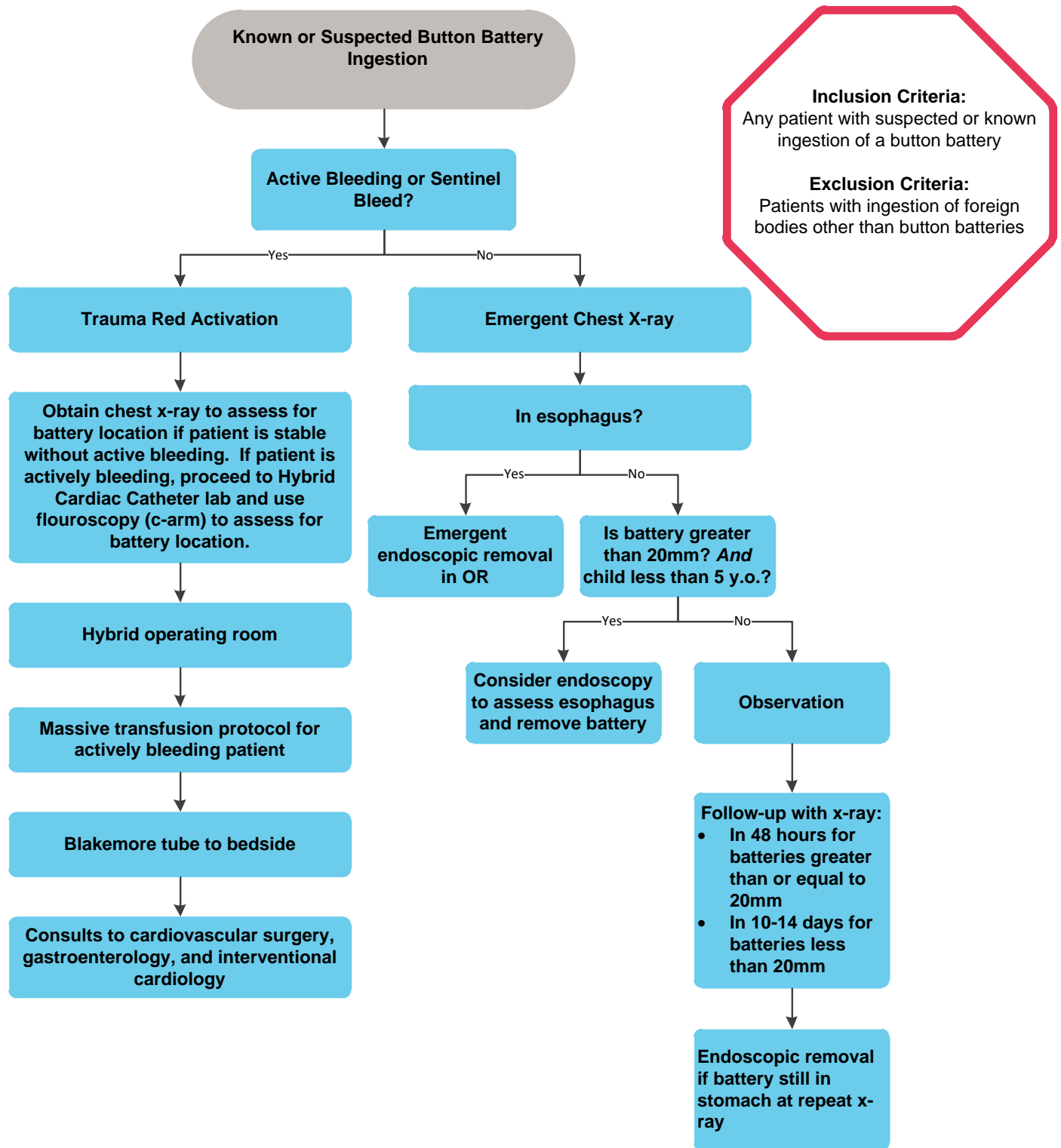
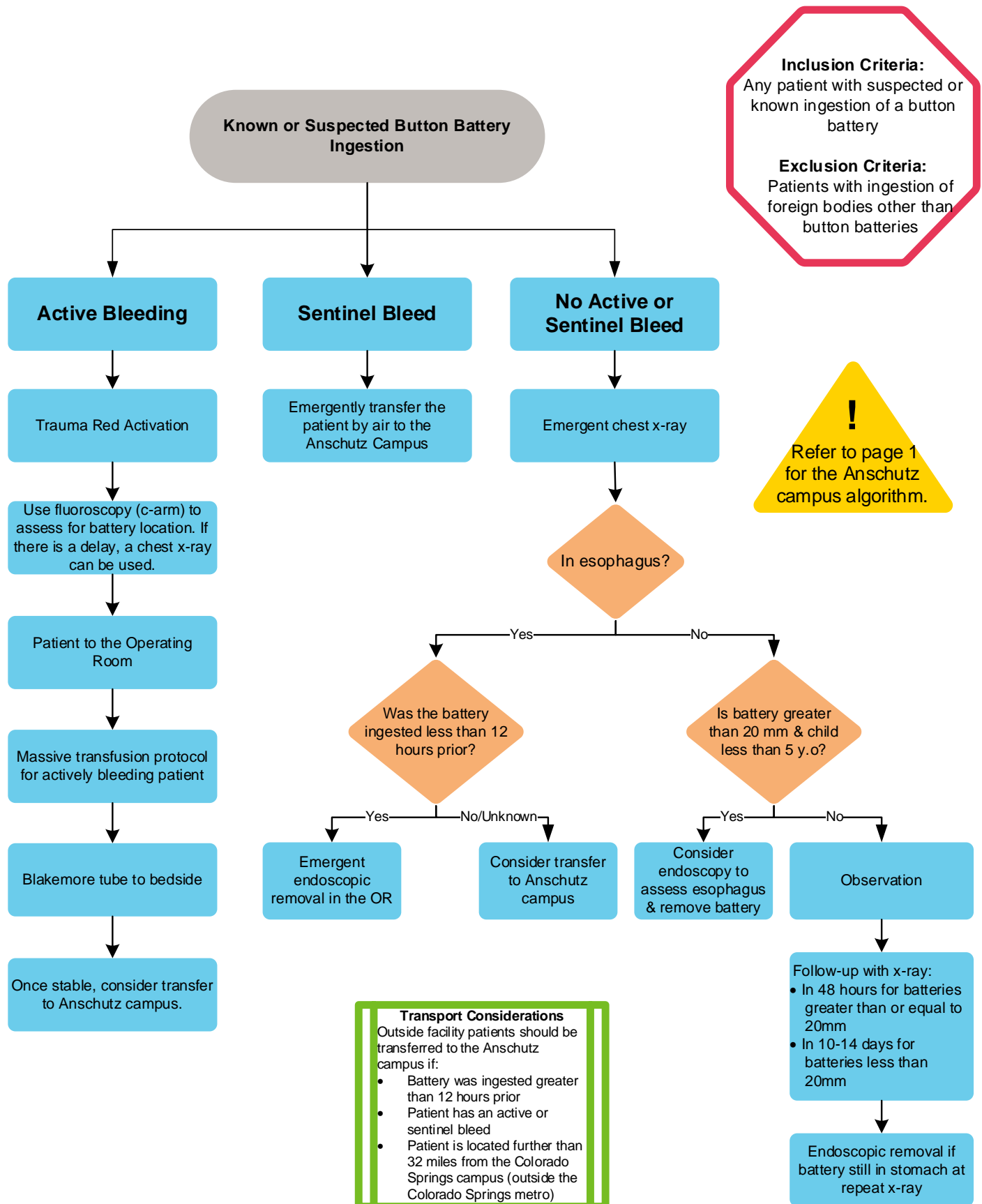


INGESTED BUTTON BATTERY

ANSCHUTZ ALGORITHM Treatment of Button Battery Ingestion



COLORADO SPRINGS ALGORITHM Treatment of Button Battery Ingestion



COMMUNITY PROVIDER ALGORITHM Treatment of Button Battery Ingestion

!
Honey is only for children greater than 12 months of age

Inclusion Criteria
Any patient with suspected or known ingestion of a button battery less than 2 hours ago

Exclusion Criteria
Patients with ingestion of foreign bodies other than button batteries

Signs of active or sentinel bleed:
Vomiting blood, spitting blood, coughing up blood, hematochezia, melena, etc.

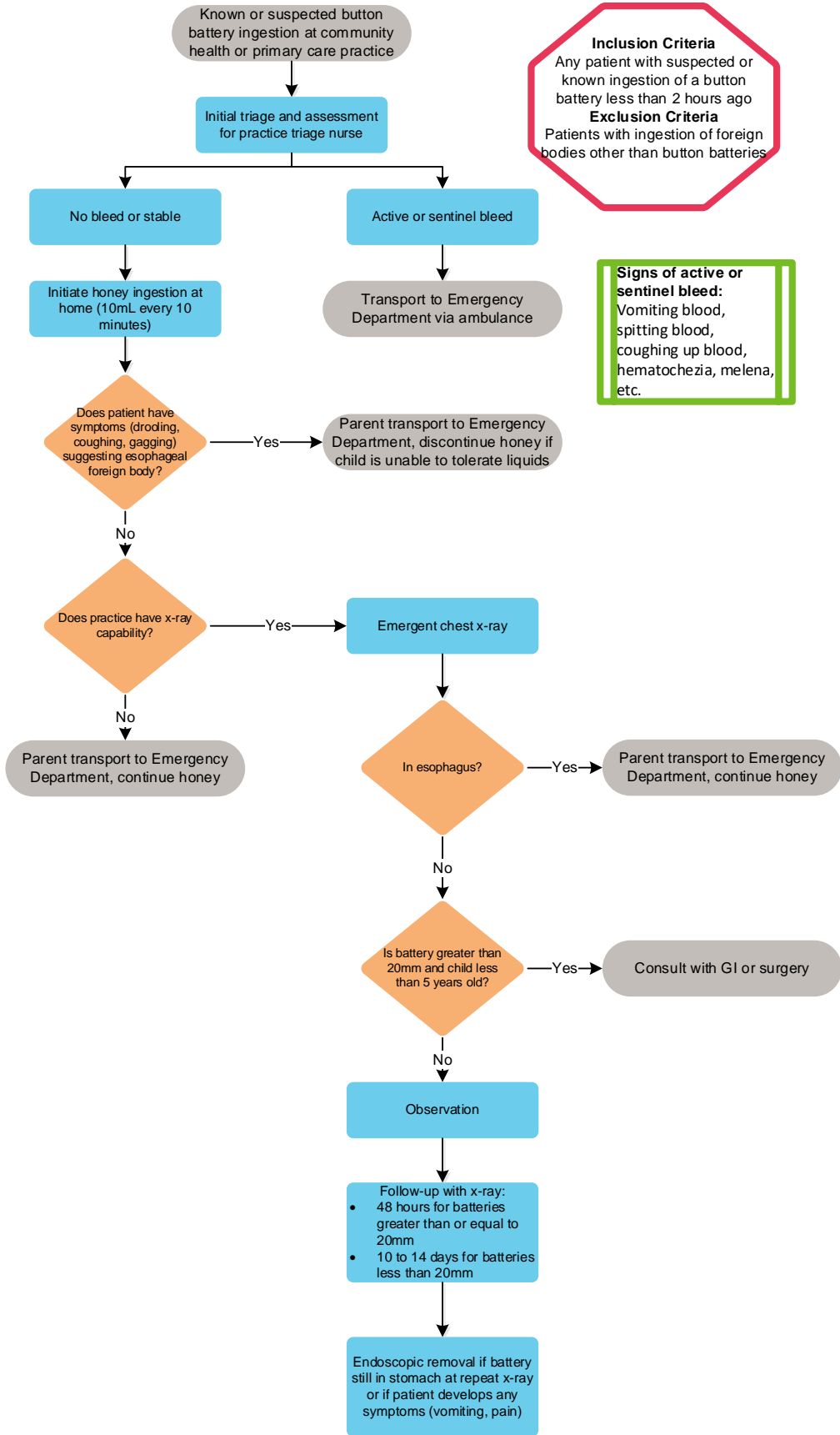


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TARGET POPULATION

Inclusion Criteria

- Any patient with suspected or known ingestion of a button battery

Exclusion Criteria

- Patients with ingestion of foreign bodies other than button batteries

INTRODUCTION

Button battery ingestions are potentially life-threatening for children. Catastrophic and fatal injuries can occur when the battery becomes lodged in the esophagus, where battery induced injury can extend beyond the esophagus to the trachea or aorta. Increased production of larger, more powerful button batteries has coincided with more frequent reporting of fatal hemorrhage secondary to esophageal battery impaction.

ETIOLOGY

The mechanism of injury of esophageal battery impaction is electrochemical. Esophageal tissue simultaneously contacts the positive and negative electrodes, which lie in proximity. The flow of electricity then leads to pH changes in surrounding tissue. Experimental models have clearly demonstrated more severe injury in esophageal

tissue approximating the negative pole of the battery, where pH changes are alkaline. The orientation of the battery within the esophagus may be helpful in predicting the anatomic direction of tissue necrosis and thus the extra-esophageal structures at highest risk of injury.

There is very rapid onset of tissue injury and injury continues for days to weeks after removal of the battery. The most common cause of death from button battery ingestion is due to the formation of an aorto-esophageal fistula (AEF).

In animal models, administration of honey or sucralfate effectively prevented battery-induced esophageal injury, ostensibly by coating the battery and preventing electrochemical activity (reference: pH-neutralizing esophageal irrigations as a novel mitigation strategy for button battery injury. Anfang RR, Jatana KR, Linn RL, Rhoades K, Fry J, Jacobs IN. Laryngoscope. Epub 2018 Jun 11).

INITIAL TRIAGE AND ASSESSMENT¹⁻³

Telephone Triage

- Advise parent or caregiver to seek immediate emergency medical care
- Administer honey immediately and while en route to the ED, if:
 - The child is 12 months of age or older; and
 - The battery was swallowed within the prior 12 hours; and
 - Honey is immediately available at home.
- If child meets above criteria, dose honey as following:
 - Give 10ml (2 teaspoons) of honey by mouth every 10 minutes for up to 6 doses.
 - Use commercial honey if available, rather than specialized or artisanal honey.
- Honey is not a substitute for immediate removal of a battery lodged in the esophagus. Administration of honey should not delay seeking immediate emergency medical care.
- If child does not meet criteria for administration of honey or if honey is not available, nil per os (NPO) status should be maintained prior to arrival to the ED.

Note: Esophageal batteries should be removed within two hours to minimize injury to tissues

- Advise parent **not** to induce vomiting

Note: Induced vomiting rarely expels the battery

Clinical Assessment

History and Physical Examination

Consider battery ingestion if:

- Airway obstruction or wheezing
- Drooling
- Vomiting
- Chest discomfort
- Difficulty swallowing, decreased appetite, refusal to eat
- Coughing, choking, or gagging with eating or drinking

Radiological Assessment

- In **all** patients with a witnessed or suspected button battery ingestion:
- Obtain urgent radiograph (X-ray) of abdomen, esophagus, and neck to locate the battery

TREATMENT¹⁻³

Ineffective interventions that should be *avoided* include:

- Ipecac administration
- Chelation therapy
- Laxatives or polyethylene glycol electrolyte solution
- Blind battery removal with a balloon catheter or a magnet affixed to a nasogastric tube

MANAGEMENT OF ESOPHAGEAL BUTTON BATTERY IMPACTION

Animal data demonstrates esophageal mucosal injury within minutes of button battery contact. Case reports demonstrate that lethal injury can be sustained in a matter of a few hours. If battery is located in the esophagus immediate removal is essential. Arrange emergent transport to center with pediatric endoscopic capability if unavailable at current location.

Using an ex vivo model of porcine tissue, irrigation of esophagus after battery removal with dilute (0.25%) acetic acid more rapidly neutralized the alkaline tissue pH. (Reference Basic mechanism of button battery ingestion injuries and novel mitigation strategies after diagnosis and removal. Jatana KR1, Rhoades K2, Milkovich S2, Jacobs I. Laryngoscope. 2017 Jun;127(6):1276-1282).

- Alert procedural service as soon as Emergency Department (ED) is aware of patient, even if still at outside facility.
- If available, initiate administration of sucralfate suspension (Carafate®) provided the battery was swallowed within the prior 12 hours.
 - Give 10ml PO every 10 minutes from the time of x-ray determination that a battery is lodged in the esophagus until sedation is given for endoscopy.
 - Do not delay battery removal because of NPO status.
- Procedural service to contact Anesthesia, to arrange emergent operating room (OR) time for removal. Blakemore tube should be available in OR at time of battery removal.
- Pediatric surgery should be alerted prior to removal of all esophageal button batteries because rigid esophagoscopy may be necessary.
- At time of battery removal, note the orientation of the battery (anterior or posterior direction of negative pole).
- Immediately after battery removal, 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.

MANAGEMENT OF GASTRIC OR INTESTINAL BUTTON BATTERY IN ASYMPTOMATIC CHILD

The most typical ingestion scenario involves witnessed battery ingestion and the rapid transit of the battery to the stomach. Based on recommendations from the National Battery Ingestion Hotline, these children are not at risk of severe injury and can be observed. Larger button batteries (larger than 20 mm) in younger children (less than 5 years of age) are less likely to traverse the pylorus.

- If ingestion was witnessed and passage was prompt to the stomach, in the asymptomatic child observation is appropriate if the child is (\geq)5 years and older AND/OR the button battery is less than or equal to (\leq) 20mm diameter.
 - When outpatient observation is appropriate for intragastric batteries, a repeat x-ray is recommended in 48 hours for batteries greater than or equal to (\geq)20mm in diameter and in 10-14 days for batteries less than

(<)20mm diameter. If battery has not traversed pylorus at time of repeat x-ray, or if patient develops gastrointestinal symptoms such as pain, nausea, vomiting, or anorexia, endoscopic removal is recommended.

- In the following scenarios upper intestinal endoscopy should be considered in assessment for esophageal injury and endoscopic battery removal, where possible: 1) unwitnessed ingestion and therefore unknown duration of battery in the gastrointestinal tract, 2) child less than (<) 5 years old and battery greater than (>)20mm in diameter.

MANAGEMENT OF GASTRIC BUTTON BATTERY IN *SYMPTOMATIC* CHILD

Gastric injury from button batteries has been rarely reported. However, the child may have sustained significant injury to the esophagus during passage of button battery. Pain or vomiting should lead to prompt endoscopic evaluation to assess for esophageal injury. Urgent endoscopic assessment of esophagus is required in the Operating Room with removal of battery from stomach.

- Blakemore tube should be available at time of removal.

MANAGEMENT OF *UNSTABLE, ACTIVELY HEMORRHAGING* CHILD WITH SUSPECTED VASCULAR INJURY

This is a life-threatening emergency requiring immediate intervention. Endoscopic intervention is of marginal to no benefit in controlling hemorrhage from an AEF. Radiologic procedures may delay necessary surgical intervention. Blakemore tube may provide temporary control of bleeding but definitive surgical intervention is necessary.

Anschutz Campus:

- Trauma Red Activation.
- Placement of two large-bore IV catheters
- Rapid correction of hemodynamic instability. Consider Massive Transfusion Protocol.
- Blakemore tube to bedside (12 French – pediatric size) with manometer (mmHg)
- Emergent consultation to gastroenterology, pediatric surgery, pediatric cardiothoracic surgery, interventional cardiology.
- Immediate transport to Hybrid Cardiac Catheter Lab (3rd floor, adjacent to cardiac surgery operating rooms) for definitive intervention.

Colorado Springs Campus:

- Trauma Red Activation.
- Emergent consultation to gastroenterology and pediatric surgery
- Use fluoroscopy (c-arm) to assess for battery location. If there is a delay, a chest x-ray can be used
- Immediate transport to the Operating Room
- Placement of two large-bore IV catheters
- Rapid correction of hemodynamic instability. Consider Massive Transfusion Protocol.
- Blakemore tube to bedside (12 French – pediatric size) with manometer (mmHg)
- Once stable, consider transport to Anschutz campus

MANAGEMENT OF **STABLE CHILD WITH HISTORY OF SENTINEL BLEED (HEMATEMESIS OR MELENA) AND KNOWN OR SUSPECTED BUTTON BATTERY INGESTION**

Development of aorto-esophageal fistula may occur in the presence of the battery or post-removal in the setting of sustained severe esophageal injury. A sentinel bleed may precede (by hours) a more severe, exsanguinating hemorrhage event. A high index of suspicion should be maintained for aorto-esophageal fistula.

Multi-disciplinary intervention is necessary, diagnostic testing should be immediate, and high-volume bleeding should be anticipated.

Anschutz Campus

- Trauma Red Activation.
- Placement of two large-bore IV catheters
- Type and cross patient for possible blood transfusion
- Blakemore tube to bedside (12 French – pediatric size) with manometer (mmHg), to follow patient to Hybrid Cardiac Catheter Lab.
- Immediate transport to Hybrid Cardiac Catheter Lab.
- If not previously performed, obtain portable x-ray to confirm button battery location.
- Emergent consultation to gastroenterology, pediatric surgery, pediatric cardiothoracic surgery, interventional cardiology. If button battery is present in esophagus, proceed to Hybrid Cardiac Catheter Lab. The patient should be prepped for aortogram and thoracotomy. Endoscopic battery removal in a patient with aorto-esophageal fistula (AEF) must be approached with caution as failure to control the aorta may precipitate life-threatening hemorrhage. If aortogram is positive for AEF, attempt should be made to stop bleeding with transcatheter balloon tamponade prior to removal of the battery. The preferred approach is emergent thoracotomy (right if button battery in upper to mid-esophagus and left if button battery in lower esophagus) with control of the aorta proximal and distal to the AEF. Once the AEF is controlled, the button battery can be removed endoscopically. If aortogram is negative for AEF, battery should be removed endoscopically in the hybrid cath lab while the femoral sheath is still in place in the femoral artery. After battery is removed, consideration should be given for a nasogastric or nasoduodenal feeding tube under fluoroscopic guidance, secured with a nasal harness.

Colorado Springs Campus:

- **Emergently transfer the patient by air to the Anschutz Campus.**
- Trauma Red Activation.
- Placement of two large-bore IV catheters
- Blakemore tube to bedside (12 French – pediatric size) with manometer (mmHg), to follow patient on transfer
- If not previously performed, obtain portable x-ray to confirm button battery location.
- Consider notifying Pediatric Surgery for delayed transports.

Protocol for Blakemore Tube Insertion for Actively Bleeding Patient with suspected esophageal source:

- Rapid sequence intubation followed by oral placement of Blakemore tube. Place 50 mL of air in gastric balloon, confirm gastric placement radiographically or clinically. Clamp gastric balloon intake lumen. Pull back on tube until gastric balloon seated at gastroesophageal junction.
 - Inflate esophageal balloon to 30 to 40mmHg. Rate of ongoing bleeding can be assessed by aspirating gastric contents from Blakemore. If necessary, increase pressure incrementally until bleeding slows.
 - Clamp esophageal balloon intake lumen.

- Place suction tube in esophagus alongside Blakemore tube to rest above esophageal balloon, connect to continuous suction
- Blakemore tube should not be used when a battery is present in the esophagus.

SURVEILLANCE AFTER BUTTON BATTERY REMOVAL

Post-removal complications include the development of fistula into a major vessel, such as AEF, which has been described up to 18 days after battery removal. Other complications include development of mediastinitis, tracheoesophageal fistula, and esophageal stenosis. There are no published data regarding the efficacy of post-removal surveillance. Degree of endoscopic ulceration may belie the extent of para-esophageal injury. Expectant management of patients is to include anticipatory guidance regarding concerning symptoms: vomiting blood (bright red or specks of black/dark red), melena, cough, fever.

More active surveillance may allow for earlier diagnosis of complications and an opportunity for intervention prior to catastrophe.

- For children with no or minimal esophageal mucosal injury visible on endoscopy, child may be successfully discharged same-day with expectant management by primary care provider.
- For moderate or severe esophageal mucosal injury at Anschutz campus, consider placement of a soft feeding tube at time of endoscopy. Obtain a contrast esophagram immediately after endoscopy to look for extravasation of contrast into the extra-esophageal space. If esophagram demonstrates perforation, treat with IV antibiotics, maintain NPO or provide nutrition via feeding tube
 - Admit patients for monitoring.
 - Multi-disciplinary approach including pediatric surgery, pediatric gastroenterology, pediatric otolaryngology, and pediatric radiology is advised.
 - MRI protocols have been developed at CHCO for surveillance imaging post-battery removal. Although no formal guidelines have been established for timing of imaging post-removal following moderate/severe injury, MRI has been obtained typically 3-5 days after removal. However, the timing of imaging would depend also on how long the battery had been impacted in the esophagus prior to removal.

Colorado Springs:

- For moderate or severe esophageal mucosal injury, transfer the patient to the Anschutz campus for continued care.

PATIENT | CAREGIVER EDUCATION

Upon discharge from the hospital, anticipatory guidance should be given to families regarding the range of potential complications of esophageal button battery impaction, which include vascular injury with hemorrhage, tracheo-esophageal fistula, mediastinitis, vocal cord injury, esophageal stenosis, and spondylodiscitis.

DISCHARGE CRITERIA

Prior to hospital discharge, in all patients with moderate-severe esophageal injury, we suggest endoscopic or radiologic surveillance studies to look for evidence of poor healing or evidence of extra-esophageal injury. Because catastrophic hemorrhage has been seen up to 3 weeks after battery removal, consideration of the timing of hospital discharge must include the proximity of the family to a pediatric facility capable of managing life-threatening bleeding.

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CLINICAL IMPROVEMENT TEAM MEMBERS

David Brumbaugh, MD | Pediatric Gastroenterology

Steven Moulton, MD | Pediatric General Surgery

Fritz Karrer, MD | Pediatric General Surgery



Robert Kramer, MD | Pediatric Gastroenterology

Hoke Stapp, MD | Pediatric Care Network

APPROVED BY

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COLORADO SPRINGS REVIEW BY	 Michael DiStefano, MD Chief Medical Officer, Colorado Springs
APPROVED BY	 Lalit Bajaj, MD, MPH Medical Director, Clinical Effectiveness

REVIEW/REVISION SCHEDULE

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