

Purpose

To provide guidelines for the initial evaluation, consultation, disposition and follow up for children that ingest button or coin batteries.

Background

Button battery ingestions have been on the rise in the past 10 years and the incidence of severe injuries has increased after ingesting button batteries. Injury can occur rapidly in asymptomatic children and it can be devastating and catastrophic. Injury is most severe at the negative pole of the battery where generation of hydroxyl ions can cause progressive inflammation and esophageal perforation in as little as 2 hours. Other delayed complications involve tracheoesophageal fistula, mediastinitis, vocal cord paralysis, tracheal stenosis or tracheomalacia, aspiration pneumonia, empyema, lung abscess, pneumothorax, spondylodiscitis, or exsanguination from perforation into a large vessel (e.g.. aorta).

Guideline Eligibility Criteria

Patients from newborn through adolescence with suspected ingestion of a coin or button battery.

Guideline Exclusion Criteria

This is a guideline only. Individual circumstances need to be considered, as there may be times when it is appropriate or desired to deviate from this guideline.

Special considerations for neonates or children with underlying neurological disorders may be needed.

Diagnostic Evaluation

History

Most serious battery ingestions are not witnessed.

Consider the possibility of a battery ingestion in every patient with any of the following:

- Acute airway obstruction
- Wheezing or other noisy breathing
- Drooling
- Vomiting
- Chest pain or discomfort
- Abdominal pain
- Difficulty swallowing
- Decreased appetite or refusal to eat
- Coughing, choking or gagging with eating or drinking
- Developmental Delay
- Patient not responding to standard therapies for URI or without classic infectious symptoms

Physical Examination

- If there is concern for button battery ingestion by history or on imaging then thoroughly check ears and nasal cavity to exclude button battery insertion.

- A nasal button battery should be suspected in the child with unilateral necrotic nasal discharge (often granular and blue/black in appearance), suspected nasal foreign body with evidence of local tissue damage (epistaxis, external nasal/facial swelling, hard palate ulceration) or if there is strong clinical or family suspicion for button battery insertion.
- Monitor patient for other concerning signs and symptoms:
 - ◇ Abnormal Breath Sounds
 - ◇ Wheezing
 - ◇ Stridor
 - ◇ Choking
 - ◇ Crepitus
 - ◇ Drooling
 - ◇ Abnormal Oxygen Saturations
 - ◇ Bloody Emesis
 - ◇ Refusing Po
 - ◇ Etc.

Imaging Studies

Suspect a button battery ingestion in every presumed "coin" or other foreign body ingestion based on [criteria in History](#).

- If button battery ingestion is suspected, immediately obtain an x-ray to locate the battery.
 - ◇ Radiation concern for plain films should not delay imaging^{1,3}:
 - a. Plain films – 0.04-0.1 mSv (10 times less than annual background exposure of living on Earth)
 - b. Dose associated with risk of cancer – 50 mSv
 - ◇ In as little as 2 hours, severe injury to the esophagus or other structures can occur².
 - ◇ Emergent radiograph and referral is warranted in all suspected button battery ingestions.
 - ◇ A two-view x-ray should always be ordered and special attention to look for a step-off or double ring on radiograph⁴.
- Carefully observe (zoom in on x-ray imaging) for the button battery's double-rim or halo-effect on AP radiograph and step-off on the lateral view. Beware that the step-off may not be discernible if the battery is unusually thin or if the lateral film is not precisely perpendicular to the plane of the battery.
- X-rays obtained to locate the battery should include the entire neck, esophagus, and abdomen.
 - ◇ Batteries located above the range of the x-ray have been missed, as have batteries assumed to be coins or cardiac monitor electrodes.
- What image to order and how (all symptomatic patients warrant ED referral for urgent imaging):
 - ◇ GI foreign bodies
 - a. Order with ARA as: AP from mouth to anus, Reason: foreign body
 - b. If a foreign body is seen then a lateral may be added for localization
 - c. A lateral neck plain film may be obtained to assess for the radio-opaque silhouette of a button battery in the nasal cavity.
 - ◇ Airway foreign bodies – many aspirated foreign bodies may be non-radiopaque and require bronchoscopy by history and exam alone
 - a. CXR - AP and lateral with Inspiratory/expiratory films (Bilateral decubitus films in patients who are unable to do inspiratory/expiratory films)

- b. AP and lateral neck films for upper airway foreign bodies (stridor, drooling)
- Never order an esophagram prior to subspecialist consultation as it may make future endoscopy more challenging.

STAT radiology read on a film

- Order the film stat
- Call ARA for stat read: 512-454-5641
- Radiation concern for plain films should not delay imaging:^{1,3}

Practice Recommendations

National battery Ingestion Hotline

800-498-8666

Emergency Department

- If patient is unstable with bleeding and button battery ingestion:
 - Call Trauma Stat 1
 - Stat Consult CV Surgery
- Review of ESI level 2 and STAT XR from triage for all suspected internal button batteries (i.e. in the nose, ear, etc).
- Have honey available in triage and begin treatment with honey for any family that reports ingestion of button battery (even before XR). [See dosing and precautions below.](#)
- Review with ED Docs on key decision points and people to call for button batteries beyond the esophagus.

Emergent Referral Indications

Emergent (immediate) Referral

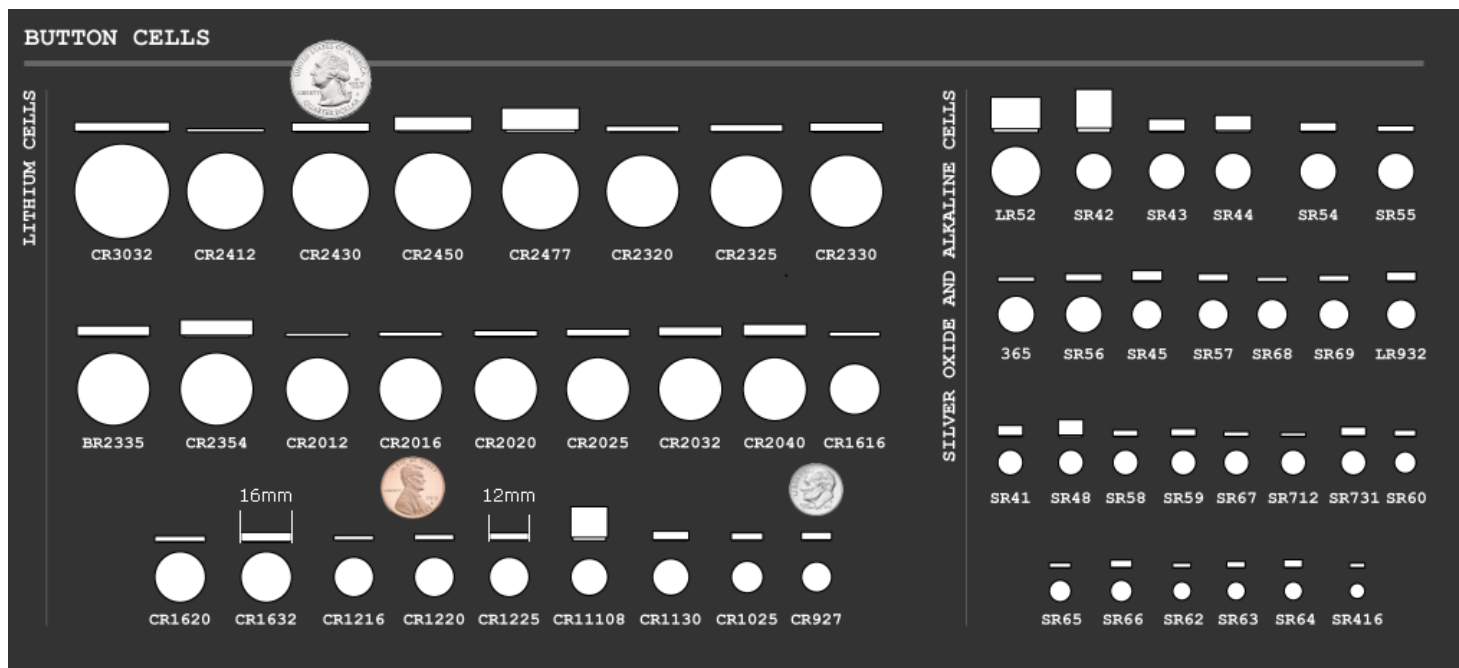
- Any battery in the esophagus
- Any signs of airway compromise in patient with ingested foreign body
 - ◇ Choking
 - ◇ Stridor
 - ◇ Unexplained Wheezing
- Any signs of GI irritation or obstruction in patient with ingested foreign body
 - ◇ Drooling
 - ◇ Refusing to Eat
 - ◇ Chest Pain
 - ◇ Vomiting and Fever
- Presence of nasal/nasopharyngeal button battery confirmed with lateral neck x-ray.
 - High Powered Magnets (i.e. Buckyballs®)
 - Sharp and long objects in the esophagus or stomach (i.e. sewing needle)

Button Battery in Esophagus

- For children 12 months and older, honey should be administered to children suspected of swallowing a button battery if the battery has been present for less than 12 hours. In experimental studies, honey has been found to coat the battery and slow the progression of injury.
 - Administer 10mL (2tsps) of commercial honey by mouth every 10 minutes, up to 6 times.
 - Potential or probable surgical extraction should not preclude the administration of this honey except within physician discretion.

- For children under 12 months, sucralfate should be given in lieu of honey.(Carafate® suspension, 1 g/10 mL). Give 10 mL PO every 10 minutes, up to 3 doses.

Figure 1: Comparative Battery Sizes



Button Battery in Stomach

- Any patient that is symptomatic, has co-ingestion with a magnet, has more than one battery in the stomach needs a STAT GI referral and endoscopic removal
 - Even if abdominal symptoms are minor, they should be considered for removal
- Esophageal injury may have occurred even though the battery is noted in the stomach and can be evaluated at the time of endoscopy. If a large button battery (≥ 20 mm) is in the stomach or beyond of a child younger than 5 years, and based on history, might have lodged in the esophagus for > 2 hours before passing to the stomach, consider diagnostic endoscopy to exclude the remote possibility of esophageal injury. (In a handful of cases, patients with significant and symptomatic esophageal injury have been found with batteries that have already passed beyond the esophagus.) If symptoms suggestive of esophageal or gastric injury are (or were) present, urgent endoscopy is recommended to exclude esophageal injury.

Large Battery (≥ 15 mm) & Young Child (<6 years)

- If the patient is **asymptomatic**, battery is large (≥ 15 mm) and ingested by a young child (<6 years).
 - Instruct caregiver to evaluate stool for up to 4 days, or until the battery is located in stool.
 - Follow up imaging in 4 days through PCP or ED if the battery is not seen in the stool.
 - If they develop any symptoms, return to the ED right away.

Small Battery (≤ 12 mm) or Older Child (>6 yrs)

- If the patient is **asymptomatic**, battery is small (≤ 12 mm), is a single ingestion, and the parent is reliable:
 - Manage at home with confirmation of battery passage by stool checks or a repeat radiograph in 10 days.

- ◇ Provide instructions to return earlier to ED if any symptoms develop.

Other Considerations

- Typical viral croup has 1-4 days of prodrome of coryza followed by a barky cough and resolution of illness by 3-5 days. If hospitalized, the typical stay is 12-48 hours.
- Alternate diagnoses should be considered if:
 - ◇ The child is drooling, has difficulty swallowing, is refusing to drink or looks toxic.
 - ◇ The child has only expiratory stridor.
 - ◇ The child has repeated presentations for the same illness or an atypical length or onset of illness.
- Children with food bolus impaction often have underlying esophageal or anatomic pathology and should be referred to specialist.⁷

Surgical Intervention

- Do not delay battery removal because a patient has eaten recently or because a patient was given honey or sucralfate (Carafate[®]) by mouth.
- Endoscopic removal is preferred as it allows direct visualization of tissue injury. After removal, inspect the mucosa surrounding the battery to determine the extent, depth, and location of tissue damage. Note the orientation of the battery in the esophagus, if possible: is the negative pole (side without the “+” and without the imprint) facing anteriorly or posteriorly? If possible, avoid pushing an esophageal battery into the stomach as the risk of esophageal perforation may increase.
 - After a battery is removed from the esophagus, inspect the area endoscopically for evidence of perforation. If none is evident, irrigate the injured areas with 50 mL to 150 mL of 0.25% sterile acetic acid (obtained from the hospital pharmacy). Irrigate in increments and suction away excess fluid and debris through the endoscope. For decades toxicologists have advised against neutralization for fear of causing a thermal injury. However, a recent study⁶ using piglet esophagus preparations after button battery removal, showed only a minimal increase in temperature (0-3° C), effective tissue surface pH neutralization, and decrease in the visible injury using this neutralization strategy. The tissue surface pH neutralization may reduce the development of progressive, delayed-onset esophageal injury after battery removal.

Post Surgical Evaluation

- Following Surgical Care, Reference [Appendix A: Post Surgical Management](#)
- After removing a battery from the esophagus, if mucosal injury was present, observe for delayed complications such as tracheoesophageal fistula, esophageal perforation, mediastinitis, vocal cord paralysis, tracheal stenosis or tracheomalacia, aspiration pneumonia, empyema, lung abscess, pneumothorax, spondylodiscitis, or exsanguination from perforation into a large vessel.
- Determine the length of observation, duration of esophageal rest, and need for serial imaging or endoscopy/bronchoscopy based on the severity and location of the injury, anticipating specific complications based on the injury location, battery position and orientation. Consider the proximity of the lodged battery and injured area to major arteries. Monitor patients at risk of fistulization into blood vessels carefully, as inpatients, with serial imaging (contrast CT or MRI of chest and/or neck) and stool guaiacs. Intervene early if perforation is imminent. Sentinel bleeds should be evaluated for additional intervention. Monitor for respiratory symptoms, especially with swallowing, to diagnose tracheoesophageal fistulas early.
- Expect delayed onset of esophageal perforations and fistulas involving the trachea or major vessels. Perforations were diagnosed by 48 days post removal in 98.1% of cases, and delays up to 27 days post removal were observed for esophageal-vascular fistulas⁸. Recurrent laryngeal nerve injury may be

evident on presentation or may not develop or be diagnosed for weeks after battery removal.

Esophageal strictures and spondylodiscitis may not manifest for weeks to months post ingestion.

- Patients with esophageal injury should be admitted and observed due to the high risk of local edema developing with worsening symptoms, especially airway compromise when the battery is lodged high in the esophagus.
- In stable, well-appearing children with a grade 0 or 1 class injury noted on esophagoscopy, a clear liquid diet can be started and may be advanced to soft as tolerated the following day. If the patient remains asymptomatic, outpatient management with close follow up in 7 days is reasonable. Symptoms that should raise alarm include dysphagia, drooling, cough, hoarseness, chest pain, tachypnea, fever, or gastrointestinal bleeding, .
- Consultation of pulmonary, otolaryngology, or cardiac surgery should be considered based on the imaging findings of structures at risk (see flow chart below).
- Patients with batteries removed from the upper esophagus should be monitored carefully for voice changes, respiratory distress, or stridor. If any of these are present or suggested, the cords should be visualized under direct laryngoscopic view in the awake patient to confirm bilateral vocal cord mobility. Unilateral or bilateral vocal cord paralysis is a common complication of battery ingestion due to damage to the recurrent laryngeal nerve(s). Paralysis may be delayed and not detected for days or weeks.
- Always consider the possibility of battery proximity to the aorta or other major vessels. If this is anatomically likely due to the position of the battery, use a contrast CT or MRI diagnostically to confirm there is a clear plane between the area of esophageal injury and adjacent vessels. Watch for sentinel bleeds, which may be subtle. Engage cardiothoracic surgery early if there is any possibility of an impending esophageal-vascular fistula.

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Approvals

The signatures below indicate support for the attached guideline, protocol and/or algorithm. The intent is not to be prescriptive but to provide a cohesive, standardized, and evidence-based (when available) approach to patient care. The physician must consider each patient and family’s circumstance to make the ultimate judgment regarding best care.

Approved by Surgical PI Council: 20May2021

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Appendix A

Post Surgical Button Battery Care

Definitions

Zargar Classification of esophageal Injury noted on esophagoscopy

- Grade 0: Normal Mucosa
- Grade I: Edema and erythema of the Mucosa
- Grade IIA: Hemorrhage, erosion, blisters, superficial ulcers.
- Grade IIB: Circumferential lesions.
- Grade IIIA: Focal deep gray or brownish-black ulcers.
- Grade IIIB: Extensive deep gray or brownish-black ulcers.
- Grade IV: Perforation

Eligibility Criteria

- Patients must meet all of the following criteria to follow this guideline:
 - Stable Patient undergoing esophagoscopy for esophageal or gastric button battery removal.
 - Children up to the age of 14 that have an esophageal button battery injury with necrosis or ulceration (grade 2 or above).
 - The following addendum is included for pediatric patients who have ingested a button battery and were found to have esophageal injury, necrosis, or ulceration intraoperatively.
 - This guideline is meant to facilitate the post operative management for stable or unstable pediatric patients that could be at risk for injury to aorta/ pulmonary vessels, spine, or airway or recurrent laryngeal nerve.

Exclusion Criteria

- Any unstable patient, with active bleeding, and history of battery ingestion should be considered outside of this guideline.
- Patients with an esophageal button battery injury of grade 0 or 1.
 - Observe overnight on a liquid diet.
 - Advance in AM to soft.
 - Follow up in 7 days to check for symptoms.
 - Seek Emergent Care if dysphagia, drooling, chest pain, cough, hoarseness, hematemesis or fever occur.

Practice Recommendations

Admit to ICU

- NPO
- Broad spectrum IV Antibiotics¹³ (e.g. Ceftriaxone and Flagyl)
- Acid Suppression (e.g. Protonix IV)
- Blakemore or esophageal balloon to bedside
- Thoracotomy Tray to Bedside
- Maintain 2 large bore IV's
- Type and Cross and maintain 2 units or 20ml/kg PRBC available

Imaging

- CT Angiography (CTA) or MRI to look for area of inflammation and structures at risk.
 - May be more than one structure at risk.
- If Normal, consider reimaging 3-7 Days

Principles of Clinical Management

As a result of the CTA, determine areas of inflammation and structures at risk:

- Aorta or Pulmonary Vessels
- Spine

- Airway or Recurrent Laryngeal Nerve

Aorta or Pulmonary Vessels

- Consult CV Surgery
- CTA (or MRI) q 1-7 days until inflammation is receding.(1, 2, 4)
- If sentinel bleeding occurs, consider emergent thoracotomy with CV1 vs. CT Angiogram for localization of Bleeding pre-op evaluation.

Spine

- Consult Neurosurgery
- Check MRI in 7 days to assess for progression or resolution of inflammation.

Airway or Recurrent Laryngeal Nerve

- Consult ENT.
- Laryngoscopy and bronchoscopy now and q 5-7 days or if stridor, aspiration, cough develop.
- Fistulas may develop over the first few weeks.

Post Op Care

- Place NJ under flouro if any abnormality noted and easy passage.
- If NJ is not possible, initiate TPN with PICC/Central Line.
- Esophagram within 24 hrs of Post Op
 - Normal Esophagram
 - Clear liquid diet (x 24-48h)
 - Advance to soft if no other areas of concern from CTA.
 - Consider repeat CTA at 2-7 days if any abnormality noted on initial CTA.
 - Mucosal abnormality but no perforation
 - NPO.
 - Repeat esophagram or endoscopy at 4 days.
 - Start NJ feeds.
 - Perforation
 - Continue NPO.
 - Consider chest tube vs thoracoscopy if pleural communication.
 - Start NJ feeds.
 - Consider GJ

Continued Management

- If there is marked improvement on imaging following detection of abnormality:
 - Start clear liquid diet and advance as tolerated.
 - Consider 4-6 wk follow up esophagram to look for stricture or if dysphagia develops.
 - Repeat cross sectional imaging (CT vs MRI) as dictated by structures at risk noted above
- If there is no improvement on imaging of injured areas:
 - Continue NPO
 - Repeat esophagram or esophagoscopy until injury is improving.
 - Repeat cross sectional imaging (CT vs MRI) as dictated by structures at risk noted above
- If associated vascular or airway injuries progress:
 - Consider G-Tube/GJ Tube
 - Consider removal of NJ
 - Repeat cross sectional imaging (CT vs MRI) as dictated by structures at risk noted above.

