Journal of Toxicology: Clinical Toxicology

ISSN: 0731-3810 (Print) (Online) Journal homepage: http://www.tandfonline.com/loi/ictx19

# Position Statement: Whole Bowel Irrigation

Clinical Toxicology, 35(7), 753-762 (1997)

# Position Statement: Whole Bowel Irrigation

American Academy of Clinical Toxicology;
European Association of Poisons Centres
and Clinical Toxicologists

## ABSTRACT

**In preparing this Position Statement, all relevant scientific literature was identified and reviewed critically by acknowledged experts using agreed criteria. Well-conducted clinical and experimental studies were given precedence over anecdotal case reports and abstracts were not usually considered. A draft Position Statement was then produced and subjected to detailed peer review by an international group of clinical toxicologists chosen by the American Academy of Clinical Toxicology and the European Association of Poisons Centres and Clinical Toxicologists. The Position Statement went through multiple drafts before being approved by the boards of the two societies and being endorsed by other societies.**

**The Position Statement includes a summary statement for ease of use and is supported by detailed documentation which describes the scientific evidence on which the Statement is based.**

**Whole bowel irrigation (WBI) should not be used routinely in the management of the poisoned patient. Although some volunteer studies have shown substantial decreases in the bioavailability of ingested drugs, no controlled clinical trials have been performed and there is no conclusive evidence that WBI improves the outcome of the poisoned patient. Based on volunteer studies, WBI may be considered for potentially toxic ingestions of sustained-release or enteric-coated drugs. There are insufficient data to support or exclude the use of WBI for potentially toxic ingestions of iron, lead, zinc, or packets of illicit drugs; WBI remains a theoretical option for these ingestions. WBI is contraindicated in patients with bowel obstruction, perforation, ileus, and in patients with hemodynamic instability or compromised unprotected airways. WBI should be used cautiously in debilitated patients, or in patients with medical conditions that may be further**

This Position Statement is endorsed by the American Board of Applied Toxicology and the Canadian Association of Poison Control Centers.

**compromised by its use. A single dose of activated charcoal administered prior to WBI does not appear to decrease the binding capacity of charcoal or to alter the osmotic properties of WBI solution. Administration of charcoal during WBI appears to decrease the binding capacity of charcoal.**

***The initial draft of this Position Statement was prepared by M Tenenbein.***

## SUMMARY STATEMENT

## INTRODUCTION

- Overall the mortality from acute poisoning is less than one percent. The challenge for clinicians managing poisoned patients is to identify promptly those who are most at risk for developing serious complications and who might potentially benefit, therefore, from gastrointestinal decontamination.

## RATIONALE

- Whole bowel irrigation (WBI) cleanses the bowel by the enteral administration of large amounts of an osmotically balanced polyethylene glycol electrolyte solution (PEG-ES) which induces a liquid stool.

- WBI has the potential to reduce drug absorption by decontaminating the entire gastrointestinal tract by physically expelling intraluminal contents.[1]

- The concentration of polyethylene glycol and electrolytes in PEG-ES causes no net absorption or secretion of ions, so no significant changes in water or electrolyte balance occur.[2]

## *IN VITRO* STUDIES

- *In vitro* studies demonstrate that activated charcoal does not produce a significant alteration in the osmolality of WBI solution.[3]

- PEG-ES may reduce the binding capacity of charcoal if both are administered concurrently.[3–5]

- However, in two other studies,[6,7] the binding of drug (mexiletine, imipramine) to charcoal was greater in WBI solution than in a slurry of charcoal.

## ANIMAL STUDIES

- Two animal studies have been performed in dogs.[8,9]

- One study[8] demonstrated a benefit from WBI. The mean total body clearance of paraquat was increased ($p < 0.05$) from 5.67 L/h to 13.2 L/h by WBI and this procedure removed 68.9% of the ingested dose.[8]

- Another study with theophylline is difficult to interpret because it lacked a control (no treatment) group.[9]

## VOLUNTEER STUDIES

- Six volunteer studies have investigated the value of WBI in reducing the absorption of ingested drugs.[10–15]

- Three studies involving dosing with ampicillin,[10] delayed-release aspirin,[11] and sustained-release lithium[12] showed significant reduction in bioavailability of 67%, 73%, and 67%, respectively (all $p < 0.05$).

- In a study designed to evaluate whether WBI enhanced the excretion of drugs during the post-absorptive phase, WBI did not reduce the bioavailability of aspirin.[13]

- Two studies[14,15] involving aspirin are difficult to interpret because one[14] lacked a control (no treatment) arm and, in both, the duration and total volume of WBI were less than in other studies.

- A study of WBI using coffee beans as a marker failed to demonstrate enhanced expulsion from the gastrointestinal tract.[16]

## CLINICAL STUDIES

- No controlled clinical studies have been performed.
- Eleven reports of the use of WBI in 17 patients have been published.[17–27] Nine patients ingested iron[17–21] and seven ingested other agents (sustained-release verapamil,[22] delayed-release fenfluramine,[23] latex packets of cocaine,[24] zinc sulfate,[25] lead oxide,[26] and arsenic[27]).

## INDICATIONS

- There are no established indications for the use of WBI.
- Based on experimental studies, WBI is an option for potentially toxic ingestions of sustained-release or enteric-coated drugs.[11,12]
- WBI has theoretical value in a limited number of toxic ingestions.
- WBI is of theoretical value in the management of patients who have ingested substantial amounts of iron because of the high morbidity and mortality of this poisoning and a lack of other options for gastrointestinal decontamination.[17]
- The use of WBI for the removal of ingested packets of illicit drugs is only of theoretical benefit.[24]
- The use of WBI in patients who have ingested substantial amounts of poisons not adsorbed by activated charcoal is only of theoretical benefit.[25–27]

## DOSAGE REGIMENS

- WBI fluid is best administered through a nasogastric tube.
- There are no dose-response studies upon which to base dosing. However, a recommended dosing schedule for WBI is:[1]

| | |
|---|---|
| Children 9 months to 6 years: | 500 mL/h |
| Children 6–12 years: | 1000 mL/h |
| Adolescents and adults: | 1500–2000 mL/h |

- WBI should be continued at least until the rectal effluent is clear although the duration of treatment may be extended based on corroborative evidence (e.g., radiographs or ongoing elimination of toxins) of continued presence of toxins in the gastrointestinal tract.

## CONTRAINDICATIONS

- Bowel perforation
- Bowel obstruction
- Clinically significant gastrointestinal hemorrhage
- Ileus
- Unprotected compromised airway
- Hemodynamic instability
- Uncontrollable intractable vomiting

## COMPLICATIONS

- Nausea, vomiting, abdominal cramps, and bloating have been described when WBI was used in preparation for colonoscopy and barium enema.[28]
- There are insufficient clinical data to describe accurately the types and incidences of complications associated with the use of WBI for the treatment of potentially toxic ingestions.
- Nausea and vomiting may complicate the use of WBI.[11] Vomiting is more likely to occur if the patient has been treated recently with ipecac[29] or if the patient has ingested an agent that produces vomiting.
- Patients with compromised and unprotected airways are at risk for pulmonary aspiration during WBI.

## SUPPORTING DOCUMENTATION

## INTRODUCTION

Whole bowel irrigation (WBI) for the management of poisoning is the enteral administration of large volumes of PEG-ES by nasogastric tube at rapid rates at least until the rectal effluent takes on the physical appearance of the infusate.[1] The duration of treatment may be extended based on corroborative evidence (e.g., radiographs or ongoing elimination of toxins) of continued presence of toxins in the gastrointestinal tract.

PEG-ES is preferred for WBI because there is no clinically significant absorption or secretion of fluid or electrolyte across the gut epithelium when PEG-ES is used as the irrigation solution.[2] The gastroenterology, surgery, and radiology literatures contain many reports of its safety and efficacy in patients ranging from infancy to seniors.

## RATIONALE

The rationale for this procedure is that it prevents the absorption of toxic substances by decontaminating the entire gastrointestinal tract by physically expelling intraluminal contents.

## *IN VITRO* STUDIES

*In vitro* studies have been conducted to determine the potential for binding of the polyethylene glycol by activated charcoal and whether such binding alters the osmotic properties of the irrigating solution or the absorptive capacity of the charcoal.

**Salicylic Acid.** Kirshenbaum *et al.*[3] tested clinically relevant ratios of PEG-ES to charcoal of 0.6:1, 1.2:1, and 2.4:1 and found that PEG-ES adsorption was 38%, 32%, and 16%, respectively. Osmolality changes were insignificant. Salicylic acid (500 mg/L) was used as a marker substance to test whether PEG-ES interfered with charcoal binding of drugs. A series of six clinically relevant ratios of volumes of WBI solution and charcoal were tested (20:1 to 1:1). There were small, clinically unimportant changes (predicted vs measured osmolality) in solution osmolality of 1–7 mOsm/kg over the entire range of ratios tested. Salicylate binding by activated charcoal decreased with increasing amounts of WBI solution from 100% binding of salicylate and charcoal alone to 68% at the clinically relevant ratio of 8:1.

**Theophylline.** Hoffman *et al.*[4] evaluated the influence of WBI solution upon drug adsorption by charcoal using theophylline as a marker. Theophylline was agitated with activated charcoal (1:4 charcoal to water slurry) in charcoal: theophylline ratios of 1:1, 3:1, and 10:1. The mean percent of theophylline adsorbed by activated charcoal was 16 ± 4%, 67 ± 5%, and 97 ± 3%, respectively. PEG-ES added to the same charcoal theophylline mixtures resulted in 17 ± 5%, 37 ± 3%, and 62 ± 2% adsorption by charcoal. All data were statistically significant ($p < 0.03$) at the 3:1 and 10:1 activated charcoal to theophylline ratios. Greater interference of drug adsorption occurred when WBI solution and charcoal were premixed (62 ± 2% vs 74 ± 1%).

**Cocaine.** Makosiej *et al.*[5] evaluated the influence of WBI solution upon drug adsorption by charcoal using cocaine as a marker. They found a statistically significant decrease ($p < 0.05$) in the mean percentage drug adsorption to charcoal: 17.8 ± 1.3% to 4.2 ± 1.1% (1:1 ratio of charcoal to cocaine), 51.0 ± 2.1% to 39.4 ± 2.6% (3:1 ratio), 80.5 ± 0.3% to 28.3 ± 3.9% (5:1 ratio), 95.4 ± 1.0% to 35.9 ± 1.5% (7:1 ratio), and 99.7 ± 0.1% to 43.8 ± 4.5% (10:1 ratio). Statistically greater interference occurred if WBI solution and charcoal were mixed prior to incubation with cocaine. In these circumstances, adsorption to charcoal was reduced from 39.4 ± 2.6% to 7.1 ± 1.0% (3:1 ratio of charcoal to cocaine), 28.3 ± 3.9% to 7.3 ± 0.3% (5:1 ratio), 35.9 ± 1.5% to 11.5 ± 1.6% (7:1 ratio), and 43.8 ± 4.5% to 14.8 ± 0.9% (10:1 ratio).

**Mexiletine.** Arimori *et al.*[6] studied the binding of mexiletine in PEG-ES by charcoal. Adsorption of mexiletine by charcoal was higher in WBI solution than in a control solution (328 mg vs 284 mg/g charcoal, respectively). Because PEG-ES has a pH of 8.5 and mexiletine has a pka of 9.1, a higher proportion of mexiletine is unionized which favors charcoal binding.

**Imipramine.** Arimori *et al.*[7] studied the binding of imipramine by charcoal in the presence of PEG-

ES. Adsorption of imipramine to charcoal was greater in WBI solution than in a control solution (610 mg vs 372 mg/g charcoal, respectively).

These *in vitro* studies[4,5] suggest that activated charcoal should be given first and not mixed with the WBI solution. The combination of multiple-dose charcoal therapy with WBI is unlikely to result in benefit from the charcoal.[3]

## ANIMAL STUDIES

**Paraquat.** Mizutani *et al.*[8] evaluated WBI in six paraquat-poisoned and six control dogs. The weights of the dogs ranged from 7–12 kg and they were given paraquat dichloride 250 mg/kg as a 25% solution in normal saline. WBI with PEG-ES 50 mL/kg/h was begun 1 hour after paraquat administration and continued for 5 hours. Rectal effluent was collected and paraquat was measured. Mean percentage of recovered paraquat dose was 68.9% with a range of 30.7–95.3%. Plasma paraquat concentrations at 2, 3, and 5 hours after the initiation of bowel irrigation to the end of the study were significantly lower in the bowel irrigation group compared with the control group. The 5-hour mean ± SEM WBI and control plasma paraquat concentrations were 5.6 ± 1.8 and 33.0 ± 10.2 mg/L, respectively ($p < 0.05$). The mean total body clearance of paraquat was significantly greater ($p < 0.05$) in the bowel irrigation group (13.2 ± 1.26 L/h) compared with control (5.67 ± 1.82 L/h). Clinical outcome was not assessed as the animals were sacrificed after the completion of specimen collection.

**Sustained-Release Theophylline.** Burkhart *et al.*[9] evaluated WBI as an adjunct to multiple-dose charcoal therapy in a crossover study of eight dogs poisoned with sustained-release theophylline 75 mg/kg. The multiple-dose charcoal regimen was charcoal 1.0 g/kg along with sorbitol (70%) 1.0 mL/kg at 2 hours followed by doses of charcoal 0.5 g/kg in water at 5 and 8 hours. WBI consisted of four doses of irrigation solution 25 mL/kg every 45 minutes beginning at 2 hours after drug administration. There were no significant differences between the AUCs for multiple-dose charcoal therapy, WBI followed by multiple-dose charcoal, and WBI during multiple-dose charcoal therapy. It is unknown if any of the interventions in this model were effective because this study lacked a control (no treatment) group.

## VOLUNTEER STUDIES

**Ampicillin.** Tenenbein *et al.*[10] evaluated WBI by utilizing a randomized two-limb crossover design in nine adults. Each subject ingested ampicillin 5 g and was subjected to WBI 2 L/H beginning 1 hour and continued until the rectal effluent was clear or 5 hours had elapsed. Ten specimens of blood for ampicillin concentration were collected during the 12 hours after ampicillin ingestion. The mean ± SEM $AUC_{0-12\,h}$ for the WBI and control limbs were 22.0 ± 2.6 and 65.7 ± 7.9 μg/h/mL, respec-tively. This represents a decreased ampicillin absorption of 67% for WBI ($p < 0.001$).

**Delayed-Release Aspirin.** Kirshenbaum *et al.*[11] studied WBI vs activated charcoal and sorbitol after the ingestion of delayed-release aspirin by utilizing a randomized three-limb crossover design in 10 adults. Each subject ingested enteric-coated salicylate 2.9 g, and either WBI or activated charcoal 50 g in sorbitol (70%) was administered 4 hours later. The rate of WBI was 1.5–2.0 L/h. Treatment was terminated when the rectal effluent was visibly similar to the infusate with a minimum of 3 hours and a maximum of 5 hours of infusion. The mean duration of WBI was 4 hours. Ten specimens of blood for salicylate concentration were collected at 11 intervals over 14 hours after drug ingestion. The $AUC_{0-14\,h}$ for WBI and activated charcoal in sorbitol both showed a significant ($p < 0.01$) decrease in drug absorption of 73% and 57%, respectively, compared to control. WBI was superior to activated charcoal in sorbitol ($p < 0.05$).

**Sustained-Release Lithium.** Smith *et al.*[12] evaluated WBI as a treatment for sustained-release lithium ingestion using a two-limb crossover design in 10 adult volunteers. Each subject ingested lithium 0.80 mg/kg and WBI was begun 1 hour later at a rate of 2 L/h for 5 hours. Mean ± SD AUCs for WBI vs control were 5.93 ± 2.50 mM × h/L and 18.26 ± 5.83 mM × h/L, respectively ($p < 0.0005$). This equals a reduction in bioavailability of 67 ± 11% due to WBI.

**Aspirin.** Mayer *et al.*[13] studied whether multiple-

dose activated charcoal or WBI would enhance the excretion of previously absorbed salicylate. There were no statistical differences in AUC after salicylate alone (2320 ± 501 mg/L × h) compared with either activated charcoal (2040 ± 454 mg/L × h) or WBI (2093 ± 418 mg/L × h). Additionally, there were no differences between and among various study limbs for percent salicylate excretion, peak salicylate acid concen-trations, and the time to peak concentration. These data do not support the use of WBI to enhance the excretion of previously absorbed salicylates.

Olsen *et al.*[14] compared low volume WBI with ipecac plus activated charcoal in sorbitol in six adults in a randomized two-limb crossover study. All treatments began 30 minutes after the ingestion of acetylsalicylic acid 3.25 g. WBI consisted of the administration of irrigation solution 3 L over 100 minutes. The ipecac charcoal limb consisted of syrup of ipecac 30 mL followed by activated charcoal 50 g with sorbitol 96 g after emesis had ceased. Urine was collected for 24 hours for salicylate analysis. The mean ± SD urine recoveries of salicylate after WBI and ipecac-charcoal were 48.6 ± 5.4% and 37.0 ± 2.6%, respectively ($p < 0.01$). The mean peak serum salicylate concentration in the WBI treated subjects (112.0 ± 25.6 mg/L) was significantly higher ($p < 0.01$) than that of the activated charcoal-ipecac group (7.4 ± 21.6 mg/L). The AUCs were 1663.5 ± 242.8 (WBI) and 951.8 ± 393 (charcoal-ipecac) μg/h/mL, respectively ($p < 0.05$). Because this study lacked a control (no treatment) arm, the effectiveness of either intervention was not demonstrated. Duration and total volume of WBI were less than other studies.[6-8]

Rosenberg *et al.*[15] compared WBI alone, activated charcoal combined with WBI, and activated charcoal alone in a four-limb crossover study in three adults who ingested acetylsalicylic acid 650 mg as two tablets. All treatments were begun 5 minutes after drug ingestion. WBI consisted of 4 L given over 40–60 minutes and activated charcoal 50 g in 250 mL of water. Salicylate excretion was quantified from 24-hour urine collection. The mean ± SD urinary salicylate excretion in the control group was 456 ± 83 mg, in the WBI treated group was 354 ± 31 mg, in the charcoal and WBI treated group was 321 ± 99 mg, and in the charcoal alone group was 98 ± 36 mg. Only charcoal alone was different from control ($p = 0.011$). Charcoal was not compared with WBI but WBI alone was not different from control. This study has several limitations. The salicylate recovery was only 70% of the administered dose in the controls, the number of subjects was very small, the dose of aspirin was only 650 mg, and the duration of WBI was only 40–60 minutes considerably shorter than that of other studies.[3,10]

**Coffee Beans.** Scharman *et al.*,[16] using a controlled crossover experimental design, evaluated WBI with and without oral metoclopramide pretreatment for the clearing of coffee beans from the gastrointestinal tract. Eleven volunteers each ingested 10 coffee beans followed by metoclopramide or placebo 60 minutes later. They then waited another 30 minutes prior to WBI which was continued for 5 hours at a rate of 2.0 L/h. For WBI with and without metoclopramide, a mean of 2.3 beans were passed at the time of clear rectal effluent, 2.9 and 3.1 hours, respectively. At 5 hours, the mean ± SD number of beans passed were 3.8 ± 2.5 and 3.5 ± 1.9 in the metoclopramide and placebo groups, respectively.

## CLINICAL STUDIES

Clinical studies of WBI consist only of case reports.

**Iron.** Tenenbein[17] described six patients aged 2–19 years who ingested a mean of 84 mg/kg of elemental iron (26, 65, 72, 88, 120, and 133 mg/kg). The ingestion was confirmed radiologically in five (the sixth had ingested a pediatric multivitamin plus iron preparation). Two patients were treated with ipecac and gastric lavage, and two with ipecac alone; however, these interventions were negligibly effective by radiologic assessment. All were treated with WBI by nasogastric tube at a rate of 0.5 L/h for the toddlers and 2.0 L/h for the teenagers. During WBI, physical evidence of the ingestant was seen in the effluent of all six patients. WBI was stopped when the rectal effluent became clear (6–12 hours). All patients were followed with serial serum iron concentrations during the first 14 hours and the individual peak serum iron values were 2.58 mg/L, 3.19 mg/L, 3.58 mg/L, 4.37 mg/L, 4.42 mg/L, and 4.59 mg/L. (Note: 2.58

mg/L = 258 μg/dL = 46.23 μmol/L.) Four of the six patients received deferoxamine, and colored urine was seen in only one of the four. The clinical courses were unremarkable.

Mann *et al.*[18] described a 16.5 kg 2.5-year-old male who was brought to the emergency department (ED) 75 minutes after having ingested elemental iron 130 mg/kg. A large amount of iron was demonstrated in a radiograph of the abdomen, but ipecac-induced emesis produced no tablets or fragments. Gastric lavage was also performed. Eight hours later, WBI 0.5 L/h for 10 hours and deferoxamine therapy were instituted. The urine did not change color and the highest serum iron concentration was 2.9 mg/L which was prior to WBI. Iron sediment was seen in the rectal effluent. The patient's course was uneventful.

Everson *et al.*[19] reported an 11-month-old infant who ingested prenatal iron supplements. An abdominal X ray on admission to the ED showed 23–26 tablets equivalent to elemental iron 130–150 mg/kg. Two doses of ipecac and two gastric lavages resulted in the retrieval of eight tablets and assorted pill fragments. The patient was treated intravenously with deferoxamine 15 mg/kg/h from 3–12 hours after ingestion and had orange urine. His highest serum iron concentration was 2.65 mg/L at 2 hours after ingestion. At 14 hours after ingestion an abdominal X ray showed "a large radiopaque mass of tablet material." He was then treated with a WBI 1450 mL over 8 hours and iron tablet fragments were seen in the rectal effluent. The clinical course was unremarkable.

A 33-month-old boy who ingested at least 160 mg/kg of elemental iron (estimated from an abdominal radiograph taken at presentation to hospital some 15 hours after ingestion) was described by Kaczorowski and Wax.[20] The child had normal vital signs and serum iron concentration was 3.67 mg/L. Gastric lavage yielded no iron tablets or fragments. WBI with PEG-ES at 500 mL/h and deferoxamine infusion were initiated. The deferoxamine was stopped 24 hours later and the urine never changed color. WBI was continued for 121 hours total because of the continual presence of iron tablets in abdominal radiographs and the intermittent passage of iron tablets in the effluent. Serum electrolytes remained normal throughout the entire WBI. Serum iron concen-tration never increased and fell to 0.86 mg/L on the day of discharge when two iron tablets were still present radiographically.

A 21-year-old patient in week 26 of her fourth gestation ingested approximately 3.9 g elemental iron with suicidal intent.[21] A serum iron concentration some 2 hours later was 5.07 mg/L. Deferoxamine 15–17.9 mg/kg/h was administered intravenously for 14 hours (total dose 10.2 g) and WBI was undertaken. PEG-ES was given at 2 L/h for 12 hours, by which time the rectal effluent had become clear. The patient delivered a healthy infant at 39.5 weeks gestation. After cessation of WBI and deferoxamine, the serum iron concentration was 0.53 mg/L.

**Sustained-Release Verapamil.** Buckley *et al.*[22] reported a 23-year-old female who ingested sustained-release verapamil 4.8 g. At 2 hours postingestion, she was asymptomatic. She was treated with gastric lavage, activated charcoal 100 g, and WBI 3.5 L. Within 2 hours she passed "a conglomerate of tablets about 2–3 cm in diameter consistent with the tablets taken." The clinical course was unremarkable. In the same report a 44-year-old female ingested slow-release verapamil 15–20 g. She presented for medical care 24 hours later after collapsing. She was hypotensive and bradycardic. Activated charcoal and PEG-ES were administered but not retained due to episodic emesis. The patient expired 39 hours postingestion.

**Delayed-Release Fenfluramine.** Melandri *et al.*[23] described a 26-year-old female who ingested delayed-release fenfluramine 1.8 g. She was treated with gastric lavage followed by WBI 5 L from 6–10 hours after overdose. The endpoint was a clear rectal effluent. Her course was unremarkable.

**Cocaine.** A 39-year-old male who had ingested 80 latex packets of cocaine, 10 g each, for the purpose of illicit drug smuggling was described by Hoffman *et al.*[24] Prior to presentation at the hospital, the patient had spontaneously passed 61 of these. WBI at 2 L/h was begun and continued over 10.5 hours (total 16 L PEG-ES). Ten packets were passed within 1.5 hours. Eight more packets were passed over the next 9 hours. The final packet remained in the stomach and was endoscopically removed. The clinical course was unremarkable.

**Zinc Sulfate.** Burkhart *et al.*[25] described a 16-year-old male in whom an abdominal X ray demonstrated approximately 50 zinc sulfate tablets despite

previous spontaneous emesis and gastric lavage. Within 1 hour of the initiation of WBI 1 L/h, he began passing pill fragments. The procedure was stopped at 4 hours at which time a repeat radiograph demonstrated a marked decrease in the number of tablets present (quantity not specified). His clinical course was unremarkable.

**Lead Oxide.** Roberge and Martin[26] described an 89-year-old male who ingested approximately 100 mL of ceramic glaze with a 30% lead oxide content. Gastric lavage was carried out within 1 hour of ingestion and a subsequent abdominal radiograph demonstrated lead throughout the small intestine. At 5 hours postingestion, dimercaprol 250 mg was given and WBI was initiated. Eight liters of solution were infused over 6 hours at which time the rectal effluent was clear. A repeat abdominal radiograph demonstrated near total clearing. The initial blood lead concentration was 180 μg/L with subsequent values of 390 μg/L at 16 hours and 420 μg/L at 24 hours.

**Arsenic.** Lee *et al.*[27] described two cases of acute arsenic ingestion treated with WBI. A 41-year-old man ingested an arsenic-containing herbicide. At 2 hours he had several bouts of emesis and diffuse abdominal pain. At 4 hours, an abdominal radiograph showed radiopaque material in the small bowel. WBI, 2 L over 3 hours, resulted in rectal effluent with the characteristic garlic odor of arsenic and a clear radiograph. He also received dimercaprol and penicillamine and his stools retained the garlic odor for two more days. His clinical course was unremarkable. The second patient was a 29-year-old male who ingested an arsenic-containing insecticide. He was asymptomatic several hours later when he presented for medical care. An abdominal X ray showed large amounts of radiopaque material. He was treated with WBI 1 L/h for 24 hours at which time a subsequent radiograph was normal. He was also treated with dimercaprol. His course was unremarkable.

## INDICATIONS

There are no established indications for the use of WBI. Based on volunteer studies, WBI is an option for potentially toxic ingestions of sustained-release or enteric-coated drugs. WBI has theoretical value for patients who have ingested substantial amounts of iron as the morbidity is high and there is a lack of other options for gastrointestinal decontamination. The use of WBI for the removal of ingested packets of illicit drugs and in the management of patients who have ingested substantial amounts of poisons not adsorbed to activated charcoal is also of theoretical benefit.

## CONTRAINDICATIONS

WBI is contraindicated in the presence of ileus, bowel obstruction, bowel perforation, clinically significant gastrointestinal hemorrhage, hemodynamic instability, uncontrollable intractable vomiting, and an unprotected compromised airway.

## COMPLICATIONS

There are few clinical data to describe accurately the types and incidences of complications associated with the use of WBI for the treatment of potentially toxic ingestions.

Ernstoff *et al.*[28] have reported nausea, vomiting, abdominal cramps, and bloating following the use of WBI as preparation for colonoscopy and barium enema. Reported complications of WBI in volunteer studies include nausea and vomiting[1,12-14,16,17,21] which was controlled in one study[11] by decreasing the administration rate from 2.0 to 1.5 L/h. Vomiting is more likely to occur if the patient has been treated recently with ipecac[29] or if the patient has ingested an agent that produces vomiting such as theophylline or aspirin.

There were no complications attributable to WBI described in any of the case reports. Patients with compromised and unprotected airways are at risk for pulmonary aspiration during WBI.

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## APPENDIX: TECHNIQUE FOR PERFORMING WBI

The required equipment and materials include a small bore (12 F) nasogastric tube, a feeding bag used for nasogastric tube feedings, an intravenous

pole, a supply of polyethylene glycol electrolyte solution, and a commode. This procedure does not require a specialized location or setting and can be performed wherever acutely poisoned patients are managed.

A 12 French nasogastric tube is passed into the stomach. A nasogastric tube is required because patients will not drink the PEG-ES at the required rate. Only a small bore tube is needed and gastric location is ensured by auscultation during air injection. It is preferable to radiologically confirm that the tip of the tube is in the midportion of the stomach as this position increases the likelihood of anterograde propulsion of the ingestant. Attach the tube to a reservoir bag of irrigation solution which is hung from an elevated site.

The patient should be seated or the head of the bed elevated to at least 45°. Placing the patient in an upright position promotes the settling of the ingestant into the distal portion of the stomach, decreases the likelihood of vomiting, and establishes a dependent relationship of the intestines to the stomach.

A recommended dosing schedule[1] is:

| | |
|---|---|
| Children 9 months to 6 years: | 500 mL/h |
| Children 6–12 years: | 1000 mL/h |
| Adolescents and adults: | 1500–2000 mL/h |

A commode or similar receptacle is useful to collect the effluent.

If emesis occurs, it is usually a consequence of the ingestant or prior administration of ipecac. Ingestant-induced emesis is best managed by the parenteral administration of an antiemetic which does not impair consciousness. Metoclopramide has both antiemetic and gastric emptying properties. The likelihood of emesis is also decreased by keeping the patient's upper half of the body upright. If emesis occurs despite the above measures, decrease the infusion rate by 50% for 30–60 minutes and then return to the original rate.

Monitoring of WBI requires no more nursing supervision than is needed for intravenous therapy. There is no need to monitor the patient's fluid or electrolyte status during the procedure. WBI should be continued at least until the rectal effluent is clear (which takes many hours) although the duration of treatment may be extended based on corroborative evidence (e.g., radiographs or ongoing elimination of toxins) of continued presence of toxins in the gastrointestinal tract. After completion of WBI, additional liquid bowel movements will occur.