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Caustic and foreign body ingestions in children: a practical approach

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Abstract
Caustic and foreign body ingestions represent a fairly frequent occurrence in children and a major concern both for families and clinicians, as it can range from non-significant to life-threatening events, leading to severe sequelae. Despite the efforts across the years to ensure safer environment and child-proof products packages, the number of new cases remains high. Most cases occur in developing countries, where preschoolers and children are less supervised, and storage of household products is often inadequate. The purpose of this paper is to perform an updated overview of the correct approach to a child with caustic or foreign body ingestion, providing an immediate practical application for the physicians.

Key words: "caustic ingestion", "children", "corrosive ingestion", "esophageal strictures"

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Introduction: Caustic and foreign body ingestion are two frequent scenarios in pediatric population, often requiring a multidisciplinary team and an immediate intervention to avoid possible severe complications. We aimed to perform an updated overview of the correct approach to these pediatric emergencies, highlighting the key points to focus on: the approach to the acute phase, discriminating a suspected or confirmed ingestion through an accurate history and clinical examination; indications and timing for endoscopy; eventually, the most appropriate therapy to administer in the clinical setting.

CAUSTIC INGESTION

In 2018, 2.1 million human exposures to toxics were reported in the US, of which nearly one-half occurred in children five years or younger (44.1%).(1) Alkali was the most frequent type of substance involved, coming from personal care products and household cleaning compounds. For his burden and frequency, prevention is crucial. Family pediatricians have a main role in it, warning parents about domestic risks and providing emergency contact numbers. Many educational and legislative efforts have been made through the years to make household products safer, but they are not yet fully implemented.

Pathophysiology

Strong acids (pH <2) are responsible for a coagulative necrosis and for creation of an eschar that prevents further deepening in the underlying layers. The most frequent site affected is the stomach, especially the prepyloric area. On the contrary, strong alkalis (pH >12) cause a liquefactive necrosis with progression to the inner layers, resulting in extensive injury, thrombosis of vessels, even perforation and death.(2,3) Thanks to the neutralizing acid of the stomach, damage from alkali in this site is less serious, while the greatest damage occurs in the esophagus. Both of them may cause fibrosis of tissues, scar retractions and strictures over time, with a probability that depends on the severity of injury.(4) Amount of substance ingested is a major determinant of outcome and it is frequently connected to the intention (voluntary/accidental).(5) Other determinants are concentration and physical state: Liquids are easily swallowed, reaching the lower sites, while powder or crystals are more likely inhaled or stopped in the upper tract, causing oral and glottic injury.(6,7)

Management

After a confirmed or suspected ingestion, presentation to the nearest emergency department (ED) should not be delayed. The common practice of administering foods or liquids is wrong and should be avoided.(5) Of a wide cohort of 968 children with corrosive substance ingestion, 47% received water, milk or other foods, although no benefits have been demonstrated from this.(8) Also administering neutralizing agent should be avoided, as it can cause an exothermic reaction with further injury.

- **Never induce emesis:** it could cause a second passage of the caustic as well as aspiration
- **Do not administer food or liquid (milk, water):** they could cause vomiting and be an obstacle to a good view during endoscopy
- **Do not administer neutralizing agents**

In front of a striking and severe clinical picture, it is mandatory to assess vital signs and patency of airways, whose obstruction may results from inflammation and swelling of tissues, making emergency endotracheal intubation or even tracheostomy necessary.(9) Many studies recommend fiberoptic laryngoscopy instead of blind intubation to reduce the risk of perforation.(10) In case of signs of hemorrhage, free perforation, mediastinitis, a chest-abdominal radiography is necessary and endoscopy is contraindicated. In those cases, some studies suggest computed tomography (CT)-scan as a valid alternative to determine the depth of intramural necrosis and complications, to select patients for surgery, and to predict esophageal strictures formation. (11-13) No benefits have been demonstrated for nasogastric tube in preventing emesis or in decreasing strictures formation, in the face of an increased risk of infections and acid reflux.(10,14)

After a first assessment, history and clinical examination will guide the subsequent choices. A thorough history

should include:

- **Amount of substance ingested** (from witnesses or from the quantity missing from the package)
- **Intention:** intentional/ unintentional

- **Characteristics of product:** brand name, pH, dilution, physical state (liquid, powder, crystals). These informations can be extrapolated from the package label or contacting Poison Centers
- **Actions taken after ingestion:** induced vomiting, food/neutralizing agents

Clinical examination

Several studies have been carried out to correlate type and severity of symptoms with the entity of gastroesophageal damage, but effective injury cannot be reliably predicted. The absence of symptoms should be weighed carefully especially with an history of confirmed ingestion, since some liquids can pass rapidly without causing proximal damage, or symptoms may appear later.(15) On the contrary, even the presence of them may be associated with a normal or mildly damaged mucosa at the endoscopy. (16,18) Recommendations for guiding the clinical examination are reassumed in Table 1.

Table 1. Recommendations for anamnestic e clinical management.

Do not underestimate mild symptoms or asymptomatic patients	
Focus on symptoms complained:	Gastrointestinal symptoms (drooling, dysphagia, vomiting, hematemesis, abdominal pain) Respiratory symptoms (hoarseness, dyspnea, laryngeal stridor)
Watch out for signs:	Oral/pharyngeal lesions, perioral burns, eyes and hands injury

Endoscopy

Esophagogastroduodenoscopy (EGD) is the gold standard in the early management of caustic ingestion (18), as summarized in Table 2. Several are the advantages: (i) evaluate presence or absence of esophageal-gastric damage, (ii) stage it in accordance to Zargar classification and guide the subsequent therapeutic choices, (iii) predict strictures formation probability, long term survival, respiratory failure and nutritional autonomy.(5)

The risk of performing endoscopy too early is of underestimating the extent of the damage even in the case of more serious injuries. On the other hand, a procedure performed too late with the beginning of the fibroblastic repair phase, exposes the patient to the risk of iatrogenic perforation.

Table 2. Indications for endoscopy, timing and precautions

- **All symptomatic patients:** presence of gastrointestinal or respiratory symptoms
- **Signs of likely ingestion:** lips/oral burns
- **Intentional ingestion**
- **Asymptomatic patient but:** (i) someone witnessed the scene, (ii) children himself is able to confirm the ingestion, (iii) despite a suspicious history, offending substance is known to be caustic

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- Perform it within 24-48h
- Endoscopy after 48-72h is not recommended, and never 5 to 15 day after ingestion
- Flexible endoscopy, gentle insufflation and great caution are recommended
- Don't stop at the first lesion but evaluate the overall damage
- Focus on physiological strictures (for alkalis) and prepyloric area (for acids)

Laboratory tests

Despite attempts to find early laboratory criteria predicting initial damage, none have been shown to be specifically related to the extent of damage. However, a worsening of laboratory data, such as onset of acidosis, elevation of RCP and WBC, impairment in liver and renal function, have been associated with higher probability of transmural necrosis and higher mortality.(9, 12, 19) Laboratory tests should comprise complete blood count, renal and liver function, creatine-phosphokinase, lactic dehydrogenase (LDH), electrolytes, lactates, Reactive C-Protein. If endoscopy is expected, cholinesterase and coagulation panels need to be included.

Therapy

If the patient is shocked or dehydrated because of repeated vomiting, intravenous fluid replacement is mandatory. Also relieving pain is recommended through the use of analgesics.(12) Administering Proton Pump Inhibitors (PPI) is a widespread practice at the EDs that mostly derives from evidence of endoscopic healing in studies on adults.(20) Except for Zargar grade I where solely observation is sufficient, PPI therapy (0.7–3.5 mg/kg/day) is suggested.(7) For his proven benefits in decreasing stricture formations, antibiotic therapy with ampicillin (50-100 mg/kg/day for 10 days) is recommended, starting from Zargar grade II.(16) Controversial is the use of steroids during the acute phase. Scarce are data about the real effectiveness, particularly in children. Both European Society of Gastrointestinal Endoscopy (ESGE)/ European Society for Paediatric Gastroenterology Hepatology and Nutrition (ESPGHAN) guidelines and recent guidelines of Società Italiana di Gastroenterologia e Nutrizione Pediatrica/Associazione Italiana Gastroenterologi e Endoscopisti Digestivi Ospedalieri (SIGENP/AIGO) recommend intravenous dexamethasone at the dose of 1g/1.73m^2/day for 3 days in Zargar (Table 3) grade IIb esophagitis and possibly in grade III.(18,21)

Table 3. Therapeutic management in accordance to Zargar classification

GRADE I	EDEMA, HYPEREMIA	NO THERAPY, EARLY REFEEDING
GRADE IIA	Hemorrhage, erosions, blisters, superficial ulcerations	PPI (0.7 – 3.5 mg/kg/day) 72 h semiliquid diet Consider antibiotics*
GRADE IIB	Grade 2a plus circumferential ulcerations	PPI (0.7 – 3.5 mg/kg/day) Steroids (1g/1.73 m2/day x 3 days) Consider antibiotics
GRADE III	deep ulcerations with necrosis of the tissue	PPI (0.7 – 3.5 mg/kg/day) Antibiotics Consider steroids Semiliquid diet (at least 72 h)

*ampicillin…. Etc

FOREIGN BODY INGESTION

Foreign body (FB) ingestions frequently occur by accident as a consequence of children's curiosity, with the most common FBs represented by coins, toys, jewelry or batteries. It mostly happens in children 6 years old or less, with a peak at 2 years. Although 80% of FBs spontaneously pass through the gastrointestinal tract, some others need a multidisciplinary approach with endoscopic or surgical removal.(22) FBs can be classified in 2 main groups: blunt objects (i.e. coins), sharp objects and toxic objects (i.e. disk/button batteries). Objects failing to pass are usually those with a large diameter or a long length. Particularly, blunt FBs with diameter ≥ 2 cm in patients younger than 1 year or ≥ 3 cm in children older than 1 year, as well as those > 6 cm in length, are unlikely to pass the pylorus.(21) A common site of impaction, especially for bigger objects, is the upper esophagus at the level of the cricopharyngeus muscle. Symptoms may include drooling, dysphagia, vomiting, chest pain or breathing difficulties.(23) In case of small and blunt objects localized in the stomach, children are frequently asymptomatic.

Management

The first step is the assessment of general condition and patency of airways, applying resuscitation protocol if necessary. If the child is not needy of intensive cares, it is recommended to collect a thorough history of the accident, obtaining information about nature and size of the object (a twin object can be useful), time of ingestion and last meal. (24)

At the ED, a bi-plan radiography of the neck, chest or abdomen is required in all cases, at least 30 minutes before the endoscopy. It provides information about nature, size and number of the object, its real-time anatomic location, as well as possible aspiration or perforation. Based on type object, size and clinic, timing of removal can be defined as "**urgency**" whether it is recommended within 24 hours, and "**emergency**" if it should be performed within 4 hours. The further management can be reassumed as follows:

Sharp objects: need to be removed in the shortest period of time (less than 4 hours), independently from symptoms and location, since it has been associated with a high risk of injury or perforation.

Blunt objects*:* timing for endoscopy is more heterogeneous, as indicated in Table 4. If any symptoms are complained, blunt FBs need to be removed in less than 4 hours, independently from the location. Otherwise, it depends on site and size of the object. Almost all esophageal obstructions should be treated, for the high risk of respiratory involvement: an emergency removal is required for proximal obstruction, while an urgent removal (within 24 hours) is sufficient in case of a distal obstruction, waiting for a possible spontaneous transit.

For gastric FBs not causing symptoms, a watchfully wait seems reasonable monitoring stools in the following days until its spontaneous expulsion. An urgent removal is needed only in case of FBs not passing pylorus (as seen above).

Table 4. Management of blunt objects ingestion and timing for removal

BLUNT OBJECTS	ESOPHAGUS	STOMACH	DUODENUM
SYMPTOMATIC	Remove always within 4h		
ASYMPTOMATIC/ MILDLY SYMPTOMATIC	Proximal: remove within 4 h Distal: remove within 24 h	Urgent removal (<24h) for FBs > 2.5 cm in diameters In other cases: Watchfully wait, elective removal whether no expulsion within 4 weeks	Same indications as for stomach

Adapted from Oliva et al., DLD, 2020

Magnets**:** Magnets management needs to be careful. In case of ingestion of a single magnet, it can be considered as blunt object and treated in the same way.(26) Multiple magnets have the potential to be attracted to each other, trapping the bowel tissue in the middle, resulting in possible ischemia, perforation, even fistulas or volvulus. For that reason, in the case of multiple magnets ingestion or a single magnet with another metallic FB an emergency removal is needed.(21)

Disk batteries**:** Recent data indicates a growing prevalence of disk batteries (DB) ingestion, which can cause serious complications if not removed immediately. The mechanism of damage is the creation of an electric circuit when disk batteries are in contact with tissues, causing the production of hydroxide ions at the negative pole of the battery and leakage of strong alkaline contents.(27) Although the patient can be frequently asymptomatic, it can lead to life-threatening complications, especially in the esophagus, such as perforation or esophago-aortic fistulas. Factors associated with a higher risk of complications are represented by longer time from the ingestion, age < 5 years, impaction on the aortic arch, negative pole orientation, battery size > 12 mm.(21) A suspected DB in esophagus always requires X-Ray and removal within 2 hours. Waiting for removal, some studies suggest administering small doses of honey in children

> 1 years old, in order to create a layer between the wall and the battery and delay the harmful effect.(27) In all cases of esophageal batteries with hemodynamic instability or sentinel bleeding, the endoscopy must be preceded by a multidisciplinary approach in the operatory room, with involvement of endoscopist and vascular surgeon's assistance. If an active bleeding cannot be ruled out, an exploratory thoracotomy followed by an intraoperative endoscopy should be performed, in order to evaluate esophageal lesions before removing the DB. On the other hand, gastric batteries seem less worrisome, since some studies showed a spontaneous pass of the DB in most cases without complications.(26) Management depends on the clinical presentation: symptomatic patients should receive an endoscopy within 4 hours, while a gastric DB not causing symptoms can be observed for the following 24 hours, with the exception of children <5 years old, where DB should always be removed within 4 hours.(21).

Conclusion: the management of the no-bleeding gastrointestinal emergencies in children is a challenge for pediatrician. The sharing of protocols is necessary to limit the risk of morbidity, complications and mortality.

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