2 hours post-ingestion.

KEYWORDS Bupropion; gastrointestinal decontamination; pediatric

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353. Pediatric exploratory psilocin ingestion: a case series

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Background: Psilocybin & psilocin are increasingly used with well-described clinical effects in adults. Pediatric exposure is sparsely reported. This is a case series of two pediatric psilocin exposures.

Case series: Case 1: 5-year-old male ate a chocolate candy. Ten minutes later, he developed a slowed verbal response, unsteadiness on his feet, and dilated eyes. The patient subsequently had a headache with two episodes of emesis and was brought to the emergency department. Initial evaluation, which included a CT head, routine labs, and a 10-panel urine drug immunoassay, were unremarkable. He was able to eat a popsicle. While being prepared for discharge, he developed sinus bradycardia (50 bpm). He became lethargic and was minimally responsive to a fingerstick glucose. He was transferred to a tertiary pediatric center. On arrival to the pediatric center, the patient had bradycardia (70 bpm), constricted pupils, and somnolence. He did move all extremities purposefully and resisted the exam. EKG revealed sinus bradycardia (68 bpm), QRS duration of 80 msec, QTc of 433 msec. Overnight, the patient's mentation gradually improved and by next morning was back to baseline with normalization of vital signs and pupils. Urine LC/TOF-MS (*Expanded Urine Drug Screen, 1876U, NMS Labs*) was sent and positive only for psilocin. Case 2: Previously healthy 20-month-old female ingested a corner of a "magic truffle" chocolate bar, corresponding to an estimated dose of 10 mg psilocin. The mother called 911 immediately and the patient was brought to a hospital. In the ED, the patient was initially asymptomatic, but within 2 hours developed somnolence with small pupils, decreased tone, and responded only to painful stimuli. EKG, a 10-panel urine drug immunoassay, and routine labs were unremarkable. Overnight, her mental status gradually improved and was back to baseline the following morning. Urine LC/TOF-MS (*Expanded Urine Drug Screen, 1876U, NMS Labs*) was sent and positive only for psilocin.

Discussion: There are few previous reports of pediatric psilocin exposure. In adult psilocin/psilocybin exposures, the commonly reported effects are dysphoria, hallucinations, drowsiness, tachycardia, and mydriasis. In our pediatric patients, we noted more pronounced CNS sedation. Interestingly, their exam finding of miosis and bradycardia are in contrary to those of adult exposures. Our patient's symptoms resolved in 16 hours. Neither their clinical history nor expanded urine drug testing indicated co-ingestion of other CNS depressants such as opioids, clonidine or benzodiazepines. Hence the differences in manifestation either represent a higher relative dose, or perhaps a relationship between psilocin and the physiology of pediatric patients.

Conclusions: As edible forms of psilocybin/psilocin products grow more popular, we may see an increase in pediatric exploratory exposure, similar to the increased exploratory exposures with edible THC products. Medical toxicology and pediatric providers should be vigilant and help educate the public on risk reduction.

KEYWORDS Psilocin; psilocybin; edible

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354. Melatonin ingestions by young children treated at emergency departments

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Background: Melatonin is a hormone produced by the body that regulates the sleep-wake cycle. It is available over-the-counter in the United States (US) in tablet, capsule, liquid, and gummy formulations. Melatonin sales in the US increased by approximately 150% between 2016 and 2020. Because of its widespread use and availability, children are at increased risk of melatonin ingestion. The more common adverse reactions associated with melatonin ingestion include drowsiness, dizziness, headache, nausea, ataxia, and agitation. A study of isolated melatonin ingestions by children reported to US poison centers during 2012–2021 found that the annual number of exposures increased 530% during the ten-year period. The objective of this study was to characterize pediatric melatonin ingestions treated at US hospital emergency departments (EDs).

Methods: Data were obtained from the National Electronic Injury Surveillance System (NEISS), a database of consumer product-related injuries (including all poisonings to children under age 5 years) collected from a representative sample of approximately 100 US hospital EDs. National estimates are calculated from database records according to the sample weight assigned to each case based on the inverse probability of the hospital being selected for the NEISS sample. To identify melatonin ingestions involving patients age 0–4 years reported during 2000–2021, all records with "melatonin" or misspellings of the word mentioned in the Narrative text field were reviewed, and those that appeared to be melatonin ingestions were included in the study. The distribution of estimated

melatonin ingestions was determined for various factors related to patient demographics, exposure circumstances, and disposition.
Results: A total of 513 melatonin ingestions involving patients age 0-4 years were reported to a sample of US hospital EDs during 2000–2021, resulting in an estimated 16,650 such ingestions. No melatonin ingestions were reported during 2000–2001; 96 (0.6%) estimated ingestions were reported during 2002-2006, 746 (4.5%) during 2007–2011, 5,307 (31.9%) during 2012–2016, and 10,501 (63.1%) during 2017–2021. Patient age distribution was 134 (0.8%) 0 years, 2,409 (14.5%) 1 year, 6,367 (38.2%) 2 years, 5,781 (34.7%) 3 years, and 1,959 (11.8%) 4 years; 9,116 (54.8%) patients were male and 7,533 (45.2%) female. The location of the incident was 14,247 (85.6%) home, 222 (1.3%) other location, and 2,181 (13.1%) not recorded. The melatonin formulation was documented as gummy in 2,204 (13.2%) estimated ingestions; 14,850 (89.2%) of the estimated ingestions did not mention other substances. Patient disposition was 14,971 (89.9%) treated or examined and released, 792 (4.8%) treated and admitted for hospitalization, 286 (1.7%) held for observation, 204 (1.2%) treated and transferred to another hospital, and 396 (2.4%) left without being seen/ against medical advice. A clinical effect was reported in 836 (5.0%) of the estimated ingestions, the most common being 532 (3.2%) drowsiness/lethargy.
Conclusions: Estimated melatonin ingestions involving patients age 0-4 years reported to US hospital EDs increased during 2000–2021. The majority of patients were age 2-3 years, and most ingestions occurred at home. Almost 90% of the ingestions did not involve other substances. The majority of patients were treated or examined in the ED and released.

KEYWORDS Melatonin

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355. Vilazodone ingestion in a 13-month-old child

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Background: Accidental pediatric exposures to selective serotonin reuptake inhibitors (SSRIs) have historically been well-tolerated, prompting consensus guidelines recommending home observation for doses not exceeding five times the initial adult therapeutic dose. Since vilazodone's introduction to market in January 2011, several case reports and retrospective analyses of the National Poison Data System have elucidated increased risks with relatively low doses. It has a dual mechanism of action as a SSRI and partial agonist at 5-HT(1A) distinguishing it from other SSRIs. We report a vilazodone overdose in the youngest patient to date to develop seizures as part of her significant intoxication.
Case report: A 13-month-old female, with history of hypotonia but otherwise healthy, presented to an emergency department (ED) drowsy but arousable and tachycardic (heart rate [HR] 150) approximately one hour after ingesting an estimated dose of 14.6 mg/kg vilazodone. Over the next 2 hours, she developed tonic-clonic seizures and increased body temperature. Two doses of lorazepam 0.5 mg/kg were administered, and she was loaded with levetiracetam. About 4.5 hours post-ingestion, she was unresponsive and tremulous, with elevated HR (172), BP (112/78), and respiratory rate [RR] (42), but protecting her airway and maintaining oxygen saturation (99%). Tremulousness persisted with uncontrolled muscular movements at 9 hours post-ingestion. She continued with sinus tachycardia (HR 170s) and tachypnea (RR 40s to 50s), but her BP improved (90s–100s/70s–80s) and she was afebrile. At approximately 20 hours post-ingestion, she remained slightly drowsy and tachycardic (HR 160) but other vitals were within normal limits. She continued to improve over the course of the next day and was medically cleared at about 48 hours post-exposure. Serial EKGs throughout her course showed sinus tachycardia. A head computed tomography and continuous electroencephalogram monitoring instituted in the ED after initial seizure activity were unremarkable.
Discussion: Previously published case reports of accidental childhood exposure to vilazodone have involved older children with estimated doses ranging from 5.45 to 37 mg/kg. This patient had seizures within 2 hours of ingestion time from an estimated dose of 14.6 mg/kg. Vilazodone's putative mechanism as both a SSRI and serotonin partial agonist lends itself to increased serotonergic neurotransmission as compared to other SSRIs. Consensus guidelines for out-of-hospital management (of five times the adult therapeutic dose) cannot be applied for accidental vilazodone exposures in the pediatric population. It remains unclear if there is any safe amount that can be managed in a home setting.
Conclusions: We report a case of vilazodone toxicity in a 13-month-old who experienced severe symptoms of serotonergic excess including rapid onset seizures after an accidental ingestion of an estimated 14.6 mg/kg dose.

KEYWORDS Vilazodone; pediatric

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356. Lamotrigine toxicosis in dogs: how much is too much?

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Background: Lamotrigine is a phenyltriazine anticonvulsant used for the treatment of bipolar disorder and partial or generalized seizures in humans. Lamotrigine is not used in dogs due to concerns for toxicity even at low dosages. While the exact mechanism of action is unknown, it is suspected that lamotrigine inhibits voltage-sensitive sodium channels, thereby stabilizing neuronal membranes and consequently modulating presynaptic transmitter release of excitatory amino acids (e.g., glutamate and aspartate). In humans, lamotrigine is extensively metabolized in the liver by glucuronic acid conjugation: the major metabolite is an inactive 2-N glucuronide conjugate (75–90%). Lamotrigine in dogs is extensively metabolized to a 2-N-methyl metabolite. This metabolite causes a dose-dependent prolongation of the PR interval, widening of the QRS complex, and complete atrioventricular (AV) conduction block at higher doses. Similar cardiovascular effects are not anticipated in humans because they only make trace amounts of the 2-N-methyl metabolite.
Case series: The database was queried for single agent dog exposures to lamotrigine. There were 4401 dogs found. Of this number, 630 were symptomatic at the time of the call. Looking further into the data the dosage was known (or suspected) for 542 dogs. The most common clinical signs were vomiting (52%), cardiac arrhythmias (both brady and tachy) (47%), lethargy (40%), ataxia (21%), tremors (13%), and seizures (11%). Death occurred in 16 (3%) of the dogs. Mild lethargy, ataxia, and vomiting began below 5 mg/kg. Dosages over 8 mg/kg resulted in tachycardia, tremors, and hypertension. Severe arrhythmias were seen over 20 mg/kg and seizures over 30 mg/kg. The lowest dosage death occurred at was 39.37 mg/kg. It is thought that the cause of the cardiac arrest was likely due to cardiac arrhythmias. Most died between 4 and 12 hours post exposure.
Discussion: Quick decontamination and in hospital veterinary monitoring is key in improving the prognosis. Several of the above animals died at home or on the way to the veterinary

clinic. Emesis can be performed if the dog is asymptomatic. Risks of aspiration should be considered if activated charcoal is given. IV fluids should be started. Electrolytes, acid-base status, and heart rhythm should be monitored. A continuous ECG should be considered in dosages higher than 20 mg/kg. Arrhythmias should be treated as necessary (VPCs, ventricular tachycardia, and AV block are most common). Intravenous lipid therapy can be used for cases with severe cardiovascular effects (will decrease effectiveness of lidocaine). Hemodialysis in people was of questionable efficacy.
Conclusions: Prognosis is good for animals showing mild signs but guarded for animals with severe cardiac arrhythmias.

KEYWORDS Lamotrigine; dogs
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357. Oral-only lead chelation therapy for severe lead toxicity in the United States

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Background: Lead toxicity continues to be a concern with complicated management despite centuries of data. Around 500,000 children in the United States have blood lead levels above the $\geq$ 3.5 mcg/dL threshold concentration. Current standard of care recommends hospitalization for intravenous and intramuscular chelation for lead concentrations $\geq$ 70 mcg/dL. We present a child with $>$ 80 mcg/dL lead concentration managed with oral-only therapy with improvement in lead toxicity.
Case report: A 20-month-old ex-32-week female who recently moved to rural Colorado from Mexico City presented to her pediatrician for her 18-month well-child appointment. She had chronic constipation and never walked. Otherwise, she had an age-appropriate neurological and physical exam. As part of routine screening, a capillary blood lead concentration was obtained and resulted 97 mcg/dL. Verification via venous sample was 83 mcg/dL. The patient was directed to the emergency department at a tertiary care children's hospital with plan to start dimercaprol and calcium disodium EDTA ($CaNa_2EDTA$) but $CaNa_2EDTA$ is no longer available in the United States as of October 2022. The plan was made to start the patient on oral dimercaptosuccinic acid (succimer)-only therapy as she was otherwise clinically well and able to take PO. Succimer was dosed at 200 mg PO every eight hours for the first five days. Venous lead concentrations were trended and decreased to 41.2 mcg/dL at time of discharge. She was prescribed 200 mg succimer twice daily as an outpatient for an additional 14 days. The Public Health Department identified Mexican pottery as the source of lead exposure. The child's mother was using the pottery to make tea and prune juice to manage her severe constipation. Unfortunately, her lead level rose again after discharge. After accounting for lead redistribution, the concentration rose to 67.3 mcg/dL, suggesting ongoing exposure and/or a lack of compliance with prescribed succimer. Patient was prescribed a second course of observed succimer therapy as an outpatient.
Discussion: The recommended standard of treatment for lead concentrations $\geq$70 mcg/dL is dimercaprol and $CaNa_2EDTA$. This therapy can be poorly tolerated due to pain and food allergies. Regardless, with current drug shortages, this modality is unlikely to be available for the foreseeable future. Literature from a mass lead outbreak in Nigeria suggested that oral chelation therapy was beneficial in lowering lead concentrations in resource limited areas in children with tremendous lead burdens. However, decrease in concentrations with treatment may not be as robust and may lead to prolonged hospitalization. As in our case, there may also be concerns of compliance once discharged home if concentrations have not completely fallen.
Conclusions: Oral chelation may be a reasonable therapeutic option even for high lead concentrations during drug shortages. However, additional factors need to be considered: how this may impact hospital length of stay while ensuring adequate decline in concentration in an era of hospital crowding and limited pediatric bed availability, patient and family compliance with long courses of outpatient care, and availability of a scarce medication.

KEYWORDS Lead; succimer; pediatrics
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358. Ethanol metabolism rate of a premature infant

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Background: In adults, ethanol is primarily metabolized by alcohol dehydrogenase (ADH) with utilization of other minor pathways such as CYP2E1, CYP1A2, and catalase. The elimination rate in non-tolerant adults is commonly accepted as 15–20 mg/dL/hr, with zero-order kinetics. However, less is known about the metabolism rate of infants, as these cases are uncommon. Previous case reports on ethanol clearance in pediatric patients have shown varying rates from 17.1–49.7 mg/dL/hr. We report the elimination kinetics of ethanol in a 6-month-old infant exposed to an ethanol-based hand-sanitizer.
Case report: A 6-month-old with a past medical history of extreme preterm birth at 22 weeks 4 days, G-tube dependence, and chronic lung disease on home oxygen, initially presented to the emergency department (ED) with altered mental status following exposure to hand sanitizer. The hand sanitizer contained 70% ethanol and had reportedly been used to flush his gastric tube by mistake. The 6.1bkg infant was noted to be tachypneic and altered on arrival to the ED. He was intubated for airway protection shortly after ED arrival. Initial labs showed an ethanol level of 414.8 mg/dL with a glucose of 92 mg/dL and a lactate of 7.9 mmol/L. He was started on fentanyl and vecuronium along with a maintenance dextrose infusion to prevent hypoglycemia. He was subsequently transferred to a tertiary care pediatric intensive care unit for higher level of care. Repeat labs 7 hours after presentation showed a down-trending ethanol level of 210 mg/dL. Lactate normalized within 24 hours. By the third blood draw, 19.7 hours after presentation, the patient had undetectable ethanol levels. The patient's hospital course was complicated by acute hypoxic respiratory failure thought to be due to aspiration and he was placed on extracorporeal membrane oxygenation (ECMO) until his respiratory status improved and he was subsequently able to come off of ECMO.
Discussion: Various factors are thought to affect the pharmacokinetics of ethanol in infants compared to adults, including variable absorption, immaturity of enzymes, and variations in volume of distribution. Absorption can be less predictable due to prolonged gastric emptying in children and variable blood flow. Ethanol is metabolized by multiple enzymes, including ADH, CYP2E1, CYP1A2 and catalase. In adults, the major pathway involves ADH, but this enzyme is developing in infants, and they only have 30-40% ADH activity by the first year of life. It is assumed that catalase plays a greater role in neonatal and infant alcohol metabolism. In our patient, the first two labs showed a metabolism rate of 29.3 mg/dL/hr. Based on that rate he may have had undetectable ethanol levels at 850 minutes from initial

hospital presentation, well before the third ethanol level was obtained.
Conclusions: There is significant variation in infant ethanol metabolism rates. Surprisingly, they appear to be faster than those seen in non-tolerant adults. This case continues to show a trend of zero-order kinetics with a metabolism rate of 29.8 mg/dL/hr though we are limited in only having 2 non-zero data points for analysis.

KEYWORDS Ethanol; zero-order

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359. Serotonergic toxidrome after insufflation of an MDMA precursor

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Background: Acetophenone is an aromatic ketone. These compounds are used in the manufacture of various substances in pharmaceuticals, agrochemicals, and as a solvent. They have also been used to induce sleep. Synthetic and naturally occurring molecules containing a dioxolane group are of particular interest due to their pharmacological properties.
Case report: A 17-year-old male was found unresponsive at a friend's house when EMS was called. He was given intranasal naloxone with no reported effect. On arrival at the ED the patient was found to be in narrow complex tachycardia at a rate in the 140's, a blood pressure of systolic 90's/60's, a pulse oximetry reading in the low 80's, respiratory rate in the 40's, and temperature of 39.5 ° Celsius, with mydriatic poorly responsive pupils, and not diaphoretic. He made no purposeful movements with a GCS of 3. No exam findings were fasciculations of his facial and truncal muscles, coarse breath sounds in the right posterior chest, and an erythematous urticarial rash on his left wrist area. The team quickly acted to oxygenate the patient, administer fluids, and for possible anaphylaxis he was given pushes of intravenous epinephrine with diphenhydramine. He was also given midazolam in the event that the fasciculations represented non-convulsive status epilepticus. His vitals improved and the patient was intubated. He was actively cooled and started on vasopressors. A baggie was then found in the patient's left pocket containing white powder with a short straw. Labs were notable for mild acidosis, mild acute kidney injury, transaminitis in the low 200's, CK elevation, and elevated troponin. Urine drug screen was positive for fentanyl, THC, and benzodiazepines (benzos having been given prior to collection). CT imaging of the entire axial body showed aspiration pneumonia and areas of myositis in the left hip and left wrist. A GC/MS on day 2 resulted with the compound 3,4-methylenedioxyacetofenone. There is little to no information available on the Internet regarding isolated use in humans. It has been detected in samples of MDMA collected from Australia, likely as a precursor or byproduct during synthesis. In nature it originates from the plant *Ruta angustifolia*, where it is known to cause dermatitis on skin contact. Commonly known as "Ruta", the plant is found in the Mediterranean and Western Asia. The molecule is available for purchase over the internet. It appears similar to cathinones and ring-substituted amphetamines. The patient was eventually discharged to physical therapy for persistent issues with ambulation but otherwise recovered two weeks later.
Discussion: This case illustrates the clinical course of a patient with exposure to a previously undocumented substance used by humans. The clinical picture appears consistent with serotonin syndrome and the compound elucidated on mass spectrometry appears structurally like compounds which are known to be serotonergic. As no methylenedioxymethamphetamine was detected on GC/MS, it is likely that the substance being used was a synthetic precursor or not previously reported novel psychoactive substance.
Conclusions: Novel psychoactive substances are widespread, should be recognized, and treated with standard measures.

KEYWORDS Serotonergic; toxidrome; precursor

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360. Poison in a pod: black locust seed ingestion with delayed symptoms in a toddler

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Background: The black locust (*Robinia pseudoacacia*), a member of the Fabaceae family is endemic to temperate zones in the United States. Blooming in early summer, a characteristic feature are brown clusters of pods during the winter. This deciduous tree contains the toxins phasin, robin, and robitin that disrupt protein synthesis. The seeds, like other legumes, are encased in a 2- to 4-inch-long pod that remains on the tree throughout winter. There are up to 10 seeds per pod. We report the youngest child in the literature with a known amount of chewed black locust seeds.
Case report: A 2-year-old previously healthy child was found chewing on seeds from an unknown seed pod. Her mother noticed that she had chewed up 4 seeds and using Google images identified the pod belonged to the black locust tree. She called the poison control center and sent an image via email. The image identification was confirmed by a medical toxicologist and the patient was referred to the emergency department (ED). The patient ingested only one third of the dose of activated charcoal (AC) within 1.5 hours of ingestion, and subsequently remained asymptomatic for 4 hours before being discharged home. Approximately 6 hours post-ingestion at home the patient had 3 episodes of emesis and returned to the ED. She was agitated, hypertensive, tachycardic and screamed throughout her physical examination. She received intravenous fluids and the antiemetic ondansetron. Her electrolytes, blood glucose, liver and kidney function were unremarkable, and she was admitted to a pediatric unit overnight for observation. The patient returned to baseline, had no further emesis, and was discharged home 21 hours post-ingestion.
Discussion: All parts of the black locust tree contain toxalbumins but the principal toxalbumin robin is most concentrated in the bark. Like ricin it is a plant glycoprotein that disables ribosomes and causes subsequent cytotoxicity and cell death in multiple organs. Early symptoms are gastrointestinal in nature that can progress to coma, seizures, hepatic and renal failure. Veterinary literature and pediatric case series ingestions all involve the bark which has a sweet, licorice-like flavor. Both seed ingestion case reports in the literature are in older children and lack information on the number of seeds ingested or whether they were chewed. In our patient, despite chewing 4 seeds there was a 6-hour delay in symptom onset. Following partial decontamination with AC and symptomatic care within a health care facility, the patient had a good outcome.
Conclusions: Delayed toxicity onset of 6 hours can occur from chewed black locust seeds. Prompt decontamination and supportive care remain the mainstay of treatment for toxalbumin ingestions.

KEYWORDS Toxalbumins; black locust

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361. Tolerance of an enteral bupivacaine exposure in an infant with a cardiac condition

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Background: Bupivacaine is classified as an amide local anesthetic widely used for local, regional, or surgical anesthesia (as well as analgesia in certain cases). Local anesthetics are leveraged for their ability to block the generation of the action potential in nerve cells via elevating the threshold of electrical excitation. Systemic toxicities, particularly with bupivacaine, such as cardiorespiratory depression, central nervous system (CNS) toxicity, and coma ultimately progressing to respiratory arrest via intravascular injection are well documented.
Case report: A six month-old 4.8 kg intubated female was in the operating room undergoing J-tube placement with a previous history of corrective surgery (Tetralogy of Fallot and major aortopulmonary collateral arteries) during the same visit when the Poison Center received a call from a hospital physician. The child received 4 mL of bupivacaine hydrochloride 0.25% solution for injection administered subcutaneously (10 mg bupivacaine) and inadvertently an additional 6 mL of bupivacaine hydrochloride 0.25% solution for injection (15 mg bupivacaine) through a nasogastric tube. At the time of the call a blood pressure of 112/59 mm Hg and heart rate of 135 bpm were recorded, the physician attributed the elevated blood pressure likely to placement of the J tube. The total dose administered was 5.2 mg/kg with 3.125 mg/kg solely representing the enteral portion. Buck et al. reference an eleven-month-old who exhibited ventricular tachycardia after administration of a 5 mg/kg parenteral bupivacaine dose. In our case the physician opted to initiate a midazolam drip for sedation with added GABAergic effects. The Poison Center confirmed precautionary heightened monitoring was instituted immediately upon exposure with close monitoring of the blood pressure, heart rate, EEG, and cardiac monitoring with no anomalies detected throughout the procedure. Six hours after exposure the patient had no documented seizure; EEG monitoring continued out of an abundance of caution.
Discussion: An inadvertent cardiotoxic exposure in an already cardio-sensitive patient is an infrequent event. The vast available literature of bupivacaine appears to only focus upon the parenteral route and its known cardiodepressive and nervous system effects, with scant evidence regarding bupivacaine's enteral effects. Mogensen et al. undertook a pharmacokinetic study utilizing bupivacaine lozenges with varied doses up to 50 mg for oral mucositis relief in adult cancer patients. Various lozenge strengths demonstrated relative bioavailability increases two-to-three-fold, dependent upon the higher degree of mucositis in patient subsets. Through measurable serum absorption of the lozenges, oral absorption occurred at a significantly low enough rate to still avoid any observable adverse effects. Our case report, a limited single case, in an already therapeutically-ladened bupivacaine infant exhibits that with the additive enteral dosing we believe that bupivacaine has extremely poor oral absorption when exposed to intact enteral membranes.
Conclusions: This exposure aids as a single case to demonstrate bupivacaine's docile nature with the enteral route, in a highly susceptible and fragile newborn as compared to its more commonly utilized parenteral usage and risk of CNS and cardiotoxicity. Until a formal toxicity threshold is determined, clinicians should continue to monitor oral exposures for possible toxic effects.

KEYWORDS Bupivacaine; oral enteral; overdose

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362. When milk formula is not a good choice: acute sodium bicarbonate poisoning in aa four-month-old infant

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Background: Sodium bicarbonate is a widely available household product used for cooking, baking, personal care, and cleaning purposes. Severe toxicity and fatality from sodium bicarbonate overdose is very rare. In adults, the most common toxicity is the use as an antacid, as a method to cause falsely negative illicit drug tests, and to treat urinary tract infections. Acute ingestions of sodium bicarbonate cause metabolic alkalosis, electrolyte abnormalities, altered mental status, dysrhythmias, tachypnea, and rhabdomyolysis. We describe a case of an infant who developed acute sodium bicarbonate poisoning, improperly used for preparing infant feeding bottle.
Case report: A four-month-old male infant, 6 kg weight, was brought to the emergency department (ED) with vomiting and diarrhea. Parents reported he was fed with 30 ml of sodium bicarbonate, instead of the formula milk, three hours before. In ED, the patient was crying and irritable. Vital signs were normal. The initial peripheral venous blood gas (PVBG) found alkalosis (pH 7.64), high level of bicarbonates (50 mEq/L), hypernatremia (153 mmol/L), hypokalemia (2.3 mmol/L), hypocalcemia (0.96 mmol/L). The pediatrician contacted our Poison Control Center. He was advised to correct acid-base abnormalities and to monitor the patient. The EKG showed sinusal rhythm and a QTc interval of 460 ms. Serial PVBGs were evaluated for monitoring the acid-base disorder. During observation, the patient had two other episodes of vomiting. He was treated with intravenous normal saline and potassium replacement. About 48 hours after ingestion, the PVBG parameters were normal and he was discharged on the fourth day. To understand what happened, the mother was asked about the mistake. She stated that the babysitter, while preparing the milk formula, mistook the sodium bicarbonate container for the milk powder and used 33.6 g of sodium bicarbonate in 210 ml of water (16%, 413 mEq of sodium and 413 mEq of bicarbonate).
Discussion: Our patient ingested 30 ml of the solution, equal to 59 mEq of sodium and 59 mEq of bicarbonate. Rapid onset of symptoms and recognition of improper infant formula preparation led to rapid ED response and treatment.
Conclusions: Sodium bicarbonate is rarely considered harmful and emergency physicians should be aware of its potential misuse and toxicity, and the early treatment can improve the outcome.

KEYWORDS Sodium bicarbonate; milk formula

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363. Assessing time to symptom onset and optimal observation period for unintentional amlodipine ingestions in pediatric patients: a 22-year retrospective review

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Background: Amlodipine, a dihydropyridine calcium channel blocker characterized by its 24-hour duration of action, has scarce literature regarding the optimal observation time for unintentional pediatric ingestions. Literature published over the last 20 years suggests observation times widely ranging from 6–18 hours post-inadvertent ingestions of amlodipine within the pediatric population. This study aims to evaluate the time to symptom onset and the appropriate observation period in pediatric patients following unintentional amlodipine ingestions.

Methods: We conducted a retrospective analysis of unintentional amlodipine ingestions reported to our regional poison center between January 2000 and January 2023. The study included pediatric patients who unintentionally ingested amlodipine-only and were followed to a known medical outcome. Multi-drug, intentional, and malicious exposures were excluded. Data on demographics, clinical presentation, treatments, and medical outcomes were collected and analyzed. The relationship between mg/kg was investigated through multiple approaches, including (1) a Cox regression to assess time-to-event, (2) a Gamma regression to examine time-to-event specifically for symptomatic patients, and (3) a logistic regression to determine the association between mg/kg and the presence or absence of symptoms, irrespective of the time taken. The analyses were adjusted for potential confounding factors, such as age and gender.

Results: Two hundred cases that met the criteria were selected for further descriptive and statistical review. Nearly all the exposures were unintentional general ($n = 194$) with the remainder being therapeutic error ($n = 5$) and unintentional unknown ($n = 1$). The median age was 24 months (IQR 20–24); median weight was 12.7 kg (IQR 24.2–32.56); median dose ingested was 10 mg (IQR 5–10); and median mg/kg ingested was 0.60 (IQR 0.42–0.82). Acute ingestions accounted for 99% ($n = 198$) of cases. Regarding certainty of exposure, 19% ($n = 35$) of cases were exact, 37% ($n = 73$) were maximum possible, 22% ($n = 43$) were estimates, and 21% ($n = 41$) were unknown. In total, 90% ($n = 179$) of cases reported no effects; 7% ($n = 19$) reported minor or moderate effects (hypotension, bradycardia, central nervous system depression), and for 2 cases the effects were recorded as unknown. There were no major effects reported. Among the 19 symptomatic cases, 90% ($n = 17$) received gastrointestinal decontamination and 37% ($n = 7$) received intravenous fluids. The median amount ingested in symptomatic patients was 0.59 mg/kg (IQR 0.41–0.80) The median time to symptom onset was 4.8 hours (IQR 3.28–8.44). In the 10 symptomatic cases where the "exact" or "max possible" quantity ingested was known, all patients developed symptoms within 12 hours of exposure. There was no statistically significant correlation noted in any of the regression models.

Conclusions: According to our 22-year retrospective review, most pediatric patients unintentionally ingesting amlodipine reported to our regional poison center experienced no or minor effects. If the “exact” or “maximum possible” quantity of amlodipine ingested is 5-10 mg, it may be reasonable to observe asymptomatic patients for up to 12 hours in a hospital setting prior to discharge. Further studies involving pediatric amlodipine exposures are required to confirm these results and solidify observation recommendations.

KEYWORDS Unintentional; amlodipine; pediatric

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