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Button battery ingestion in children: Update and practical approach

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ABSTRACT

The ingestion of button batteries is an increasingly recognized medical emergency in pediatrics, particularly among children under the age of 6. These batteries, which are widely used in everyday electronic devices, can cause serious and potentially life-threatening injuries, especially when they become lodged in the esophagus.

Timely diagnosis and immediate intervention are essential to prevent serious complications, including perforation, mediastinitis, and fistula formation. This review summarizes the most recent clinical practice guidelines, with an emphasis on pathophysiology, clinical implications, management criteria, and follow-up recommendations, to provide an up-to-date framework for the diagnostic and therapeutic approach in pediatric patients.

Keywords: *accidental injuries; button battery; foreign body reaction; esophageal perforation; pediatrics.*

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INTRODUCTION

The ingestion of foreign objects is a common reason for visits to pediatric emergency departments; button batteries (BBs) are one of the most feared causes due to their potential to cause serious injury. Over the past three decades, the widespread use of these items in toys, remote controls, thermometers, keychains, and hearing aids has increased the risk of exposure in young children.[1] Their small size, attractive shape, and widespread availability contribute to accidental ingestion.

A literature search was conducted in PubMed for studies published between 2010 and 2024 on button battery ingestion. The keywords used were "button battery," "foreign body," "pediatrics," "accidental ingestion," and "esophageal injury." Thirty-eight publications in English and Spanish were selected based on their clinical relevance, recency, and methodological quality.

The purpose of this review is to provide an update on the available evidence regarding the epidemiology, pathophysiology, clinical presentation, and complications associated with this condition. In addition, it aims to present recent advances in treatment, particularly mitigation and neutralization strategies, as incorporated into the latest guidelines.

EPIDEMIOLOGY

According to recent data from the National Capital Poison Center (NCPC), approximately 3500 cases of BB ingestion occur annually in the United States; the incidence of BB ingestion has increased significantly since 2000, with the rate of serious complications having tripled over the past two decades.[2] A recent review showed that BB ingestion is most common among children under 6 years of age (75% of cases) and that the incidence increased from 0.14% in 1995 to 8.4% in 2015, making it the second leading cause of hospitalizations for foreign body ingestion.[3,4]

In the latest report by the Rocky Mountain Poison Center's National Battery Ingestion Hotline (NBIH), out of a total of 2784 battery ingestion cases, the most affected age group was 0 to 5 years old (1701, 61%), with a slight predominance among males (53%) and a mortality rate of 0.2%.[5]

Although button batteries swallowed by young children do not typically cause esophageal impaction and are expelled spontaneously, complications associated with button battery ingestion and mortality have increased 6.7-fold over 25 years. This has been attributed to the greater number of electronic products available on the market and also to the increased use of 3-volt lithium button batteries, compared with other 1.5-volt batteries.[1]

In Argentina, there are no epidemiological data on button battery ingestion because there are no national registries, and reporting is not mandatory.

WHAT IS A BUTTON CELL BATTERY?

A button battery is a metallic electrochemical cell that converts the chemical energy released in a reaction into electrical energy; it is disc-shaped and resembles a coin. High voltage, wide temperature ranges, long life, and low cost characterize them.[6-10] In terms of chemical composition, there are lithium, alkaline, silver oxide, and zinc-air button cells, which differ in voltage, size, capacity, and hazard potential. According to NCPC reports, 20-mm lithium button cells are most commonly found in remote controls, toys, and watches. At the same time, in a significant percentage of cases (42%), the original object cannot be identified.[10]

PATHOPHYSIOLOGY

Children under 3 years of age are more susceptible to swallowing foreign bodies because they explore and investigate their surroundings using their mouths. In many cases, these foreign bodies pass spontaneously and without complications through the gastrointestinal tract; however, up to 12.6% of patients who swallow BBs larger than 20 mm will experience serious complications.[11,12]

MECHANISMS OF INJURY

Electrolysis (primary mechanism)

When esophageal tissue contacts both poles of the BB, a circuit is completed, allowing an electric current to flow. At the anode, many hydroxide ions (OH-) are produced; when these ions reach the esophagus, they concentrate at a single contact point rather than dispersing throughout the esophagus. This creates a highly alkaline environment (pH 10 to 13), which, in proportion to the BB charge, causes liquefactive necrosis and a deep chemical burn (mucous secretions are very good electrical conductors). This initial injury can progress to further tissue damage, which may continue for days or weeks even after the BB has been removed. At the cathode, an acidic environment and coagulative necrosis are induced, limiting the depth of the BB-induced injury.[9,12-15]

FACTORS THAT INFLUENCE THE INJURY

The most rapid and severe injuries occur with lithium batteries. These 20-mm BBs are 3 V (twice the 1.5 V of other BBs), have a higher capacitance, and generate more current; therefore, they produce more hydroxide and do so more rapidly than other BBs, causing visible injuries within 15 minutes of ingestion and resulting in severe injuries even 2 hours after ingestion.

New BBs are 3.2 times more likely to cause injuries than used ones; however, any BB with a residual charge of 1.2 V can cause tissue damage at a slightly slower rate. Therefore, we know that even when BBs are discharged, they can cause significant injuries.[9,12-15]

Other mechanisms of injury

- **Leakage of contents:** Unlike other primary batteries, lithium batteries contain an organic electrolyte rather than an alkaline electrolyte; leaks do not cause local injuries but are mildly irritating, so they do not typically lead to serious complications through this mechanism.[16]
- **Pressure ulcer:** Physical pressure on adjacent tissue does not usually cause significant damage over short periods.

DIAGNOSIS

Medical history and physical examination

The medical history and physical examination are basic components of an initial evaluation. The most useful aspects of the medical history include: symptoms, type of foreign body, battery charge status, number of foreign bodies ingested, duration of symptoms, ingestion of magnets, clinical presentation, associated conditions (intellectual disability, esophageal atresia), and previous surgeries.[12] In most cases, no significant findings are noted on physical examination; however, the patient's general condition, vital signs, and airway status or emergency situations should be assessed.

Abnormal findings on examination may include swelling or crepitus in the neck, with subcutaneous emphysema suggesting a possible esophageal perforation; inspiratory stridor or expiratory wheezing, indicating a possible airway obstruction; or abdominal pain and signs of peritoneal irritation, which warrant investigation for a possible intestinal perforation.[11]

Symptoms

The frequency of symptoms varies across studies, although the main symptom is usually excessive salivation. Similarly, Butazzoni *et al.*, when analyzing symptoms related to BB ingestion, observed a higher probability of dysphagia (30.19; 95%CI: 17.83-42.55), fever, and cough (26.42; 95%CI: 14.55-38.28; both values are equal) compared to other symptoms (*Table 1*).[17]

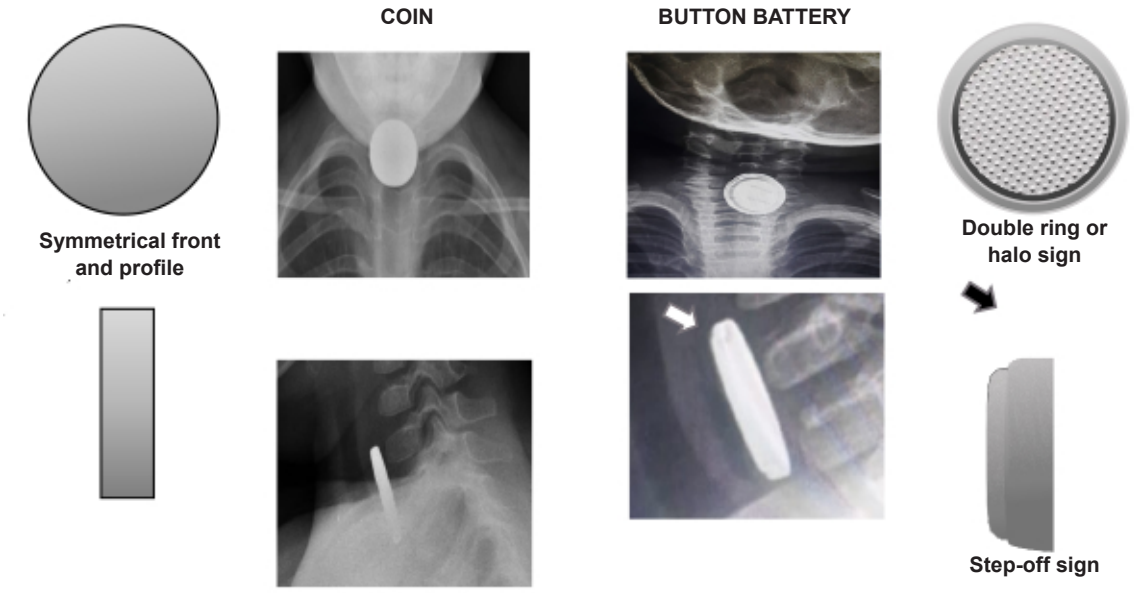
Unfortunately, patients may also present with nonspecific symptoms similar to those of respiratory or gastrointestinal viral infections, or

Table 1. Symptoms based on the time elapsed since ingestion of a button battery

Acute ingestion (≤24 hours)	Chronic ingestion (>24 hours)
Vomiting and nausea	Fever
Dysphagia	Loss of appetite (anorexia)
Drooling	Weight loss
Cough	Growth retardation
Hemoptysis	Vomiting
Hematemesis	Hemoptysis
Refusal to eat (anorexia)	Hematemesis
Foreign body sensation	Blood in the stool
Pain (neck, throat, chest, or abdomen)	Melena
Difficulty breathing	Chronic cough
Stridor	Persistent pain (neck, throat, chest, or abdomen)
Wheezing	Recurrent pneumonia
Irritability or fussiness	Dyspnea

Adapted from Wright CC, Closson FT. Updates in pediatric gastrointestinal foreign bodies. Pediatr Clin North Am. *2013 Oct;60(5):1221-39.*
Acute ingestions were defined as those diagnosed within the first 24 hours, and chronic ingestions as those with a delayed diagnosis or prolonged presence of the foreign body.

Figure 1. Radiological differences between coins and button batteries



Source: Prepared by the authors.
In Argentina, the 20-mm BBs are similar in size to the 1-peso (22 mm) and 2-peso (24.5 mm) coins, which are the only ones composed of two metals—a core and a ring—giving them a similar double ring appearance when viewed from the front, but they do not exhibit the classic "stepped" appearance when viewed in profile.

they may even be asymptomatic. Furthermore, there is not always a known history of ingestion, which can significantly delay diagnosis and timely treatment.[12,13]

Additional tests

X-rays are an essential tool for the early diagnosis of BB ingestion; not only do they reveal the location, number, size, and shape of most foreign bodies, but they can also help us rule out the presence of foreign bodies in the airway and detect a co-ingestion with other foreign bodies and identify signs of perforation (pneumomediastinum and pneumoperitoneum).[8,13]

A chest, neck, and abdominal X-ray should be ordered, including anteroposterior and lateral views (*Figure 1*). BBs are round, opaque foreign bodies that appear coin-like on X-rays. In the anteroposterior view, images showing the double ring sign (halo sign) or outline are highly suggestive of a BB. In the lateral view, the "step-off" sign (an area with a slight protrusion) may be observed, corresponding to the negative pole of the battery (anode). This sign may be absent in very thin batteries or may be mimicked by multiple coins of different sizes stacked together.

It is important to determine whether the anode (the harmful pole of the battery where the most severe tissue damage occurs) is oriented forward or backward, as this will indicate the direction of the most severe injury and the potential structures at risk.[2,8,14,18]

In a retrospective review of 139 patients treated at a tertiary pediatric care center between 2017 and 2019 who were suspected of having swallowed coins or BB, the combination of medical history and radiological evaluation achieved a sensitivity of nearly 100% and a specificity of 40%.[12,19]

COMPLICATIONS

Serious complications have been reported following BB ingestion in children, both when the BB is removed early (2–2.5 hours) and when it is removed after a longer period (3 months). Late complications may also occur, even weeks after removal.[20,21]

Several published case series have identified factors that predict long-term complications, including the esophageal location and orientation of the battery's negative pole, the anatomical location of the esophageal injury, the estimated duration of impaction, and the electrochemical properties of the specific battery.[12,14]

Possible complications are listed in *Table 2.*

Delays caused by late consultation, misdiagnosis, limited access to care from endoscopy specialists, difficulties with referrals to tertiary care centers, or concerns about anesthesia induction (patients who do not comply with the fasting period) undoubtedly contribute to the severity of complications.[1]

TREATMENT

In cases of BB ingestion, care should ideally be provided by a multidisciplinary team, including the on-call pediatrician, a radiologist, a pediatric endoscopist, a pediatric surgeon, an otolaryngologist, an anesthesiologist, and other subspecialists as indicated.[13]

It is important to reach a consensus among the various stakeholders, given that life-threatening conditions are not always clinically apparent at the time of evaluation.

Initial management

Upon arrival at the emergency department, the facility-specific protocol should be activated to minimize the time required for endoscopic extraction.

The patient should be kept fasting, a peripheral venous line should be placed, and additional tests should be performed, including a complete blood count, coagulation panel, blood type and factor determination, and an electrocardiogram. Inducing vomiting or using cathartic agents or laxatives is not recommended.[12,13]

Mitigation strategies before extraction

The most recent updates from the NCPC and ESPGHAN include recommendations to mitigate esophageal damage caused by the alkaline environment generated by BB (*Table 3*).[13,14,22,23] These are based on experimental studies demonstrating that irrigation with weakly acidic solutions, such as honey and sucralfate, forms a viscous barrier between the BB and the tissue surface, neutralizing the alkaline environment and reducing tissue damage compared to irrigation with saline.[24,25]

These strategies are contraindicated if ingestion occurred more than 12 hours ago, the time of ingestion is unknown, or there is suspicion of esophageal perforation, mediastinitis, or sepsis. Transfer to an emergency department to administer honey should not be delayed, nor should other medications or fluids be administered orally before removing the BB.

Anesthesia

Removal of a foreign body from the esophagus—or the stomach if a magnet has been swallowed or the foreign body is ≥20 mm—should be performed within 2 hours to minimize tissue

Table 2. Complication following ingestion of a button battery

Type of injury	Specific complication
Esophageal injury	Esophageal ulceration (22.1%)
	Esophageal perforation (18.1%)
	Esophageal stenosis (13.7%)
Esophageal fistulas	Esophageal-vascular fistula (6.2%) (aorta, aberrant right subclavian artery, hyroid artery, left common carotid artery, posterior aortic arch, vascular ring)
	Tracheoesophageal fistula (14.6%)
Mediastinal injury	Pneumothorax
	Pneumomediastinum
Airway injuries	Vocal cord paralysis (2.2%)
	Croup
	Mediastinitis
	Spondylodiscitis (0.4%)
Infectious	Bronchopneumonia (0.4%)

This section summarizes the main gastrointestinal and respiratory complications associated with PB ingestion. The percentage distribution is based on a recent study that evaluated 136 191 cases over a 20-year period.
Sources: Varga Á, Kovács T, Saxena AK. Analysis of Complications Following Button Battery Ingestion in Children. Pediatr Emerg Care*. 2018;34(6):443-6. doi: 10.1097/PEC.0000000000001413; Wright CC, Closson FT. Updates in pediatric gastrointestinal foreign bodies. Pediatr Clin North Am. 2013;60(5):1221-39. doi: 10.1016/j.pcl.2013.06.007.*

damage and potential complications.[14]

Historically, it has been recommended to monitor button batteries located in the stomach for up to 48 hours in asymptomatic patients. However, recent evidence indicates a high incidence of mucosal lesions (see: Button battery in the stomach, ahead), which is why early removal is recommended.

Table 3. Treatment for a patient with a button battery located in the esophagus

Strategy	Treatment
Pre-extraction	**At home and during transport:** for patients >1 year of age, administer 10 ml (2 teaspoons) of honey every 10 minutes for up to 6 doses. **Hospital:** Administer sucralfate 1 g per dose (10 ml if the suspension is 1 g/10 ml; 5 ml if it is 2 g/10 ml) (a) every 10 minutes until the BB is removed. This strategy can begin upon arrival at the emergency department and continue through the X-ray examination; once esophageal impaction is confirmed, three additional doses may be administered until sedation is given for endoscopy. Medical staff may administer extra doses of honey or sucralfate if there is a delay in transferring the patient to a tertiary care hospital. These mitigation strategies do not replace the urgent removal of the BB. Children under 1 year of age should not be given honey or sucralfate.
Extraction	**Anesthesia:** Risk stratification for BB ingestion in pediatrics (b): *High risk*: <5 years of age, BB >20 mm, underlying esophageal pathology or stenosis, esophageal retention at the level of the aortic arch or with the negative pole facing backward, or prolonged retention, or a history of gastrointestinal bleeding. *Intermediate risk:* esophageal retention that does not meet the criteria for high risk; symptomatic gastric BB. *Low risk*: >5 years, BB <20 mm, no esophageal pathology or stenosis, asymptomatic gastric BB. **Intraoperative management:** rapid sequence intubation (not delayed due to fasting). Airway monitoring during extraction. Be prepared for hemodynamic or respiratory instability (c). **Endoscopy:** direct visualization with a flexible or rigid endoscope. If there is no endoscopic evidence of perforation, the area should be irrigated with 50 to 150 mL of sterile 0.25% acetic acid while simultaneously suctioning the excess irrigation fluid. If perforation or severe circumferential injury is suspected, place a nasogastric tube under direct visualization (d).
Post-extraction	**If the esophageal injury is Zargar grade I or II** (edema or ulcerative lesions): admit to a general ward, begin oral feeding after 24–48 hours with clear liquids, and subsequently progress to a soft diet; administer a gastric protectant and analgesics. The patient may be discharged once symptoms resolve and adequate oral tolerance has been established. **If the esophageal injury is Zargar grade IIb, IIIa, or IIIb** (deep, circumferential ulcers, or necrosis): a nasogastric tube must be placed under endoscopic guidance; the patient will be admitted to the ICU with hemodynamic and respiratory life support measures, gastric rest, gastric protection, and broad spectrum antibiotics to prevent mediastinitis in patients with severe lesions, perforations, and/or fever. **Esophagram with water-soluble contrast:** perform 1 to 2 days after BB removal, and in complicated cases, this period may be extended until the patient's condition stabilizes. In cases of significant esophageal injury (especially circumferential injury), a repeat examination is indicated after 4 weeks. **Contrast-enhanced CT scan and angiography or magnetic resonance imaging (MRI) with MR angiography: for a** less invasive and more comprehensive assessment of the lesion's proximity to major vascular and respiratory structures.

(a) In Argentina, the sucralfate suspension contains 2 g/10 ml; 5 ml (1 teaspoon) should be administered.
(b) Low- and intermediate-risk patients may be treated in a general operating room by gastroenterologists, with or without pediatric surgeons on call. For high-risk patients, the involvement of interventional cardiologists or cardiovascular surgeons should be considered.
(c) At least two large-bore intravenous catheters should be placed for volume replacement and the administration of blood products, if necessary. During endoscopy, care must be taken to prevent accidental extubation and compression of the endotracheal tube.
(d) If oral intake cannot be ensured due to the patient's complications, enteral tube feeding or parenteral nutrition should be considered, with enteral feeding always being the preferred option. The enteral feeding tube can also prevent tissue adhesions and strictures, and it serves as a guide to maintain the esophageal lumen for potential dilations. Gastrostomy may be considered in cases where enteral feeding is expected to continue for more than 30 days.

Initially, risk stratification is necessary to determine the level of complexity required in the operating room, the availability of specialists, the requirements for intraoperative monitoring, and the level of postoperative care needed.[13,21]

Surgical extraction

For BB removal, an endoscopic approach with direct visualization is preferred to allow inspection of the tissue lesion and identification of the BB position and orientation, and to avoid excessive manipulation of the battery due to the risk of esophageal perforation. Both flexible and rigid esophagoscopes have been used successfully, and having both available may be beneficial if an initial extraction attempt fails.[8,20,22] The choice between the two will depend on the operator's expertise. It will also be necessary to have the appropriate instruments on hand: rat-tooth forceps, alligator forceps, nasogastric tube, Dormia-type basket, syringes or irrigation system, water-soluble contrast material, and 0.25% acetic acid solution.

Post-extraction management strategy for button batteries

After removal, the mucosa should be examined to determine the extent, depth, and location of the tissue damage, stratifying it according to the Zargar classification.[23]

If there is no evidence of esophageal perforation (obvious disruption of the continuity of the mucosa and submucosa, or the escape of air or bubbles through (depending on the defect, such as mediastinal, adipose, pleural, or connective tissue), the area can be irrigated with 50 to 150 mL of 0.25% sterile acetic acid, with continuous endoscopic aspiration of excess fluid and debris, to neutralize the alkaline environment.[22]

This recommendation is based on experimental studies conducted by Jatana *et al*., which demonstrated that such irrigation could slow the progression of tissue damage by halting the progression of liquefactive necrosis, immediately restoring the highly alkaline tissue pH (pH 10-13) to the physiological range, and preventing late complications following BB extraction.[26]

Initial clinical experience, reported in a case series of 6 pediatric patients, showed macroscopic improvement in esophageal tissue without thermal tissue damage following irrigation with 0.25% acetic acid; no esophageal perforations or stenoses were observed during a follow-up period of 4 to 11 months.[27]

Button battery in the stomach

If the BB is in the stomach or in a more distal segment and a magnet has been ingested, endoscopic removal should be performed within the first 2 hours.[14] Recent studies evaluating gastric removal of the BB within 24 to 48 hours reported that up to 50% of patients had significant mucosal lesions. The main risk factors identified were: age under 5 years, batteries ≥20 mm, and an unknown or >48-hour time since ingestion.[28] In these scenarios, removal is recommended as soon as possible, without requiring a 48-hour observation period.[29]

POST-EXTRACTION FOLLOW-UP

Post-endoscopy management is perhaps the most challenging and controversial aspect of caring for these patients. The level of care required will depend largely on the severity of the injury; the duration of hospitalization, esophageal rest, and the need for serial imaging studies or additional endoscopies will be determined on an individual basis.[12,30]

An esophagogram with water-soluble contrast is a useful test for detecting perforations or strictures. In cases of stricture, endoscopic dilation should be considered.[14,30]

Early follow-up endoscopy (2-4 days post-extraction) may underestimate the degree of esophageal injury and the risk of complications. In this context, contrast-enhanced CT scans and angiographic studies, including magnetic resonance angiography, allow for a more comprehensive and less invasive assessment of the lesion's proximity to major vascular and respiratory structures.

These imaging studies are particularly indicated for mid-esophageal lesions, given their proximity to the aortic arch and the risk of massive bleeding, as well as for fecal impaction of unknown duration. They should also be considered before procedures such as esophageal dilation and stent placement or removal.[12,14,30,31]

Discharge criteria include

1. Good oral or enteral tolerance via nasogastric tube or gastrostomy tube.
2. Absence of signs of vascular injury.
3. Adequate family involvement to ensure follow-up, as well as understanding of warning signs and recommendations.

The use of proton pump inhibitors to minimize the impact of acid reflux on esophageal lesions has not been studied, but it could be justified.[14,30]

CONCLUSION

Ingestion of BB is a time-sensitive pediatric emergency. Immediate diagnosis and urgent endoscopic removal are critical for reducing morbidity and mortality.

Current evidence supports the use of mitigation and neutralization strategies as complementary measures.

Coordination among healthcare teams, regulatory agencies, and stakeholders across the toy production and distribution chain is essential to improve safety systems and promote awareness campaigns. ■

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