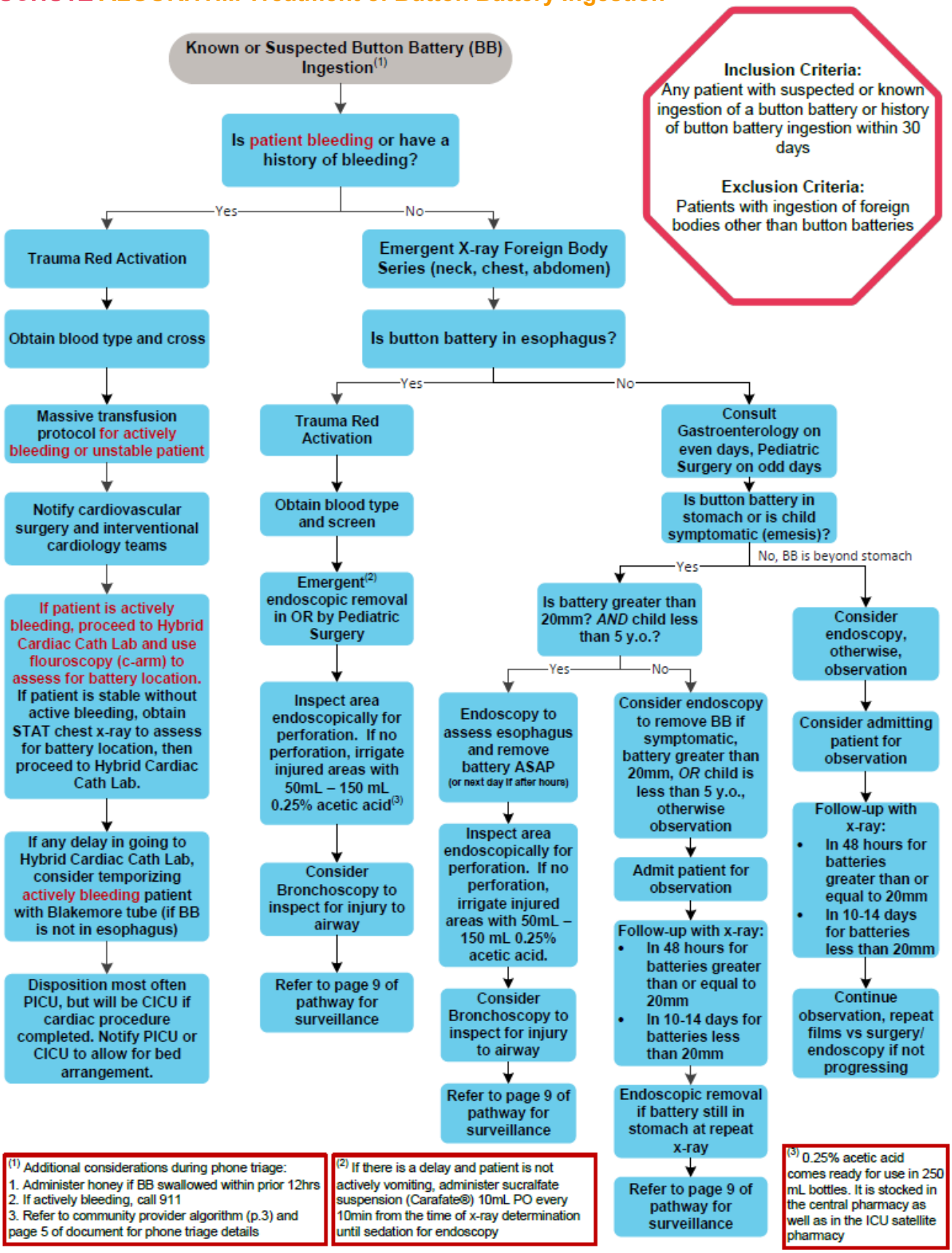
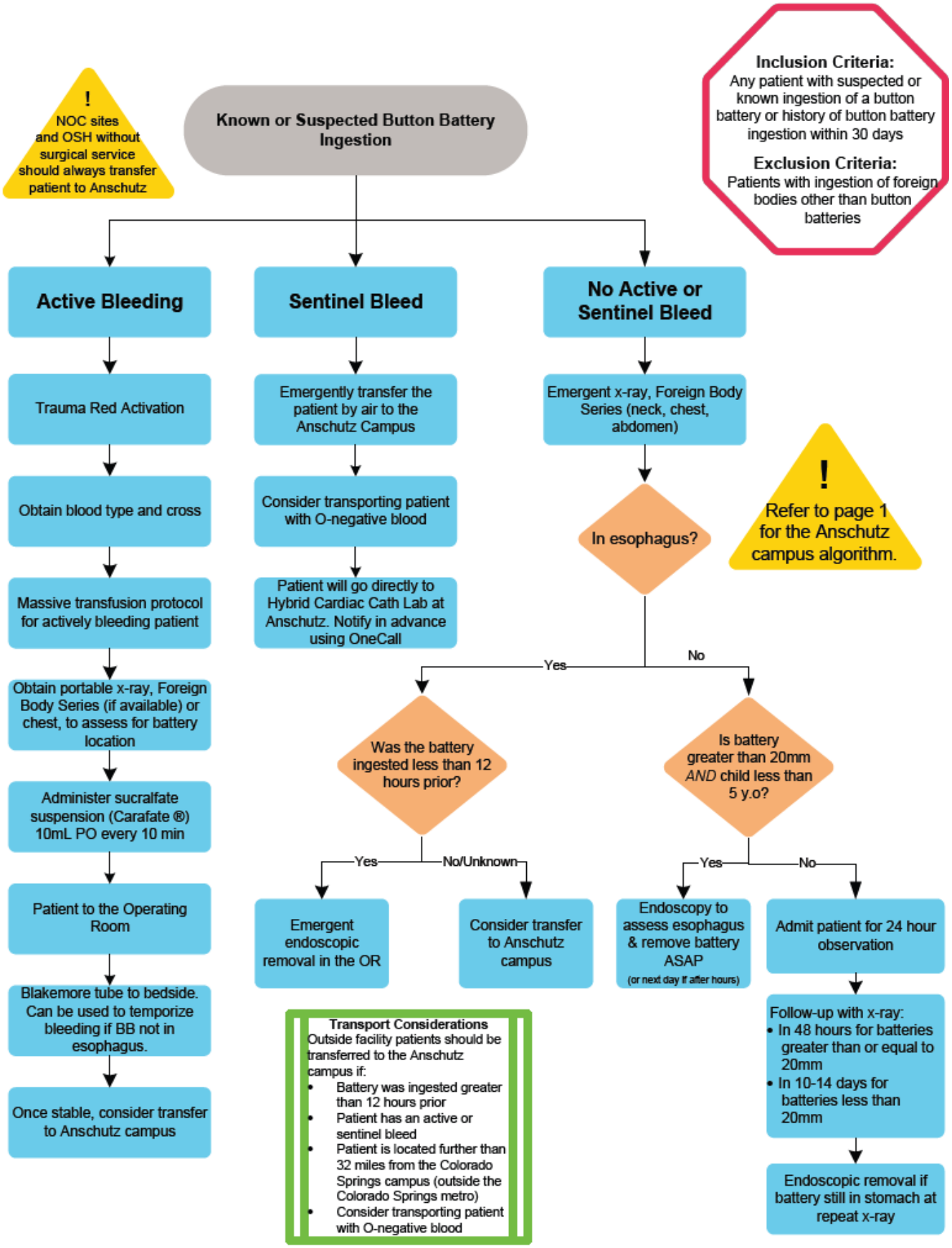
INGESTED BUTTON BATTERY

ANSCHUTZ ALGORITHM Treatment of Button Battery Ingestion



COLORADO SPRINGS ALGORITHM Treatment of Button Battery Ingestion



COMMUNITY PROVIDER ALGORITHM Treatment of Button Battery Ingestion

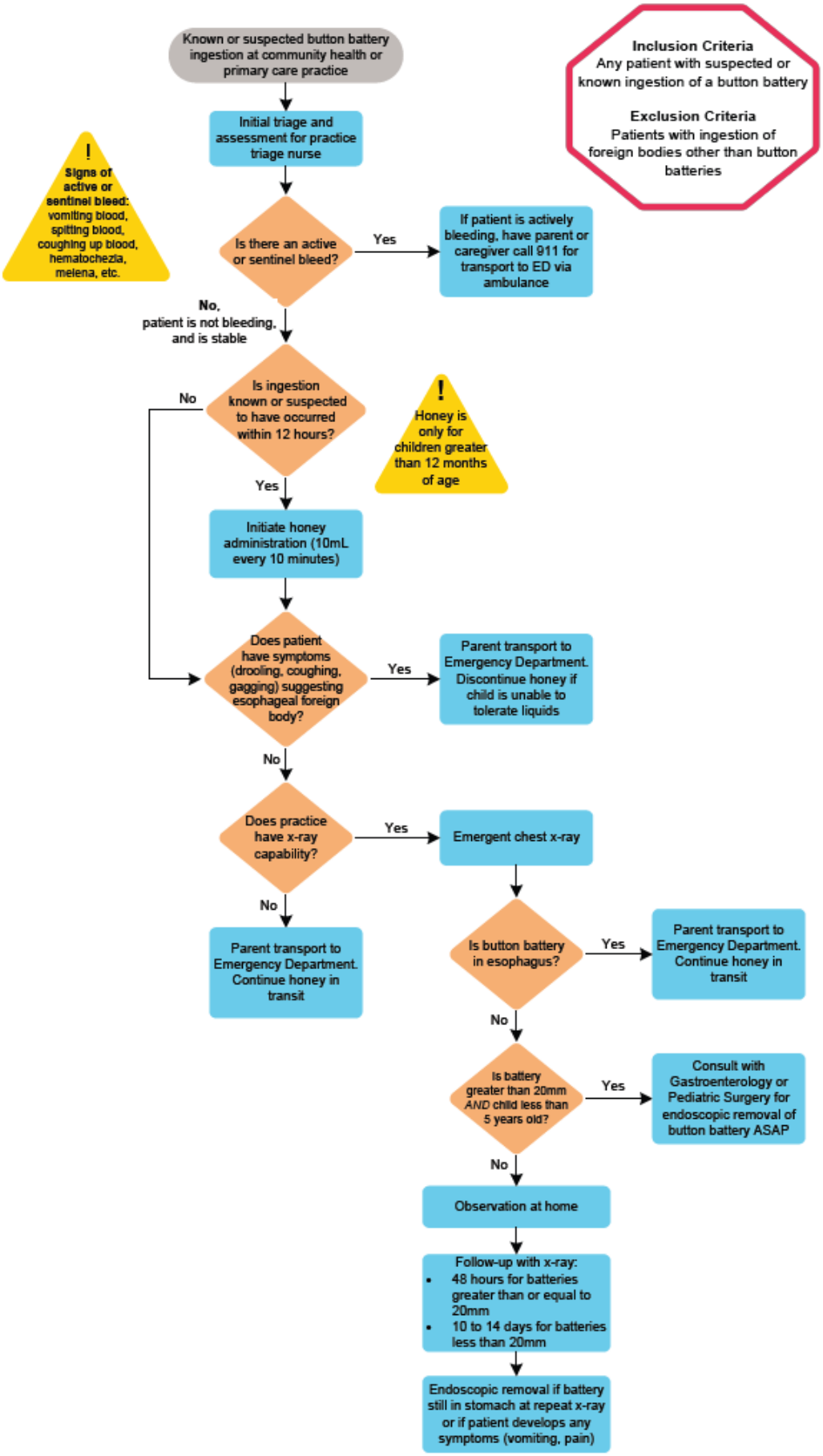


TABLE OF CONTENTS

ANSCHUTZ Algorithm Treatment of Button Battery Ingestion

COLORADO SPRINGS Algorithm Treatment of Button Battery Ingestion

COMMUNITY PROVIDER Algorithm Treatment of Button Battery Ingestion

Target Population

Introduction

Etiology

Initial Triage and Assessment

Telephone Triage

Clinical AssessmentTreatment

Management of the Unstable, Actively Hemorrhaging Child with Suspected Vascular Injury

Management of Stable Child with History of Sentinel Bleed (Hematemesis or Melena) and Known or Suspected Button Battery Ingestion

Protocol for Blakemore Tube Insertion for Actively Bleeding Patient with Suspected Esophageal Source

Management of Esophageal Button Battery Impaction

Management of Gastric or Intestinal Button Battery in Symptomatic Child

Management of Gastric or Intestinal Button Battery in Asymptomatic Child

Surveillance After Button Battery Removal

Parent | Caregiver Education

Discharge Criteria

References

Clinical Improvement Team

TARGET POPULATION

Inclusion Criteria

Any patient with suspected or known ingestion of a button battery or history of button battery ingestion within 30 days.

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 aortoesophageal fistula (AEF).

INITIAL TRIAGE AND ASSESSMENT[1-3]

Telephone Triage

- Advise parent or caregiver to seek immediate emergency medical care. If actively bleeding, the parent or caregiver should call 911 for emergent EMS transport.
- 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 follows:
  - 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.
  - 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).

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 the neck, chest, and abdomen ("X-ray Foreign Body" order) to locate the battery

TREATMENT[1-3]

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 *UNSTABLE, ACTIVELY HEMORRHAGING* CHILD WITHSUSPECTED 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 pediatric surgery, pediatric cardiothoracic surgery, and interventional cardiology.
- Immediate transport to Hybrid Cardiac Catheter Lab (3rd floor, adjacent to cardiac surgery operating rooms) for definitive intervention.
    - Note: after hours, staff will arrive within 30 minutes when called.

Colorado Springs Campus:

- Trauma Red Activation.
- Emergent consultation to gastroenterology and pediatric surgery
- Obtain portable x-ray, Foreign Body Series (if available) or chest, to assess for battery location.
- 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 an aortoesophageal fistula may occur in the presence of the battery or post-removal in the setting of prior 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 an aortoesophageal fistula.

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

Anschutz Campus

- Trauma Red Activation.
- If not previously performed, obtain portable x-ray, Foreign Body Series (if available) or chest, to confirm button battery location.
- 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 Cath Lab.
- Immediate transport to Hybrid Cardiac Cath Lab for angiogram and removal of button battery, possible placement of nasogastric feeding tube.

Colorado Springs Campus:

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

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

- For an actively bleeding patient, a Blakemore tube can be considered for temporizing bleeding if button battery is NOT present in esophagus.
- 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.
    - Again -- Blakemore tube should NOT be used when a button battery is present in the esophagus.

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 occur within a few hours. If a button battery is located in the esophagus, immediate removal is essential. If pediatric endoscopic removal of button battery is not available at current location, arrange emergent transport to appropriate facility.

- Alert Pediatric Surgery as soon as Emergency Department (ED) is aware of patient, even if still at outside facility.
- If the button battery was swallowed within the prior 12 hours, initiate administration of sucralfate suspension (Carafate®).
    - 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.
- Pediatric Surgery must contact main OR desk to arrange emergent operating room (OR) time for removal. Blakemore tube should be available in OR at time of battery removal.
- At time of battery removal, note the orientation of the battery [anterior or posterior direction of smaller negative pole (the anode, from which electrons flow out) versus the larger positive pole (the cathode)].
- 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. 0.25% acetic acid comes ready for use in 250 mL bottles, and can be obtained from the hospital's central pharmacy or ICU satellite pharmacy. Irrigate in increments and suction away excess fluid and debris through the endoscope.
    - 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 andnovel mitigation strategies after diagnosis and removal. Jatana KR1, Rhoades K2, Milkovich S2, Jacobs I. Laryngoscope. 2017 Jun;127(6):1276-1282).
- Consider bronchoscopy to inspect for injury to airway.

MANAGEMENT OF GASTRIC BUTTON BATTERY IN *SYMPTOMATIC* CHILD

Gastric injury from button batteries is 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 the esophagus is required in the Operating Room with removal of battery from stomach. If it is determined that an endoscopy is required, also consider bronchoscopy to inspect for injury to airway

- Blakemore tube should be available at time of removal.

MANAGEMENT OF GASTRIC OR INTESTINAL BUTTON BATTERY IN *ASYMPTOMATIC* CHILD

The most typical ingestion scenario involves witnessed battery ingestion and 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 greater than or equal to 5 years old AND/OR the button battery is less than 20mm diameter.
    - When outpatient observation is appropriate for intragastric batteries, a repeat x-ray is recommended in 48hours for batteries greater than or equal to 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.
- Upper intestinal endoscopy should be considered in the following scenarios to assess for esophageal injury and endoscopic battery removal: 1) unwitnessed ingestion and therefore unknown duration of battery in the gastrointestinal tract, 2) child less than 5 years old and battery greater than or equal to 20mm in diameter.

SURVEILLANCE AFTER BUTTON BATTERY REMOVAL

Post-removal complications include the development of a fistula into a major vessel, such as an aortoesophageal fistula (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. The degree of ulceration seen at the time of endoscopy 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, the 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 within 24-48 hours after removal of battery to look for extravasation of contrast into the extra-esophageal space. If esophagram demonstrates perforation, treat with IV antibiotics, maintain NPO and 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 should be obtained within 3 days of button battery removal, then weekly until edema subsides in airway and vessels.
    - Serial MRIs have demonstrated that all patients with severe complications have greater than 2 cm length of blooming artifact (i.e. inflammation of soft tissue), while those with less severe complications have less than 2 cm of blooming artifact (Grey et al., 2021).

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 of 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.

REFERENCES

1. Anfang RR, Jatana KR, Linn RL, Rhoades K, Fry J, Jacobs IN. pH-neutralizing esophageal irrigations as a novel mitigation strategy for button battery injury. Laryngoscope. Epub 2018 Jun 11.
2. Brumbaugh D, Kramer RE, Litovitz T. Hemorrhagic complications following esophageal button battery ingestion. Arch Otolaryngol Head Neck Surg 2011;137:416; author reply -7.
3. Brumbaugh DE, Colson SB, Sandoval JA, et al. Management of button battery-induced hemorrhage in children. JPediatr Gastroenterol Nutr 2011;52:585-9.
4. Jatana KR1, Rhoades K2, Milkovich S2, Jacobs I. Basic mechanism of button battery ingestion injuries and novelmitigation strategies after diagnosis and removal. Laryngoscope. 2017 Jun;127(6):1276-1282.
5. Litovitz T, Whitaker N, Clark L, White NC, Marsolek M. Emerging battery-ingestion hazard: clinical implications. Pediatrics 2010;125:1168-77.
6. Grey NEO, Malone LJ, Miller AL, Carroll HF, Khalaf RT, Kramer RE, Browne LP. Magnetic resonance imaging findings following button battery ingestion. Pediatric Radiology. 2021 Jun 1. doi: 10.1007/s00247-021-05085-w. Epub ahead of print. PMID: 34075452.

CLINICAL IMPROVEMENT TEAM MEMBERS

David Brumbaugh, MD | Gastroenterology & Chief Medical Officer, Anschutz
Steven Moulton, MD | Pediatric Surgery, Anschutz
Fritz Karrer, MD | Pediatric Surgery
Robert Kramer, MD | Pediatric Gastroenterology, Anschutz
Lorna Browne, MD | Radiology, Anschutz
LaDonna Malone, MD | Radiology, Anschutz
Jim Jaggers, MD | Chief Congenital Cardiothoracic Surgery
Gareth Morgan, MD | Interventional Cardiology, Anschutz
Melissa Anderson | Trauma Program Manager, Anschutz
Christine Waasdorp, MD | Gastroenterology, COS
John Bealer, MD | Trauma Program Medical Director, COS
Lana Martin | Trauma Program Manager, COS
David Listman, MD | Emergency Department, COS
Jeffery Tutman, MD | Radiology Medical Director, COS
Julie Marshall, RN | MedSurg CPS, COS
Andrew Hatt, PharmD | Pharmacist, Anschutz
Hoke Stapp, MD | PCN

APPROVED BY

Clinical Pathway and Measures Committee – 5/4/2022
Pharmacy & Therapeutics Committee – 11/4/2021 (no medication changes)

MANUAL/DEPARTMENT	Clinical Pathways/Quality
ORIGINATION DATE	July 11, 2011
LAST DATE OF REVIEW OR REVISION	May 4, 2022
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

Scheduled for full review on May 4, 2026

Discrimination is Against the Law. Children's Hospital Colorado complies with applicable Federal civil rights laws and does not discriminate on the basis of race, color, national origin, age, disability, or sex. Children's Hospital Colorado does not exclude people or treat them differently because of race, color, national origin, age, disability, or sex.

Children's Hospital Colorado provides free aids and services to people with disabilities to communicate effectively with us, such as: Qualified sign language interpreters, written information in other formats (large print, audio, accessible electronic formats, other formats). Children's Hospital Colorado provides free language services to people whose primary language is not English, such as: Qualified interpreters, information written in other languages.

If you need these services, contact the Medical Interpreters Department at 720.777.9800.

If you believe that Children's Hospital Colorado has failed to provide these services or discriminated in another way on the basis of race, color, national origin, age, disability, or sex, you can file a grievance with: Corporate Compliance Officer, 13123 E 16th Avenue, B450, Aurora, Colorado 80045, Phone: 720.777.1234, Fax: 720.777.7257, corporate.compliance@childrenscolorado.org. You can file a grievance in person or by mail, fax, or email. If you need help filing a grievance, the Corporate Compliance Officer is available to help you.

You can also file a civil rights complaint with the U.S. Department of Health and Human Services, Office for Civil Rights, electronically through the Office for Civil Rights Complaint Portal, available at ocrportal.hhs.gov/ocr/portal/lobby.jsf, or by mail or phone at: U.S. Department of Health and Human Services 200 Independence Avenue, SW Room 509F, HHH Building Washington, D.C. 20201 1-800-368-1019, 800-537-7697 (TDD) Complaint forms are available at www.hhs.gov/ocr/office/file/index.html.

Children's Hospital Colorado complies with applicable Federal civil rights laws and does not discriminate on the basis of race, color, national origin, age, disability, or sex.

ATENCIÓN: si habla español, tiene a su disposición servicios gratuitos de asistencia lingüística. Llame al 1-720-777-9800.

CHÚ Ý: Nếu bạn nói Tiếng Việt, có các dịch vụ hỗ trợ ngôn ngữ miễn phí dành cho bạn. Gọi số 1-720-777-9800.

주의: 한국어를 사용하시는 경우, 언어 지원 서비스를 무료로 이용하실 수 있습니다. 1-720-777-9800 번으로 전화해 주십시오

注意：如果您使用繁體中文，您可以免費獲得語言援助服務。請致電1-720-777-9800。

ВНИМАНИЕ: Если вы говорите на русском языке, то вам доступны бесплатные услуги перевода. Звоните 1-720-777-9800.

ማስታወሻ: የሚናገሩት ቋንቋ ኣማርኛ ከሆነ የትርጉም እርዳታ ድርጅቶች፣ በነጻ ሊያግዝዎት ተዘጋጀተዋል፡ ወደ ሚከተለው ቁጥር ይደውሉ 1-720-777-9800 (መስማት ለተሳናቸው.

ملحوظة: إذا كنت تتحدث اذكر اللغة، فإن خدمات المساعدة اللغوية تتوافر لك بالمجان. اتصل برقم 1-720-777-9800 (رقم)

ACHTUNG: Wenn Sie Deutsch sprechen, stehen Ihnen kostenlos sprachliche Hilfsdienstleistungen zur Verfügung. Rufnummer: 1-720-777-9800.

ATTENTION : Si vous parlez français, des services d'aide linguistique vous sont proposés gratuitement. Appelez le 1-720-777-9800.

ध्यान दनु होस्;तपाइले नेपाल बोल्नहन्छ भन तपाइको निम्त भाषा सहायता सवाहरू नःशल्क रूपमा उपलब्ध छ । फोन गनु होसर् 1-720-777-9800 ।

PAUNAWA: Kung nagsasalita ka ng Tagalog, maaari kang gumamit ng mga serbisyo ng tulong sa wika nang walang bayad. Tumawag sa 1-720-777-9800.

注意事項：日本語を話される場合、無料の言語支援をご利用いただけます。1-720-777-9800 まで、お電話にてご連絡ください。

Ntị: Ọ bụrụ na asụ Ibo, asụsụ aka ọasụ n'efu, defu, aka. Call 1-720-777-9800.