SPECIAL ISSUE ARTICLE

Pediatric Toxicology: Household Product Ingestions

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ABSTRACT

Nonpharmaceutical household products are the most common substances involved in exploratory ingestions in young children. Fortunately, most of these products are not toxic if ingested in small volumes. However, there are several household products that have the potential to cause significant toxicity and, rarely, fatalities in young children. Key products reviewed in this article include alcohols, button batteries, corrosive cleaning products, laundry detergent pods, hydrocarbons, and magnets. **[*Pediatr Ann*. 2017;46(12):e449-e453.]**

More than 90% of poisoning exposures reported to poison control centers in the United States occur in the home environment. In children younger than age 6 years, exposure to household products is the most common reason for poison control center calls[1] (**Table 1**). In fact, exposures to three categories of household products, namely cosmetics/personal care products, household cleaning substances, and foreign bodies/toys accounted for one-third of the more than 1 million calls for this age group in 2015.[1] Although exploratory, unintentional exposure to these products is by far the most common mechanism in this age group, but it is important to remember that malicious administration of these products to young children also occurs.[2]

Reassuringly, the vast majority of these products are associated with minimal toxicity in exploratory exposures. However, several household products have the potential to cause severe toxicity and even death. This article reviews some of the most toxic household products with the hope of both educating pediatric providers and guiding targeted counseling for poison prevention.

APPROACH TO THE PEDIATRIC PATIENT WHO HAS BEEN POISONED

In addition to the general steps taken to approach the pediatric patient with possible toxic exposure, a few additional steps should be taken in the setting of household product exposures. First, as there are numerous household products with similar names and various active ingredients, having the original container for the product or the exact name of the product (not just the brand) can be incredibly helpful for obtaining information on active ingredients and potential toxicities. Poison center specialists can assist by accessing Material Safety Data Sheets for the products in question. At times, the manufacturers themselves can also be helpful in clarifying active ingredients in various formulations. Second, as many of these products are in liquid formulation, they can easily get onto clothes and skin and into a child's eyes, so decontamination may need to involve removing clothes, rinsing skin, and flushing eyes as indicated.

THE NONTOXIC INGESTION

Many lists of "nontoxic" products are available to assist providers in triaging patients.[3] However, in order for any exposure to be deemed nontoxic by history alone, the following criteria should be met: (1) the product/active ingredient must be definitively identified, (2) the estimated amount ingested should be below the smallest amount predicted to cause toxicity, (3) the label should be without signal words such as danger, caution, warning, poison or "call physician immediately," and (4) the child should be asymptomatic.[4]

SPECIFIC PRODUCTS

Alcohols

Various forms of alcohols exist in most home environments, with ethanol being the most commonly encountered (**Table 2**). The toxic volume depends on the ethanol content of the product in question, but a general rule is that ingestion of 1 g/kg of ethanol is enough to raise the blood alcohol level to 100 mg/dL. Importantly, the clinical

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TABLE 1.

Most Commonly Reported Household Product Exposures in Children Younger than Age 5 Years

Cosmetics/personal care products
Cleaning substances (household)
Foreign bodies/toys
Pesticides
Plants
Arts/crafts/office supplies
Deodorizers
Essential oils

Adapted from Mowry et al.[1]

TABLE 2.

Household Alcohols

Alcohol	Common Sources
Ethanol	Beer, wine, spirits, hand sanitizers, mouthwash, cologne, perfume
Ethylene glycol	Antifreeze, radiator coolant, de-icing solutions, brake oil
Isopropyl alcohol	Rubbing alcohol, hand sanitizers
Methanol	Windshield wiper fluid, de-icing solutions, denatured alcohol

presentation of ethanol toxicity in infants and young children is different than that in adults, and is marked by coma, hypothermia, and hypoglycemia.[5] Mild lactic acidosis may also be present in severe toxicity. Evaluation and management includes prompt assessment of blood glucose level, glucose repletion as indicated, intravenous (IV) fluid resuscitation, airway protection, and ventilation if needed. As most alcohols are rapidly absorbed from the gastrointestinal (GI) tract, there is little role for GI decontamination. Hemodialysis may be considered in the setting of profound toxicity.

Methanol and ethylene glycol are known as the "toxic alcohols" due to their ability to cause profound anion gap metabolic acidosis and end-organ toxicity, namely nephrotoxicity from ethylene glycol and ocular toxicity from methanol. Few institutions have the capability of running serum methanol and ethylene glycol levels, thus empiric antidotal therapy should be initiated pending confirmatory levels in cases with high suspicion for significant ingestion or clinical signs of toxicity. Ideally, blood should be sent to a laboratory that can provide results within 24 hours so as to guide decision-making about continuing versus stopping therapy. The mainstay of treatment is fomepizole, an alcohol dehydrogenase inhibitor that prevents the metabolism of methanol and ethylene glycol to their toxic metabolites.[6] When fomepizole is not readily available, another option is IV administration of ethanol. Ethanol has a higher affinity for alcohol dehydrogenase than methanol or ethylene glycol, and thus competitively inhibits the metabolism of ethylene glycol and methanol. However, this is a challenging therapy in infants and young children because they must be closely monitored for signs of ethanol toxicity including coma, hypoglycemia, and hypothermia. Hemodialysis should be considered in children with significant metabolic acidosis, renal failure, or markedly elevated methanol or ethylene glycol levels.

Isopropyl alcohol products are typically produced in concentrated formulations (70% concentration by volume), and thus small volume ingestions may be associated with clinical toxicity. Although isopropyl alcohol can produce a similar clinical picture of coma and hypothermia, it can be distinguished from other alcohol ingestions by the fact that it is associated with an osmolar gap but not an anion gap (as it is metabolized directly to a ketone). Isopropyl alcohol ingestion may also cause gastritis, and in massive ingestions can function as a direct myocardial depressant with resulting hypotension and shock. Treatment is largely supportive.

Button Batteries

Button batteries are used in multiple devices, including remote controls, hearing aids, watches, electronic toys, musical greeting cards, and small flashlights. The commonplace use of these batteries has led to increasing reports of morbidity and mortality related to ingestion in small children.[7] Lithium-containing button batteries ≥20 mm in diameter are associated with the highest rates of injury. In the absence of a history of battery ingestion, clinical presentations may mimic croup, gastroenteritis, or a deep space neck infection, and thus diagnosis may be delayed.

Due to the size and shape of these batteries, they frequently become lodged in the esophagus, leading to caustic injury, coagulative necrosis, and esophageal perforation. The most commonly reported cause of death is massive hemorrhage secondary to aortoenteric fistula formation.[8]

Esophageal button batteries should be urgently removed as serious injuries may develop in as little as 2 hours. Patients with evidence of esophageal injury should be closely monitored because aortoenteric fistula and resulting hemorrhage may develop several days to weeks later. Providers should consider endoscopic evaluation and battery removal in children younger than age 5 years who have large (≥20 mm) button batteries in their stomach, but asymptomatic in older children and/or smaller button batteries

in the stomach may be monitored with serial X-rays and examinations instead. The National Battery Ingestion Hotline (202-625-3333) is a helpful resource, and their triage and treatment guideline for battery ingestions can be accessed at http://www.poison.org/battery/guideline.

Cleaning Products

Soaps, liquid detergents, and household bleach are rarely toxic in small volume ingestions. However, corrosive cleaning products, which are typically strong acids or strong alkalis, do have the potential to cause significant caustic injury even with a mere sip or swallow. Acid corrosives (sulfuric acid, nitric acid, hydrochloric acid) are found in toilet bowl cleaners and drain cleaners. These agents tend to cause a coagulative necrosis and thus are less commonly associated with full thickness injuries or perforations. On the other hand, alkali corrosives (ie, sodium hydroxide) tend to cause a liquefactive necrosis with deeper tissue injury and increased rates of perforation. Circumferential esophageal injuries from both types of corrosives are associated with subsequent formation of esophageal strictures and the need for long-term serial esophageal dilations.

These agents may also cause direct injury to the airway with subsequent edema and airway narrowing; thus careful assessment of and attention to the airway is important. Attempts should be made to identify the actual product, the active ingredients, and the pH because this will allow the provider to gauge the risk of injury. Decontamination with activated charcoal is not advised given that this may both limit the future endoscopic evaluation and may lead to emesis, which could re-expose the esophagus to the corrosive substance.[9] Attempts to "neutralize" the substance should absolutely be avoided as this may cause an exothermic reaction that can lead to further esophageal injury. Given that neither the presence nor the absence of visible oropharyngeal injury accurately predicts or excludes esophageal or gastric injury, providers should strongly consider endoscopic evaluation even in asymptomatic patients with a history of ingesting agents with a pH of <2 or >12.[10] The ideal timing of endoscopy is between 12 and 24 hours after ingestion.

Treatment is largely supportive, including intravenous fluids if the patient is not tolerating oral intake, acid suppression, and consideration of placement of a nasogastric tube at the time of endoscopy if there is evidence of circumferential burns. Steroids, either systemic or intra-lesional, may be beneficial in a small subgroup of patients but are not routinely recommended.

Detergent Pods

Individual laundry detergent pods merit separate discussion given their demonstrated potential for severe toxicity. These products were first introduced to the US market in 2010, and from March 2012 to April 2013, the number of exposures to these pods in children younger than age 6 years reported to poison control centers rose by over 600%.[11] These pods are often brightly colored and may resemble candy, making them particularly attractive to young children. They are composed of highly concentrated detergent enclosed in a water soluble membrane.

The most common route of exposure to these agents is ingestion, followed by ocular exposure. Ingestions are most commonly associated with nausea and vomiting, although have also been associated with lethargy, coma, respiratory distress, and pulmonary edema. Caustic injury to the GI tract has been demonstrated in some cases. Several children have required intubation and admission to the intensive care unit after ingestion of these products. Ocular exposures can lead to conjunctival erythema, corneal abrasions, and even ocular burns.[11]

Treatment is largely supportive, including intubation and ventilation if indicated, management of caustic injury to the gastrointestinal tract (as previously discussed), and copious flushing of eyes with isotonic saline in the context of ocular exposure. Ophthalmology and gastroenterology specialists should be consulted in the setting of concern for significant ocular or gastrointestinal injury, respectively. Recognition of the rising rates of pediatric exposures to laundry pods has led to nationwide alerts about their dangers, inclusion of safety messages in ads for the products, and changes to the packaging of these products in hopes of decreasing exposures and injuries.

Hydrocarbons

Hydrocarbons are found in fuels, lamp oils, solvents, polishes, and some household cleaners. They can be further classified as aliphatic hydrocarbons (petroleum distillates), aromatic hydrocarbons (ie, toluene, benzene, and xylene), and halogenated hydrocarbons. Although the specific toxicities vary by class, all hydrocarbons have the potential for severe pulmonary toxicity if aspirated.

Decontamination with activated charcoal is not recommended given that this may lead to emesis and increase the risk of aspiration.[9] Any patient with coughing or respiratory symptoms should have a chest X-ray performed. If the initial X-ray is normal, a repeat examination should be done in 4 to 6 hours to assess for evolving signs of pulmonary injury. Admission for ongoing cardiorespiratory monitoring is strongly recommended for any patient with an abnormal chest X-ray or persistent respiratory symptoms.

Management is again largely supportive, with intubation and ventilation as needed, supplemental oxygen for hypoxia, and bronchodilators for wheezing. Neither empiric steroids nor prophylactic antibiotics have been associated with improved outcomes.

Magnets

Starting in the early 2000s, small, powerful neodymium-containing magnets became increasingly used in desktop toys, building sets, and other household products. With increasing use came more reports of both ingestion and injuries related to these magnets. Although ingestion of a single magnet is rarely problematic, ingestion of multiple magnetic foreign bodies has been associated with bowel obstruction, bowel necrosis, perforation, and even death.[12] Although educational efforts, voluntary recalls, and national safety standards for high-powered magnet sets have both raised awareness of the dangers of these products and perhaps decreased exposures, they continue to be marketed in various forms.[13]

Initial assessment should include questions about timing of the suspected ingestion, source of suspected ingestion (ie, name of the actual product), estimated number of magnets ingested, and presence of any GI symptoms. In addition to a physical examination, any child with suspected magnet ingestion should undergo plain X-rays of the abdomen in an attempt to verify the ingestion, distinguish between single and multiple magnet ingestion, clarify location of the magnets, and assess for any signs of obstruction or injury. Importantly, many of these magnet ingestions may not be directly observed, so providers should ask about high-powered magnets in the environment of any child with unexplained GI symptoms and evidence of foreign body on abdominal imaging.

Whereas most single-magnet ingestions can be managed conservatively, ingestion of multiple high-powered magnets confers significant risk of gastrointestinal injury. In 2015, the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition endorsed an algorithm for the management of magnet ingestion in children.[14] This algorithm recommends consultation with the gastroenterology department for endoscopic removal of magnetic foreign bodies in the stomach and esophagus, especially if a child presents within 12 hours of ingestion. Children with more delayed presentations, with evidence of foreign bodies beyond the stomach or with clinical or radiographic signs of obstruction or perforation, should be evaluated by a pediatric surgeon for consideration of operative removal.

POISON PREVENTION: HOUSEHOLD PRODUCTS

A key message for storage of poisonous household products is ensuring that they are kept in their original, labeled containers. This allows ready access to the active ingredients, and the actual product name and safety advice. Families should specifically be advised not to store these products in cups, bottles, or jars so as to decrease the risk of a child mistakenly drinking or eating these products. Although up to 55% of parents in one study reported keeping poisonous products in a locked cabinet, home observation subsequently demonstrated that a minority of families stored these products correctly.[15] Thus, ongoing education as to the potential toxicities of common household products and reminders about safe storage techniques should continue to be part of well-child care. Innovations, including safer packaging for laundry pod products and safer button batteries, are crucial next steps in decreasing the rates of significant injuries from household product exposures in young children.

CONCLUSIONS

Although the majority of household product exposures in young children are associated with minimal clinical toxicity, there are multiple products routinely available in home environments that have the potential for severe outcomes even in small-volume exposures. Pediatricians should be aware of the potential toxicity of these products and provide anticipatory guidance to caregivers as a part of routine health care maintenance. As with the examples of laundry detergent pods and high-powered magnets, pediatricians and emergency care providers play a crucial role in monitoring for emerging household dangers. Providers should have a low threshold for reporting concerns to the Consumer Product Safety Commission and poison control centers as this may lead to further investigation, educational efforts, voluntary recalls, and other risk-mitigation strategies to protect children.

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