Pediatric Ingestions: New High-Risk Household Hazards

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PRACTICE GAPS

1. Most poisoning events in preschool-aged children continue to be accidental ingestions in the home, ranging from medications to toys and common household products.
2. Knowledge of these common ingestions is important to properly diagnose, treat, and refer to emergent care as needed.
3. Pediatricians and emergency physicians should be familiar with new exposures and treatment options that have been recommended for some novel agents.

OBJECTIVES *After completing this article, readers should be able to:*

1. Explain the general epidemiology and emerging trends for pediatric poisonings and exposures.
2. Become familiar with several new products that have emerged as high-risk exposures in preschool-age children.
3. Describe the potential serious clinical complications and treatment options for these new high-risk agents.

INTRODUCTION

There is good news and bad news when it comes to pediatric poisoning and exposures. The last full year that the American Association of Poison Control Centers reported data was 2017. (1) There were 2,115,186 human exposures called in to poison centers in the 50 states and US territories, of which children represented the largest percentages. Children younger than 6 years were the concern in 45% of calls, those 6 to 12 years of age represented 6% of calls, and adolescents 13 to 19 years of age 8% of calls. (1) Although no death of a child is considered a positive outcome, the trend in fatalities from poison exposure for toddlers has been decreasing. The good news is that of 956,871 calls to poison centers regarding preschool-age children (<6 years old), there were only 19 fatal outcomes. The bad news is that the data identify room for improvement in adolescent poison prevention. In adolescents, ages 13 to 19 years, in a much smaller number of calls with a total of 171,303 encounters with poison centers, there were 53 deaths and 3,149 major outcomes recorded. (1) This article summarizes the emerging ingestion trends of new toxic products that seem to be the most concerning for children's health. Our companion article will address adolescent poisoning.

AUTHOR DISCLOSURE Drs Sheridan, Hughes, and Horowitz have disclosed no financial relationships relevant to this article. This commentary does not contain a discussion of an unapproved/investigative use of a commercial product/device.

MAGNETS

Most preschool-age children involved in poisoning have accidental ingestions in the home, with commercial and over-the-counter products predominating. New exposures and treatment options have been recommended for some novel products. Although removed from the market in children's toys and gift items in 2012, ultrapotent magnets made from rare earth metals, such as neodymium, were popular just a few years ago and remain in many households. (2)(3) They can still be purchased on the Internet and in hardware stores for commercial use. These magnets are produced as small round balls about the size of a BB shot, but also as squares, round washers, and a variety of other shapes and sizes. In a review of pediatric ingestions reported to the US Consumer Product Safety Commission between 2000 and 2012 there were 72 cases. Of these 72 cases, the mean age of the child was 6.4 years, and 69.7% required surgery for removal of the magnets. (3) Three patients required multiple surgeries. (3) This report, however, clearly represents underreporting of the problem because physicians and health-care workers are generally unaware of the US Consumer Product Safety Commission or the mechanism for reporting ingestions to this agency and do not usually report cases of concern to them. For example, a single pediatric medical center between 2003 and 2009 had 38 cases, although only 8 were for more than 1 magnet. (4) However, 4 of these 8 patients with multiple magnets presented with peritonitis and required emergency surgery for intestinal perforation. (4)

When more than 1 of these highly magnetic items is swallowed, these magnets can move through the gastrointestinal tract at different rates and become lodged in adjacent loops of intestine. Due to their ability to attract each other across bowel walls, the adjacent bowel segments may stick together, creating a closed-loop obstruction. If left undiagnosed, obstruction can lead to perforation, fistula formation, and necrotic bowel. (5) Theoretically, obstruction could even occur with a single magnet and a second object made of metal. (6) Based on their experience, one pediatric group with survey feedback from the North American Society of Pediatric Gastroenterology, Hepatology, and Nutrition proposed an algorithm to manage magnet ingestions. (5) The first step is to ascertain the number of metallic objects ingested and their locations by abdominal radiography. Any object lodged in the esophagus should be emergently removed by a pediatric gastroenterologist. If more than 1 object is seen in the stomach, these objects should be removed as well; however, an isolated single object may be watched expectantly for signs of obstruction. Once an object is past the stomach and beyond the reach of endoscopy, affected patients need to be watched carefully for signs of obstruction or peritonitis, either occurrence requiring the prompt consultation of a pediatric surgeon. The algorithm also suggests consultation with a surgeon for cases when the foreign bodies fail to progress on serial radiographs. (5) Enhancement of magnet movement through the gastrointestinal tract may be aided by a laxative such as polyethylene glycol, but there is no clear data that this approach speeds the passage of the magnet. There is no clear guidance on how frequently to obtain abdominal radiographs to determine movement or passage of ingested magnets. Clinical judgment and close daily follow-up seem prudent.

BUTTON BATTERIES

Another ingestion by preschool-age children that poison centers commonly receive calls about are ingestions of small button batteries. (6)(7) Although neither magnets nor batteries are toxins, per se, they both represent frequent exposures in toddlers that if not managed quickly can result in disaster. In the case of button batteries, these more frequently lodge in the esophagus due to their size and begin to cause an electric burn on contact (Fig 1). (7) If not removed as soon as feasibly possible, perforation or fistula formation may occur. (7)(8) A recent study to investigate modalities to slow the rate of electric burn using a porcine esophagus and a variety of readily available household liquids found that honey, or the liquid ulcer medication carafate, slows the extent of esophageal injury. (9)(10) Current recommendations from the National Button Battery Hotline, adopted by poison centers, call for a caregiver to give 2 teaspoons of honey every 10 minutes while en route to a health-care facility based on the suspicion of a battery ingestion in children. (9) In addition, since going to a facility where subsequent transfer would ultimately be needed, if a reasonable travel time exists, parents or the transporting emergency medical system ambulance should go directly to a facility where tertiary pediatric services are available to remove the battery by a pediatric gastroenterologist. Time is of the essence, as one study found the time to perforation to be less than 18 hours, but mucosal injury begins almost immediately. (11)

LAUNDRY PODS

Introduced in the United States in 2011 after 10 years' experience with use in Europe, the single-use laundry detergent "pod" caught on as a consumer product and is now found in many homes. Soon after their introduction to the American market there were 2 pediatric cases with severe

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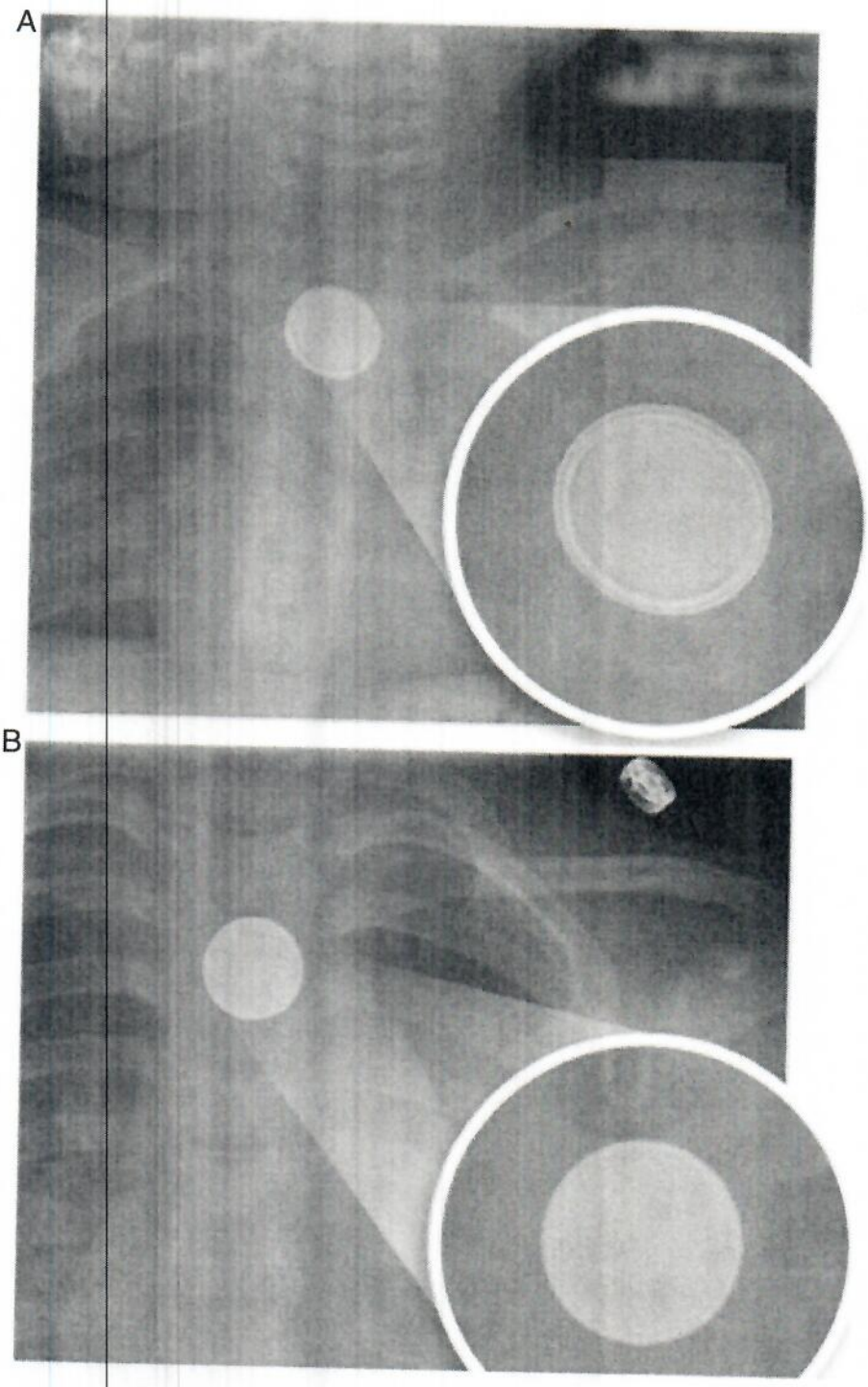

Figure 1. Anteroposterior chest radiographs of a button battery with a double ring or halo sign (A) and a coin with a homogenous appearance (B). Reprinted with permission from Kris Jatana, MD, *Pediatric Otolaryngology,* Columbus, OH.

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outcomes in children who placed the colorful and squishy object into their mouth. (12) Not much pressure or saliva was required for these sacs to burst open and their contents to propel backward into a child's throat and upper airway. With caustic contact to the vocal cords, acute laryngospasm leading to upper airway occlusion occurred in a few patients in the United States who required intubation and ICU admission. There were 2 deaths reported, although possible upper respiratory tract disease may have contributed to 1 of these. (13) Since these early cases, stronger binding wraps, child-resistant containers, and more experience with the spectrum of cases has occurred. Originally, many of these cases were referred to

the emergency department for observation or admission. However, over time, more comfort with observing minimally symptomatic cases at home has tempered physician and poison center anxiety over these products. What may have caused the original cases of airway obstruction and central nervous system depression has been debated but never clearly resolved. Hypoxia, some contents of the detergent packet such as propylene glycol, small amounts of ethanol or ethoxylated alcohols in some brands have been suggested as the cause of obtundation early after exposure. (13) Airway compromise, if it is to occur, happens rapidly, and if after brief observation it does not appear is very unlikely to be a late occurrence.

Once the airway is stable, attention must be turned to the corrosive effects of these pods on the gastrointestinal tract. In fact, the pH of these detergents is often in the range of 7 to 9, which is not extremely alkaline. In a small case series of children undergoing upper endoscopy, only erythema was reported. (13) Current signs and symptoms used to screen for patients who require endoscopy to delineate esophageal injury are similar to those existing for other caustic agents. Any child with difficulty swallowing, drooling, stridor, and recurrent vomiting should have immediate consultation with and referral to a pediatric gastroenterologist for endoscopy. (13) Although not specific to laundry pods, a recent randomized study in children with caustic ingestions who received intravenous methylprednisolone for 3 days if they had a grade 2B injury (partial-thickness circumferential injury) showed that these children had a lower incidence of stricture formation compared with usual care. (14) None of the children in this study were exposed to laundry pods, and all had ingested a liquid alkaline cleaning product. Because the nature and intended use of these products changes over time, consultation with a poison center to identify the product's specific contents and pH may help with initial decision making on which children may require extended observation versus those who can be observed at home with phone follow-up. Specialty cleansers for toilets, tile, brass cleaners, oven cleaners, and those used in the marine environment all have different products, some of which are very toxic.

The impetus to create poison centers in the 1960s was driven by pediatric lye ingestions from oven cleaners. Lye caused a severe caustic injury due to sodium hydroxide necessitating emergent endoscopy. However, these products are less available now, and for children younger than 5 years there were fewer than 300 calls nationwide to poison centers concerning lye ingestion and no deaths in 2018. (1)

One other serious caustic agent worth mentioning, because it is infrequent but often fatal, is gun bluing. This product, which contains selenous acid, is used to polish gun metal and is extremely toxic. Several fatalities in children who ingested even small amounts of gun bluing have occurred. (15)

HOUSEHOLD LOOK-ALIKES: TIKI TORCH OIL, HYDROGEN PEROXIDE, AND NICOTINE REFILLS

Ingestion of household products that are oils and solvents have been an issue in childhood exposures for many decades. (16) Several new products have emerged as high-risk exposures. Lamp oil has been available for a long time, and occasional accidental ingestions occurred because the pleasant-scented oils present attracted the curious preschooler. One new twist in attracting the preschooler is the oil used to light tiki torches, a popular backyard ornament in summertime picnics. (17) The bottle shape and liquid coloration of tiki torch oil look nearly identical to a bottle of apple juice (Fig 2), which has led to accidental ingestions and aspiration events. Very few of these products have any child-resistant packaging. (17)

The hydrogen peroxide preparation used for wound care and cleaning usually comes as a 3% solution, and in this concentration it is only mildly irritating to the mouth and gastrointestinal tract when inadvertently swallowed by a young child. Recently, 35% hydrogen peroxide has gained popularity as a food-grade or nutraceutical product, which is a food additive purportedly used for medicinal purposes. (18) When even small amounts as a swallow or 2 are ingested, this product of hydrogen peroxide reacts with hydrochloric acid in the stomach and liberates large volumes of oxygen. (19) This causes immediate expulsion of frothy vomitus as well as systemic absorption of the oxygen. Gastric oxygen, once absorbed, will pass via the portal vein to the liver. Numerous cases of oxygen gas embolism to the liver have appeared in the literature in both children and adults who accidentally mistake this product for water, as both are clear, odorless, and often kept in the refrigerator by their owner in an unlabeled container such as a standard pitcher or water bottle. (19) Although there is some debate on how to approach these cases, a recent review of all cases in the AAPCC database over 10 years has shown that there is a risk of systemic gas embolism to the brain causing strokes and to the cardiopulmonary vasculature causing pulmonary embolism and acute cardiac artery occlusion. (20) The preferred evaluation of these children with acute onset of symptoms of vomiting should be immediate imaging by noncontrast limited upper abdominal computed tomography (to reduce radiation exposure) to assess the bubble burden. An abdominal computed tomographic scan of a 10-year-old who took only 1

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Figure 2. Apple and fruit juice bottles (top) and tiki torch fuel bottle (bottom). Reprinted with permission from Zane Horowitz, MD.

swallow of 35% hydrogen peroxide that we treated is shown (Fig 3). (18) There is controversy on what constitutes a significant air embolism burden that would require hyperbaric treatment. When administered early, hyperbaric treatment can completely shrink all the gas and avoid the need for admission to a neurology unit where once an hour neurologic examination is otherwise necessary to detect a central nervous system embolism. (20) An embolic stroke can occur

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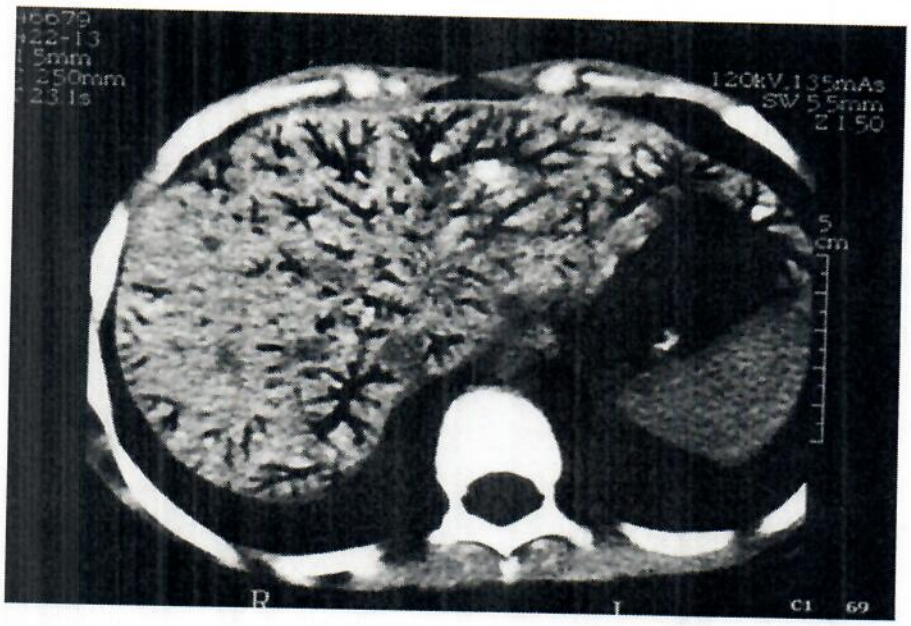

Figure 3. Abdominal computed tomographic scan showing a massive portal venous air embolism in the liver of a 6-year-old boy 1 hour after drinking a clear liquid from a water pitcher that was actually 35% hydrogen peroxide. Reprinted with permission from Zane Horowitz, MD.

even in the absence of a patent foramen ovale, so a negative result by a screening echocardiogram for a patent foramen ovale does not eliminate the risk of central nervous system embolism.

Vaping is the new technique for smoking. As the habit becomes popular among adolescents and young parents, vaping paraphernalia poses some unique risks to the children in their households. Several cases of nicotine refill liquid ingestions have occurred, and not all were by the explorative toddler who inadvertently sipped from a cartridge. (21)(22) Some of these cases happened when the original nicotine liquid was diluted and decanted into a child's liquid ibuprofen container left in the refrigerator. (22) In one case, an unsuspecting parent then gave what they thought was the usual 10-mL dose for fever to a 6-year-old child. The child had vomiting, myoclonic jerks, and significant altered mental status, which required intubation for airway protection. With supportive care the child made a full recovery, but serum examination revealed elevated levels of nicotine (3.48×10^7) and its 2 metabolites: cotinine (7.42×10^7) and 3-hydroxy-cotinine (3.2×10^8). (22)

BUPRENORPHINE: THE ONE PILL THAT REALLY CAN KILL

A popular theme in reviews of pediatric toxins is the rhyme "one pill can kill." The first list of these medications was proposed by Gideon Korn in 1993 and has since been added to by various authors. (23) Among the pharmaceuticals often proposed for this list are opioids, (24) cardiovascular medications, (25)(26)(27)(28) psychiatric medications, (29)(30)(31)(32)(33)(34) sulfonylurea, (35) and seizure medications. (36)(37)(38) Comprehensive reviews of both the literature and poison center data have shown that few of these medications have lethality with a single pill, and most cases of severe outcomes and death occur with larger overdoses. (25)(26)(27)(28)(29)(30)(31)(32)(33)(34)(35)(36)(37) However, the one group of medications that can produce death in a young child after a single dose are the long-acting opioid narcotics. (24)(39)(40)(41)(42) With the increasing use of medication-assisted therapy for substance abuse disorder, more buprenorphine is being dispensed. A single tablet of buprenorphine, or a single dissolvable gel strip of its formulation as Suboxone® (Indivior Inc, North Chesterfield, VA), has been lethal to children. (42) Prescribing intranasal naloxone spray to the family of patients on buprenorphine (and methadone as well) is potentially lifesaving to the patient, should they take too much, but also for children in their homes who may accidentally eat a single tablet or chew on what appears to be a "gummy" product, a dissolvable formulation of Suboxone. (43) Many states have passed statutes making the ability to automatically dispense naloxone or to self-request it at a pharmacy widely available. Pediatricians doing anticipatory safety guidance to parents at the 9-month-old to 1-year-old health supervision visit should ask about opiates and medication-assisted therapy present in the home or used by caregivers (especially grandparents) and should offer to write a

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prescription for naloxone nasal spray, which can rapidly reverse opiate respiratory depression. Naloxone nasal spray is easy to use by lay bystanders such as parents. Essentially, in 2020 for toxic exposures, naloxone is the new ipecac.

Summary

1. Based on observation, young children can ingest a variety of agents ranging from medications to toys and common household products. This can be due to a child's explorative nature as well as poor labeling of dangerous chemicals.
2. Based on opinion, knowledge of these common ingestions is critical for frontline providers to diagnose, treat, and refer for emergent care as needed.
3. Based on opinion, various quality improvement efforts could target policies specifically around labeling of substances that look benign and similar to common nontoxic products.
4. Based on consensus, child-resistant packaging should be advocated for many more products than is currently mandated.

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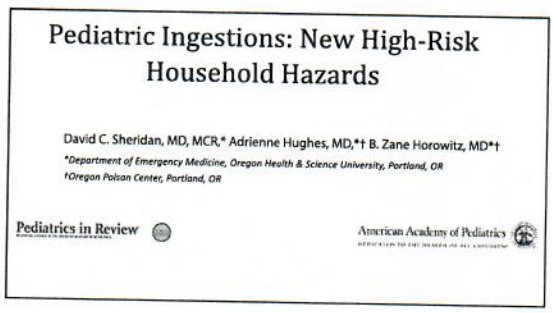

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1. An ill-appearing 6-year-old boy is being evaluated in the emergency department (ED) for vomiting over the past 6 hours. On physical examination he has direct tenderness over the left upper quadrant of his abdomen with no rebound. An abdominal radiograph is obtained and reveals 2 radiopaque round objects each measuring 0.5 cm in diameter in the left upper quadrant that appear to be touching. Air fluid levels are also seen. Which of the following in the most appropriate next step in the management of this patient?

   A. High-dose polyethylene glycol.
   B. Oral metoclopramide.
   C. Pediatric surgery consult.
   D. Repeat abdominal radiography in 5 days.
   E. Upper endoscopy.

2. A mother calls the Poison Control Center because her previously healthy 3-year-old girl started complaining of throat pain and is drooling. The mother saw her put a button battery in her mouth shortly before this happened while replacing the batteries in the child's toy. She is responding appropriately, is not coughing, and does not appear to have difficulty breathing per her mother's report. The Poison Control Center instructs the mother to bring the child to the ED immediately to remove the battery by endoscopy. In addition, the Poison Control Center would advise the mother to administer which of the following liquids on the way to the ED?

   A. Apple juice.
   B. Honey.
   C. Ipecac syrup.
   D. Milk.
   E. Salt water.

3. A 4-year-old girl is being monitored in the emergency department for hypoxia. She was playing at a family picnic and drank out of what appeared to be an apple juice container and then began to cough, choke, and vomit. The clinicians are concerned about which of the following sequalae of ingestion of this liquid in this patient?

   A. Bronchoconstriction.
   B. Esophageal alkali burn.
   C. Esophageal perforation.
   D. Chemical aspiration.
   E. Nicotine overdose.

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4. A 15-year-old adolescent is brought to the ED by emergency medical services after he began vomiting frothy contents. He had recently drank a clear odorless liquid from an unmarked water bottle in the fridge. He had nothing else to eat or drink in the past 2 hours. He currently has normal mentation and is not in acute respiratory distress. Which of the following is the most appropriate imaging study to obtain next in this patient?

   A. Chest computed tomography with contrast.
   B. Chest radiography, anteroposterior and lateral views.
   C. Echocardiography.
   D. Esophagography with barium.
   E. Noncontrast upper abdominal computed tomography.

5. During a routine health supervision visit of a 1-year-old boy an update of the social history is significant for recent enrollment of the patient's grandmother in medication-assisted therapy for substance use. The grandmother lives in the same household. In addition to anticipatory guidance about safety and childproofing the house, a prescription for which of the following agents should be provided to the mother to keep at home?

   A. Intranasal midazolam.
   B. Intranasal naloxone.
   C. Oral lorazepam.
   D. Oral methadone.
   E. Oral syrup of ipecac.

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