

BUTTON BATTERY INGESTION IN CHILDREN

Alberta Provincial Management Pathway

Button Battery Ingestions in Children:

A clinical care pathway for Child Health, Alberta Health Services

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A. Background

Button battery ingestions have been a problem for decades. However, in recent years the increased use of household electronic devices requiring button batteries, particularly of the larger, more powerful, 20mm CR2032 lithium/manganese dioxide batteries, has paralleled a rise in severe and even fatal injuries. Not only has the severity of injury evolved with time, but the frequency of button battery ingestions by children has also increased. In the US, battery ingestions accounted for 0.14% of all foreign body ingestions in 1995 and 8.4% in 2015. Button batteries were the most frequently ingested batteries (85.9% of battery ingestions by children) and children under six years of age accounted for 62% of all ingested button batteries.¹

Button battery ingestions can be devastating due to the production of hydroxide ions at the negative terminal of the battery and subsequent *liquefactive necrosis* of the tissue by the alkaline pH that is generated.² Animal models show esophageal injury including the lamina propria and inner muscular layer in as little as 15 minutes. Although evidence is limited, there is considered to be a greater risk of injury for esophageal button batteries retained greater than 2 hours. Furthermore, injury may be ongoing, even after removal of the button battery. Fatal hemorrhage due to aorto-esophageal fistula has been reported up to 21 days after initial ingestion.³⁻⁵

In response to two fatalities in Alberta since 2018, an ad-hoc working group was established by the Alberta Health Services (AHS), Maternal Newborn Child Youth (MNCY) and Emergency Strategic Care Networks (SCN) to provide strategic direction and expertise in the development, implementation and evaluation of a provincial clinical care pathway for the management of pediatric button battery ingestions (BBI) in Alberta. Specifically, the working group was tasked with developing a provincial clinical care pathway that addresses the management of BBI from the initial presentation to health care workers; through to the phase of battery removal by appropriately trained staff; to the follow up and management of complications of the BBI or re-presentations to health care facilities as a result of the BBI.

The development of this management pathway was faced with a number of challenges:

1. There currently exists no provincial or national system to track button battery ingestions and the subsequent complications. Consequently, the committee had access to very limited statistics on the scope of the problem particularly outside the immediate catchment areas of the Alberta Children's Hospital and Stollery Children's Hospital.
2. The clinical presentation in children may vary according to the size and type of battery, the residual charge in batteries, the timing of ingestion and the patient age, size and medical comorbidities.
3. There is a spectrum of outcomes ranging from harmless to catastrophic/fatal. At the same time, there is a limited ability to determine who is at risk for complications and the most concerning

outcomes. Worldwide there is controversy around several aspects of management due to the limited evidence in the published literature.

4. Clinical care of children who have ingested a button battery may be initiated by emergency services in small towns far removed from specialist care. The resources available to local emergency department providers across the province are not the same as in larger urban centres. Cognizant of the time imperative, (2 hours from ingestion can produce significant injury), the potential for significant delays in access to specialist care due resource limitations, the distances required for transport and the centralisation of cardiovascular surgery services at Stollery Children's Hospital needed to be considered.

Nonetheless the working group recognized several areas where current care could be potentially improved namely:

- Pre-hospital management
- Recognition of button battery ingestion (BBI) and notification/mobilization of most appropriate care team
- Post-removal management, including imaging
- Longer term (post-disposition) care and follow up
- Management of asymptomatic patient with ingestion of BB found to be beyond the esophagus (stomach, duodenum, etc).
- Provision of post-discharge information for parents and caregivers.

B. Button Battery Ingestion Clinical Care Pathway Working Group Terms of Reference

Type

This ad hoc working group is established by the Alberta Health Services (AHS) Maternal Newborn Child Youth (MNCY) and Emergency Strategic Care Networks (SCN).

Purpose

The working group has been established to provide strategic direction and expertise in the development, implementation and evaluation of a provincial clinical care pathway for the management of pediatric button battery ingestions (BBI) in Alberta, Canada.

Scope

IN SCOPE: The working group will operate within the scope of Alberta Health Services and under the purview of the MNCY and Emergency SCNs to develop this provincial clinical care pathway taking into account practice conditions in urban, regional and rural health care facilities. The process used will be evidence based, patient and family-oriented, and will seek to deliver the highest quality care possible to patients. The working group will partner and collaborate with relevant stake holders to formulate a pathway implementation and evaluation strategy that efficiently builds on opportunities afforded by Connect Care, the expansion of AHS Enterprise Data Warehouse, and MyCHILD^{Alberta} data analyst initiative.

OUT OF SCOPE: An AHS initiative to educate the public about the dangers of button batteries ingestions will be addressed by a parallel working group coordinated through the Population, Public Health and Indigenous portfolio; the issues of public education and prevention strategies will not be addressed by this working group.

Process and Authority

Once a comprehensive and near-final draft of the clinical pathway is complete, the working group will circulate it per MNCY and Emergency SCN standard protocols to all relevant stake holders for comment and potential revision. The working group will then review, consider, and incorporate all end user feedback through consensus. Following final approval, the working group will submit the clinical pathway to both the Child and Youth Standing Committee, MNCY SCN, and the Emergency SCN for final ratification.

Membership

Members will be appointed by the Co-Chairs of the working group.

Co-Chairs: Dr. Steven Martin, Pediatric Gastroenterology, Hepatology & Nutrition, Alberta Children's Hospital, Calgary, AB.

Dr. Matthew Carroll, Pediatric Gastroenterologist, Stollery Children's Hospital, Edmonton, AB.

Members: Dr. David W. Johnson, Senior Medical Director AHS MNCY SCN and Medical Toxicologist, Alberta Poison and Drug Information Service.

Matt Mink, Information Specialist, Alberta Poison and Drug Information Service

Dr. Troy Turner, AHS CK CM Pediatric Emergency Medical Lead, and Pediatric Emergency Physician, Stollery Children's Hospital, Edmonton, AB.

Dr. Mike Weldon, Red Deer Emergency Physician

Dr. Melanie Robles, Strathcona Community Hospital, Emergency Physician
Heather Hair, Executive Director, Emergency SCN, Calgary, AB.
Andrew Fisher, Manager, Emergency SCN, Calgary, AB
Laura Gibson, Policy Advisor, Health Profession Strategy & Practice, AHS
Dana Malloy, Senior Advisor, Policy Services, HPSP
Dr. Denise Watt, Emergency Physician and Health Link Medical Director
Dr. Bryan Dicken, General Surgery, Edmonton
Dr Carl Nohr, Regional Centre, General Surgery, Medicine Hat
Dr. Hamdy El-Hakim, ENT, Edmonton
Dr Andre Isaac, ENT, Edmonton
Dr. Adrienne Thompson, Radiology, Edmonton.
Dr Seemab Hader, Radiology, Calgary
Dr Jaime Blackwood, PICU, Calgary
Dr Jonathan Duff PICU, Edmonton
Dr Antonia Stang, Pediatric Emergency Physician, ACH, Calgary
Dr Simone Kortbeek, Pediatric Gastroenterology, ACH PICU sub-committee
Dr Paul Beaudry, Pediatric Surgery, ACH PICU sub-committee
Dr Gregory Samis, Vascular Surgery, ACH PICU sub-committee
Dr Mark Mackenzie, Emergency Physician; Senior Medical Director, AHS, EMS
John Montpetit, Provincial Director, RAAPID
Erika Helmerson, Administrative Support, MNCY. Administrative Assistant

Meeting arrangements

Meetings will occur monthly and will utilize Skype Business for teleconferencing. Ms. Erika Helmerson will book and distribute meeting details online in advance of the meetings and will take minutes of the minutes. Minutes will be subsequently distributed to working group members for revision. The final agenda for each meeting will be set by the Co-Chairs but all members will have to opportunity to add items to the agenda in advance of each meeting. The meeting agenda will be distributed by email in advance of each meeting by Ms. Helmerson Meetings will be co-chaired by Drs. Steve Martin and/or Matt Carroll unless otherwise indicated.

Reporting

The group will be responsible to and report to the Child and Youth Standing Committee, MNCY SCN.

Resources and budget

Broadly the development and planning document for implementing and evaluating the button battery clinical pathway produced by this working group will use AHS in-kind resources. More specifically, co-chairs and members will provide their time for meeting and meeting preparation in-kind. Secretarial time for coordinating the meeting arrangements will be provided, as noted above, in kind by the Emergency SCN. The funds necessary to implement and evaluate this clinical pathway will be determined at a later time.

Deliverables

The working group is tasked with the development of:

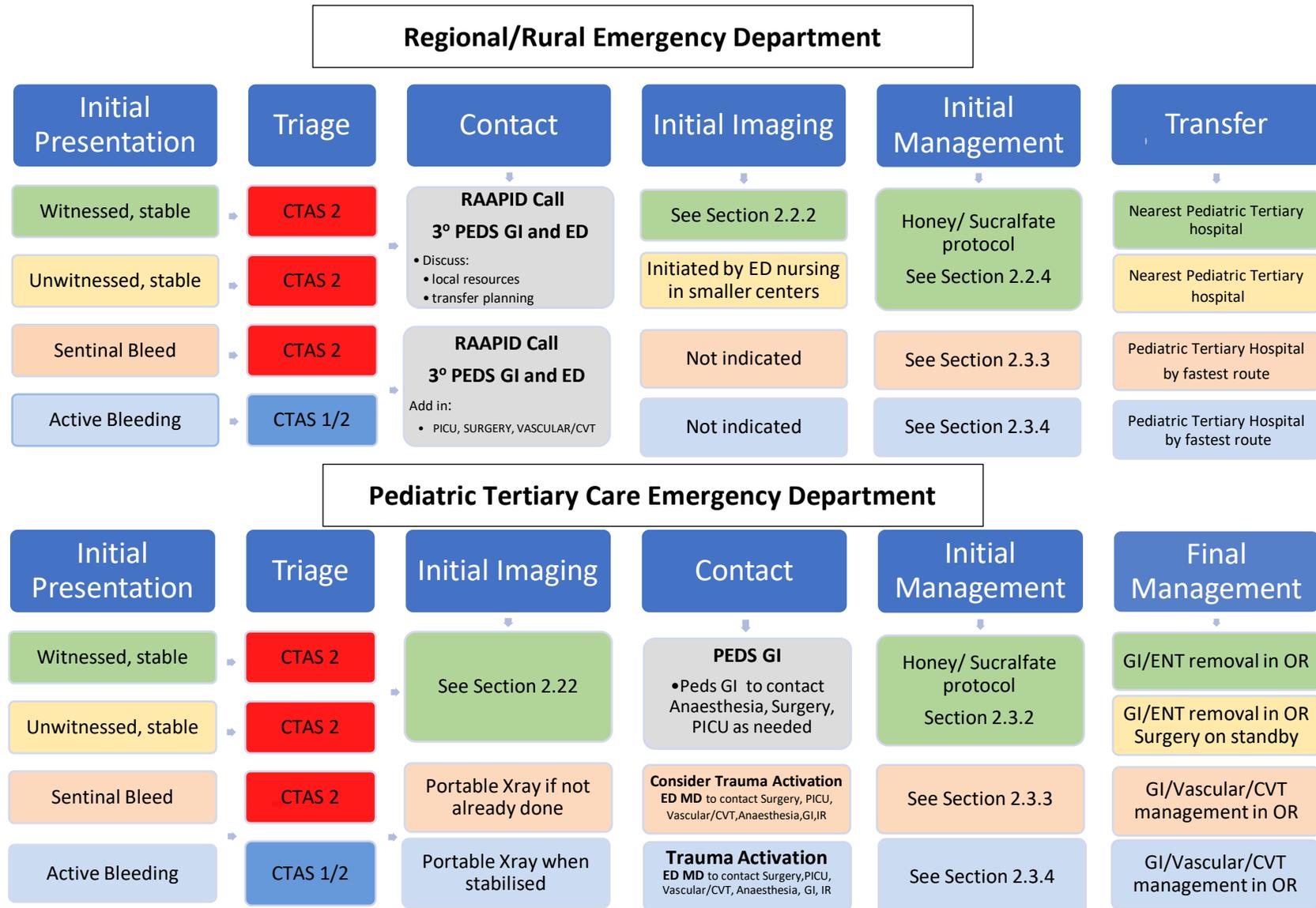
1. A provincial clinical care pathway that addresses: the management of BBI from the initial presentation to health care workers; through to the phase of battery removal by appropriately trained staff; to the follow up and management of complications of the BBI or re-presentations to health care facilities as a result of the BBI.
2. The development of provincial electronic health record order sets that will be incorporated into Connect Care and will facilitate the use of the clinical pathway.
3. With creation of Connect Care physician order sets for BBI events, opportunities for mandatory reporting which capture the occurrence and clinical outcomes of BBI will be identified and secured.
4. A proposal for implementing and evaluating the clinical pathway will be written, and potential funding opportunities and in-kind resources to carry out the proposal will be identified.

The group is accountable for:

- Fostering collaboration
- Identifying and addressing potential obstacles to the successful delivery, adoption and implementation of the BBI clinical care pathway

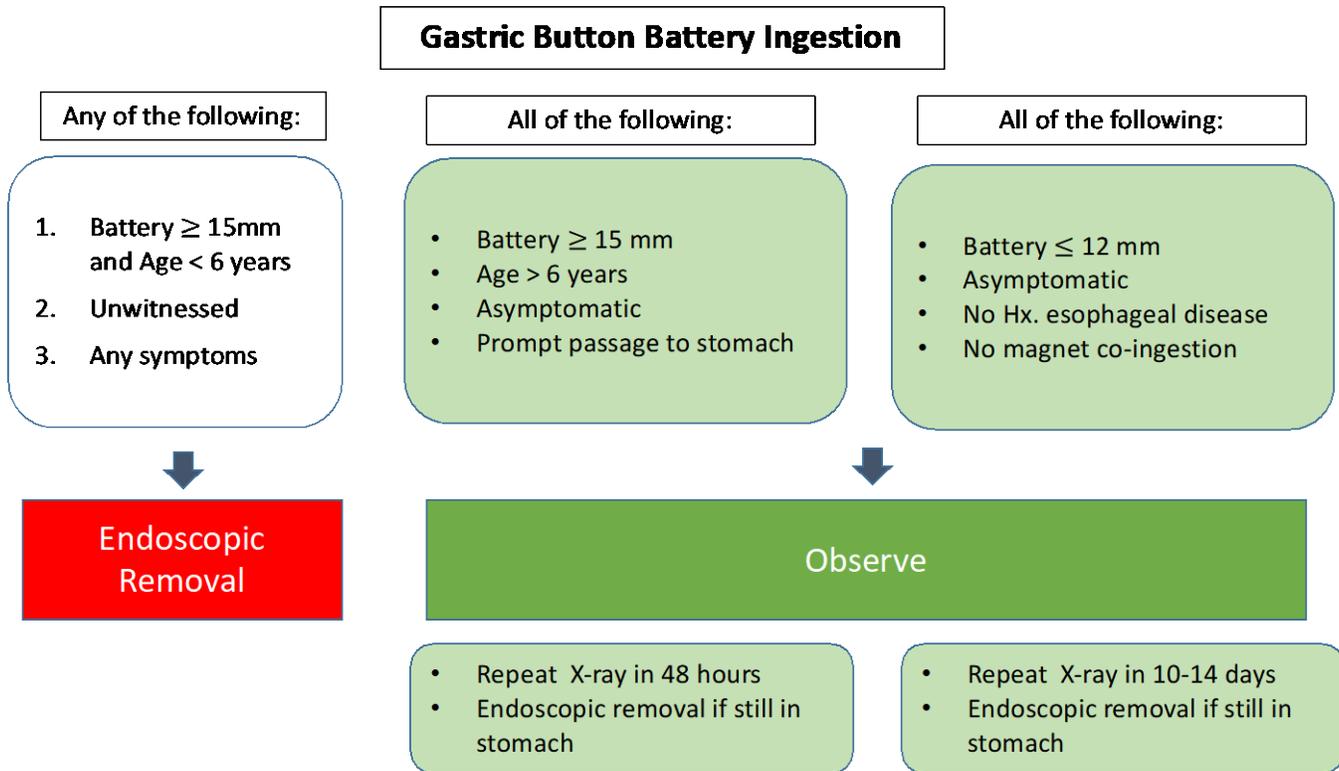
C. Button Battery Ingestion Clinical Care Pathway

Figure 1: Algorithm for Emergency Department Assessment and Management of Esophageal Button Battery Ingestions



Refer to text for details

Figure 2: BBI with a gastric location of the battery



Note: Observation can take place as an outpatient - refer to section 2.2.3 for details

1. Phone Triage

1.1 Phone Advice

The initial contact for phone advice for **known or suspected** button battery ingestion in most instances will be:

- Health Link (811)
- PADIS (1-800-332-1414)
- Emergency services (911)
- Direct to ED call

Uniform messaging: (also located at My Health Alberta - <https://myhealth.alberta.ca>)

- *If you think a child has swallowed a button battery:*
 - **do not** try to make them vomit
 - take them to an **emergency department immediately**
- **Serious injury can occur within 2 hours** of the battery being swallowed.
- *If you have honey at home, you can give 2 teaspoons (10 ml) of honey if your child meets **all** of the following:*
 - it's within 12 hours of swallowing the battery
 - they can swallow liquids
- *You can give your child honey even if they're under 12 months of age. There is a higher risk of injury from the battery than your child getting sick from the honey.**
- *Take your child to the emergency department **right after** you give them honey.*
- *You can give up to 6 doses of honey, about 10 minutes apart. If your child vomits, do not give another dose.*
- **Do not delay transport to hospital to get or give honey. Do not give your child anything else to eat or drink.**

* Recommendations from the Canadian Pediatric Society, American Academy of Pediatrics and the National Capital Poison Centre in the USA exclude children under 12 months of age due to potential risk of infant botulism (Appendix A2). The committee strongly believes that the risk of button battery injury far outweighs the remote chance of infant botulism which disproportionately affects infants < 6 months of age. **Recognizing that the age limit of one year is arbitrary the committee recommends the honey protocol be used for all children with suspected or witnessed button battery ingestion.**

1.2 Notification

- Treat button battery ingestion as a surgical emergency
- Families should be directed to the closest ED
- Urgent involvement of **tertiary children's hospital pediatric gastroenterology (GI) service** and where applicable, surgical service in rural areas (via RAAPID)
 - Referral, Access, Advice, Placement, Information & Destination (RAAPID)
 - RAAPID North (for ALL patients north of Red Deer, Alberta)
1-800-282-9911 (Canada ONLY)
780-735-0811
 - RAAPID South (for ALL patients in and south of Red Deer, Alberta)
1-800-661-1700 (Canada ONLY)
403-944-4486
 - Priority notification of pediatric GI by ED staff in instances of direct to ED presentation or direct call to ED.

2. Emergency Department (ED) Response

2.1 Triage

- Esophageal button batteries need urgent removal. Each hour that passes increases the risk of severe esophageal injury and the subsequent development of complications in adjacent structures including life-threatening hemorrhage from esophago-vascular fistula.
- Asymptomatic foreign body ingestions are usually triaged as Canadian Triage and Acuity Scale (CTAS) 3. Any suspicion of a button battery ingestion should prompt rapid evaluation, **even if asymptomatic and appearing well. Esophageal button battery impactions should be triaged as CTAS 2.**
- **High index of suspicion** for esophageal foreign body ingestion especially in children < 6yrs is required.
- Any report by parents of refusal or reduction in food/fluid intake, difficulty swallowing, coughing, wheezing, choking or gagging, drooling, chest discomfort, vomiting should prompt radiograph of neck, chest and abdomen.

2.2 Regional/ Rural ED presentation

- All suspected or confirmed BB ingestions should trigger an immediate RAAPID call to Pediatric GI at the nearest tertiary children's hospital to discuss the best management/transfer plan.
- Stable patient with witnessed ingestion: initial management as per section 2.24
- Presentation with **active bleeding or sentinel bleeding (any hematemesis or melena in a child with a history, or suspected history, of BB ingestion including at any time following BB removal)** is at minimum CTAS 2 triage, requires immediate stabilisation (tertiary care approach is outlined in sections 2.33, 2.34) and initiation of transfer planning via RAAPID call with pediatric GI, PICU and ED.
- Priority management goals for active bleeding in a regional or rural site are focused on airway protection and hemodynamic stability followed by **immediate consultation with Pediatric GI, PICU, and the ED at a tertiary site via RAAPID.** Further management of active bleeding, including the placement of a Pediatric Blakemore tube shall be guided by specialist consultation and local resources.

2.2.1 RAAPID call

- to teleconference-in Pediatric Gastroenterologist and ED physician from closest children's hospital (Stollery Children's Hospital or Alberta Children's Hospital).
According to circumstances Pediatric GI may include PICU and Surgery.
 - RAAPID North (for ALL patients north of Red Deer, Alberta)
1-800-282-9911 (Canada ONLY)
780-735-0811
 - RAAPID South (for ALL patients in and south of Red Deer, Alberta)
1-800-661-1700 (Canada ONLY)
403-944-4486
- Decision to be made as to whether or not urgent transfer is required and by what means is the most expeditious.
- Considerations:
 - What are the local resources?
 - General surgeon/ENT/adult GI/anesthesia with capability and willingness to remove battery vs. transfer to children's hospital.
 - Can an X-ray be obtained quickly (within 1 hour) to determine if there is an esophageal foreign body? If not, then first initiate possible transfer to tertiary children's hospital by way of RAAPID call. Imaging may subsequently be obtained while awaiting transfer.
 - In smaller centres, consideration for delegation of CXR to onsite ED nursing may reduce delays.
 - Risk Factors:
 - Unstable patient
 - Age less than 5 years
 - Button battery > 20mm
 - Ingestion > 12 hours
 - Unwitnessed ingestion, duration unknown
 - Sentinel bleed or active bleeding

In the presence of these risk factors, BB removal should not be performed in a regional centre.

2.2.2 Immediate Imaging

- If X-ray can be obtained and reviewed, **ALL** patients with button battery ingestion should be imaged with following recommendations,
 - Regardless of location of battery at presentation
 - Regardless of duration of ingestion
 - Regardless of whether it was witnessed/unwitnessed
 - Regardless of location of the battery/injury within the esophagus
- Order Stat:
 - A. PA or AP **and** lateral chest radiograph.
 - B. AP supine radiograph of the abdomen
 - Must include GE junction to pubic symphysis
 - Note: KUB is NOT acceptable
 - C. AP and lateral neck radiograph
 - Nasopharynx to thoracic inlet.
- Image report should include:
 - diameter measurement of battery
 - direction of NEGATIVE pole

2.2.3 Gastric location of battery

Endoscopic removal recommended for:

- Unwitnessed ingestion
- Child less than 6 years with battery ≥ 15 mm
- Any child eligible for observation (see below) who develops symptoms

Observation at home and follow-up X-ray recommended for:

- Smaller Button Batteries (12 mm or less) with **all** of following:
 - If the ingestion was witnessed
 - Asymptomatic
 - No co-ingestion of a magnet
 - No known esophageal disease
- Repeat X-ray in 10-14 days
- Endoscopic removal if battery still in stomach.

- Larger batteries (≥ 15 mmm) with **all** of the following:
 - Age > 6 years
 - If the ingestion was witnessed

- Asymptomatic
- Prompt passage to stomach (if in doubt discuss with Peds GI on call)
- Repeat X-ray in 48 hours
- Endoscopic removal if battery still in stomach.

Any child with a button battery in the stomach presenting with bleeding, dysphagia, feeding compromise, airway compromise, hemodynamic instability or suspected aspiration should be treated as an esophageal button battery injury and **urgent referral to tertiary center arranged via RAAPID.**

2.2.4 Regional/Rural ED Management - stable patient, witnessed and unwitnessed ingestion

- ED administration of honey/sucralfate⁶⁻⁸
 - Give honey 10mls (2 teaspoons) every 10 mins if ≤12 hours post ingestion (up to 6 doses). DO NOT delay going to ER to give honey. Otherwise, NPO, until esophageal position ruled out.
 - OR
 - Give sucralfate – 1 gram (5 mls of 200mg/ml) every 10 minutes (up to 3 doses). Note that sucralfate may make everything white and so may limit operative visualization.
- Immediate neck, chest and abdominal imaging for any child with known or suspected BBI from triage. (See Immediate Imaging recommendations – section 2.22)
 - If the ED physician is off-site, nursing staff should contact the on-call ED physician immediately for a verbal order for imaging.
 - Frontline physicians should be aware to look for evidence of a button battery including a "halo" sign on PA view or step-off on a lateral x-ray using magnified views (Appendix B2)
- Stable patient
 - Obtain IV access (1 large bore IV cannula)
 - NPO (other than honey or sucralfate as described above)
 - If not already done, Initiate RAAPID call to tertiary pediatric GI on call as soon as possible.

2.3 Pediatric Tertiary Care ED presentation

2.3.1 Triage:

- Asymptomatic foreign body ingestions are usually triaged as Canadian Triage and Acuity Scale (CTAS) 3. Any suspicion of a button battery ingestion should prompt rapid evaluation, **even if asymptomatic and appearing well. Esophageal button battery impactions should be triaged as CTAS 2.**
- **High index of suspicion** for esophageal foreign body ingestion especially in children < 6 years is required.
- Any report by parents of refusal or reduction in food/fluid intake, difficulty swallowing, coughing, wheezing, choking or gagging, drooling, chest discomfort, vomiting should prompt radiograph of neck, chest and abdomen.
- Presentation with **active bleeding or sentinel bleeding (any hematemesis or melena in a child with a history, or suspected history, of BB ingestion including at any time following BB removal)** is at minimum CTAS 2 triage, requires immediate stabilisation (see sections 2.33, 2.34)
- Immediate Imaging: see section 2.22
- Gastric location of BB: see section 2.23

2.3.2 Tertiary Care ED Management - stable patient, witnessed ingestion

- ED administration of honey/sucralfate⁶⁻⁸
 - Give honey 10mls (2 teaspoons) every 10 mins if ≤12 hours post ingestion (up to 6 doses). DO NOT delay going to ER to give honey. Otherwise, NPO, until esophageal position ruled out.
OR
 - Give sucralfate - 1 gram (5 mls of 200mg/ml) every 10 minutes (up to 3 doses). Note that sucralfate may make everything white and so may limit operative visualization.
- Immediate neck, chest and abdominal imaging for any child with known or suspected BBI from triage. (See Immediate Imaging recommendations – section 2.22)
 - Frontline physicians should be aware to look for evidence of a button battery including a "halo" sign on PA view or step-off on a lateral x-ray using magnified views (Appendix B2)
- Stable patient
 - Obtain IV access (1 large bore IV cannula)
 - NPO (other than honey or sucralfate as described above)

- Notification of pediatric surgery and anesthesia if plans for pediatric gastroenterology/ENT to take the OR for endoscopy. These phone calls will be initiated by pediatric gastroenterology/ENT
- Consider consulting pediatric intensive care if there are high-risk patient factors (including prolonged interval from ingestion, unwitnessed ingestion, respiratory symptoms, or concerning findings at time of endoscopy. This notification will be initiated by pediatric gastroenterology/ENT.

2.3.3 Tertiary Care ED Management - stable patient with sentinel bleed

An **aorto-esophageal fistula** may develop in the presence of the battery or following removal in the setting of severe esophageal injury. **Sentinel bleeds (hematemesis or melena stool)** may also occur as late as 6 weeks following button battery removal. A sentinel bleed may precede a severe, life-threatening hemorrhage. In the context of a sentinel bleed, there should be a high index of suspicion for an aorto-esophageal fistula. When a patient presents to the ED having had a sentinel bleed, the following steps should occur:

Note: Outside of the tertiary care pediatric hospitals, a patient with a sentinel bleed should be prepared for transport by the most expeditious route in discussion with team members at ACH or Stollery Children’s Hospital (pediatric gastroenterology, pediatric intensive care) via RAAPID call by ED MD.

Detailed ACH PICU management guidelines for sentinel bleeds are available at:

<https://insite.albertahealthservices.ca/Main/assets/tms/picuc/tms-picuc-physician-button-battery-ingestions.pdf>

- Emergent consultation by ED MD to pediatric gastroenterology, pediatric surgery, pediatric intensive care, cardiothoracic/vascular surgery.
- Consideration of trauma activation to be made by ED MD with pediatric surgery.
- Consider activation of massive transfusion protocol.
- Obtain IV access (2 large-bore IV cannula)
- CBC, type and screen with cross match, Coagulation studies – STAT
- Have 12 French Sengstaken Blakemore and manometer at bedside (for insertion instructions see Appendix D). This will be supplied by pediatric gastroenterology if required. This should be available, but not inserted unless required due to ongoing refractory, bleeding as this may result in dislodgement of clot. **Note: The tube must not be inserted if the battery is still located in the esophagus.**
- If not done previously, obtain portable x-ray to determine button battery location
- In some circumstances, consideration should be given for emergent transfer of the patient to Stollery Children’s Hospital.

- Decision for transfer to be made in discussion by team members at Stollery Children’s Hospital and ACH (pediatric gastroenterology, pediatric intensive care, cardiovascular (CV) /vascular surgery).
- Considerations:
 - Unwitnessed ingestion
 - >12 hours from ingestion
 - Findings on CTA/MRA of vessel injury/troubling integrity
 - Significant esophageal injury on endoscopy
- In the instance of an active bleed in a hemodynamically stable child or of a sentinel bleed in a child at Alberta Children’s Hospital, the transfer may be highly risky and the child may need to be managed by the onsite teams (ED, GI, Surgery, Vascular surgery, PICU, Interventional radiology). Recommend discussion with Stollery Cardiothoracic Surgery.
- Decision for additional imaging (e.g. CT angiography) can be made in discussion with team members at Stollery Children’s Hospital based on anticipated need and timing.
- If transfer of patient is not possible:
 - If button battery is present, proceed to urgent endoscopic removal with pediatric surgery and cardiovascular/vascular surgery present in the OR. Patient should be prepped for urgent thoracotomy and laparotomy. If high suspicion of aorto-esophageal fistula initial thoracotomy is preferred to control major vessels.
 - If button battery is not present, consider urgent CT angiogram to evaluate for possible fistula - this step should be performed in a combined surgical – imaging suite where available.
 - Preferred imaging will likely be intra-operative angiogram, facilitated by interventional radiology in conjunction with vascular surgery.
 - If aortoesophageal fistula is present, proceed with emergent surgical intervention. Anticipate a combined pediatric surgery and vascular surgery approach.
 - If aortoesophageal fistula is not visualized, proceed with upper endoscopy to evaluate source of bleeding. Pediatric surgery and vascular surgery should be present at time of endoscopy. Patient should be prepped for urgent thoracotomy and laparotomy.

2.3.4 Tertiary Care ED Management – unstable bleeding patient

Detailed ACH PICU management guidelines for active bleeding are available at:

<https://insite.albertahealthservices.ca/Main/assets/tms/picuc/tms-picuc-physician-button-battery-ingestions.pdf>

- Trauma activation
- Activate massive transfusion protocol and ensure blood box accompanies patient to the OR
- Emergent consultation to pediatric GI, pediatric surgery, pediatric cardiothoracic surgery/vascular surgery, anesthesia, consider involving interventional radiology (ACH).
- Obtain IV access (2 large bore IV cannulae)
- Stat CBC; type and cross for transfusion; Coagulation studies stat
- Rapid correction of circulatory instability.
- If not done previously, obtain portable x-ray to determine button battery location
- Avoid CT angiography in unstable patient to not delay emergent surgical intervention
- Avoid intubation in ED unless required for respiratory failure due to airway obstruction secondary to blood, inability to protect airway due to level of consciousness or a Sengstaken-Blakemore tube is to be inserted. If must intubate, ensure ready for cardiovascular collapse.
- Have 12F Sengstaken Blakemore/ manometer at bedside if available (for insertion instructions see Appendix B5) **Note: must not be inserted if the battery is present in the esophagus**
- Since aorto-esophageal fistula is present or suspected, anticipate proceeding with emergent surgical intervention. Anticipate a combined pediatric surgery and CV/vascular surgery approach.
- Patient should be prepped for urgent thoracotomy and laparotomy.
- OR should be set up so that patient can be positioned for optimal c-arm access.
- Preferred imaging will likely be intra-operative angiogram, facilitated by interventional radiology in conjunction with cardiovascular/vascular surgery.
- If aorto-esophageal fistula is not visualized, proceed with upper endoscopy to evaluate source of bleeding. Pediatric surgery and cardiovascular/vascular surgery should be present at time of endoscopy.

3. BB Removal

3.1 OR Preparation

- **Immediate removal of BB in OR requires E1 booking**
 - Fasting history should not delay removal or the administration of anesthetic.
 - Rapid sequence induction and intubate patient
 - If anesthesiologist able to view clearly, remove with Magill forceps under direct visualization with subsequent endoscopy to inspect esophagus
 - If unable to visualize battery, then proceed with flexible endoscopy
 - Attempt to identify the position of the battery with respect to the negative battery pole and position in esophagus and document this, and size of battery, clearly
- Equipment to have available:
 - For flexible endoscopic removal: coin grasper, rat tooth or “Raptor” or “Gator” type toothed forceps; Roth net retrieval basket
 - Magill forceps under direct vision with post removal endoscopic look
 - Rigid esophagoscopy by ENT or Gen Surg may be required (risk of perforation may be substantially higher)
- ENT attendance for possible bronchoscopy should be anticipated for anterior position of anode and prolonged interval from ingestion.

3.2 Acetic Acid Irrigation

- If no **obvious** perforation, irrigation of injured esophageal tissue with 50-150 ml of sterile 0.25% acetic acid to neutralize residual alkali. Irrigate with aliquots, suctioning the excess from the stomach. Product comes sterile, in 250ml bottles and required SAP approval from Health Canada. The product is marketed in the USA by ICU Medical. In the absence of this product a proprietary solution can be made (Appendix B3)

3.3 Post-irrigation

- Insert NG feeding tube under endoscopic guidance – for Zargar Grade 2b or higher. (Appendix B4)
- All patients should be admitted. PICU admission should be considered for:
 - Airway concerns
 - High bleeding risk

4. Post-Removal Management

Goals:

1. Feeding
2. Imaging
3. Criteria for complications
4. Length of F/U and by whom
5. F/U - imaging
6. F/U instructions
7. F/U visits
8. Transfer of care

4.1 Feeding

- NPO until water soluble contrast esophagram done at 24-48 hours. Not required for Zargar Grade 1.
- In the presence of perforation, **may** be able to feed by NG tube.
- If no concern for perforation, then may have full liquid diet until more detailed imaging performed.
- Consider need for IV antibiotics if presence of perforation
- Consider administration of Proton Pump Inhibitor.

***Endoscopic findings of esophageal injury (necrosis, eschar, suspicion of perforation etc) should mandate further imaging as endoscopic appearance may underestimate the depth of injury and progression of the injury beyond BB removal is known to occur.**

4.2 Imaging

A. Within 24-48 hours post-removal:

1. CROSS-SECTIONAL:

- Sedated MRI/MRA of neck and chest (from skull base to gastric body).
- Sedated CTA of neck and chest instead of MRI **only** if retained metal fragments after button battery removal.
- **Note:** MRA/CTA should be done **before** esophagram so as not to obscure findings.

2. ESOPHAGRAM:

- Esophagram within 24 hours with water soluble contrast (Omnipaque 300)
 - If normal, child may resume PO intake if no other contraindication. Repeat at 1 week if needed for reconsideration of introduction of PO feeds. Repeat at 4 weeks for determination of stricture/fistula development (even if asymptomatic) and even 3-6 months with use of marshmallow cine-swallow to assess for motility or bolus transit dysfunction.

B. First follow-up imaging at 10-14 days post-removal:

1. MRI/MRA of neck and chest (skull base to gastric body)
2. Esophagram with water soluble contrast. If no leak, it is ok to do additional Barium study.
3. If the day 14 MRI is improved and the esophagram is normal, advance feeds as tolerated clinically and discharge home.
4. Repeat an MRI and esophagram at 30 days. Repeat imaging at 6-8 weeks is acceptable in adherent families and with no clinical concerns.

C. Second follow-up imaging at 21 days post-removal:

1. If patients have persistent abnormality of the airway or vessels on the 14-day MRI, repeat the MRI/MRA at 21 days.
2. These patients may need to be kept on NG/NJ tube feeds. If the MRI improves at 21 days, then they are allowed to advance feeds and the child goes home. An MRI and esophagram are then repeated at 30 days.

4.3 Discharge and Follow Up

- Needs to be booked to follow up with managing subspecialist (typically Ped GI, ENT or Surgery depending on the institution) at 4 weeks.
- Needs clear (preferably written) instructions regarding the need to return immediately to ER in the event of a sentinel bleed (hematemesis/hemoptysis/melena), dysphagia or suggestion of pulmonary compromise - cough, respiratory infection- that may indicate development of tracheal fistula (Appendix c)

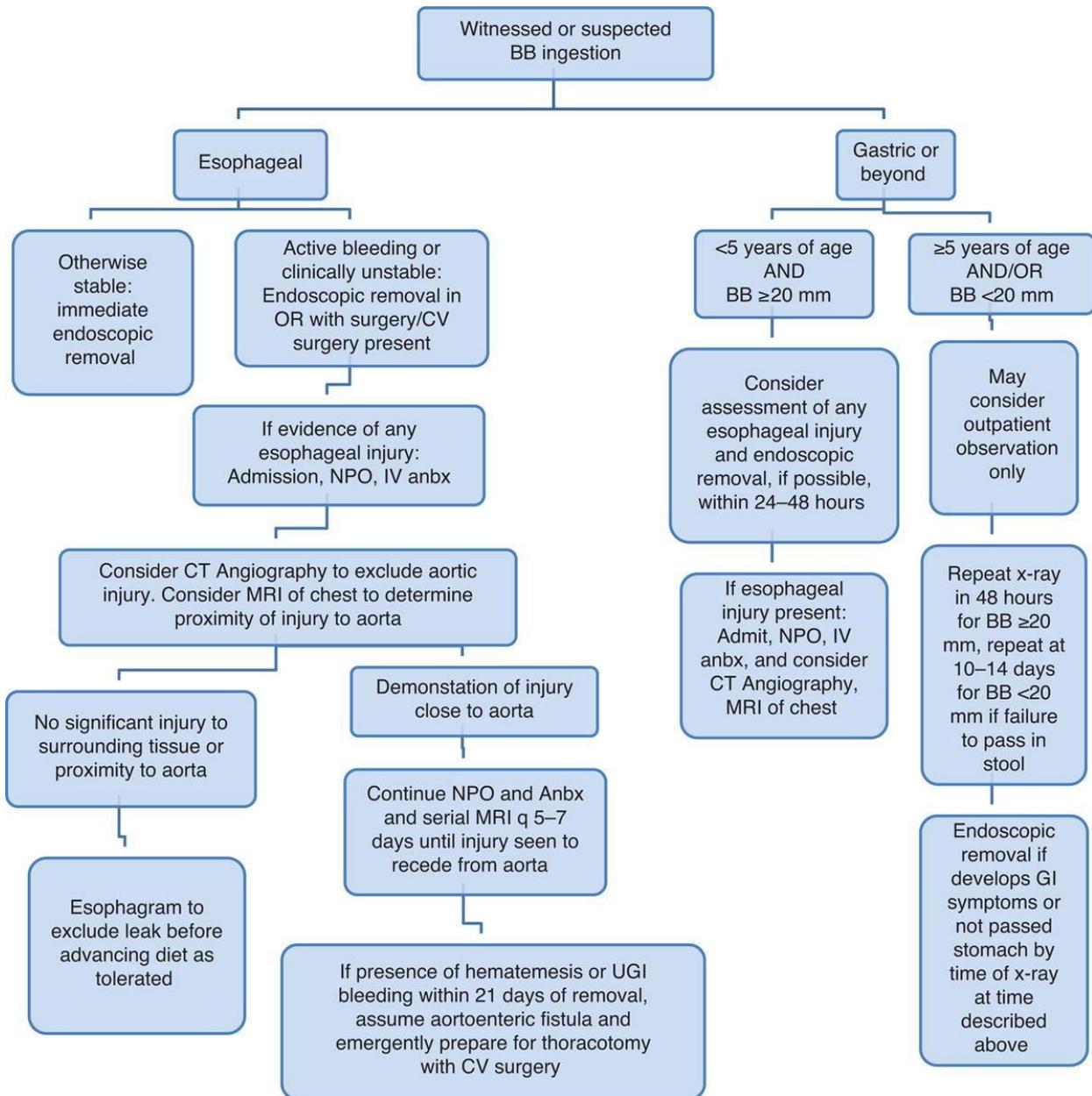
5. Delayed Complications

- Delayed complications following button battery ingestion include: tracheoesophageal fistula, tracheal stenosis, vocal cord paralysis, tracheomalacia, esophageal perforation, esophageal

stricture, mediastinitis, aspiration pneumonia, empyema, lung abscess, pneumothorax, spondylodiscitis and hemorrhage from perforation into a large vessel (i.e. aorto-esophageal fistula). Complications should be anticipated based on the location of impaction and orientation of the battery (Appendix B1). Duration of observation, NPO status and need for serial imaging should be based on specific complications, location and extent of injury. Appropriate subspecialty referral and follow-up is required according to the complications present.

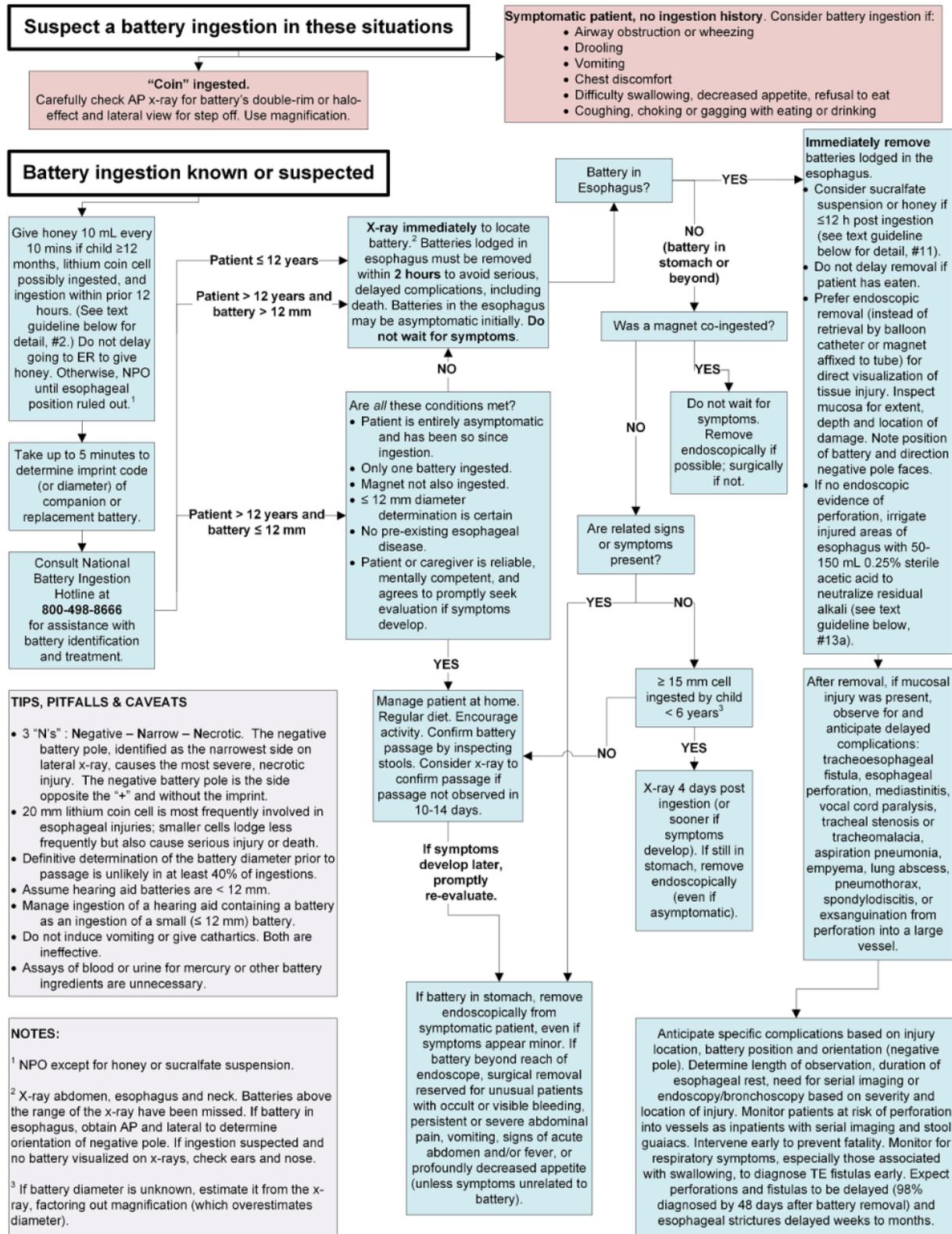
Appendix A: Existing published guidelines:

1. Management of Ingested Foreign Bodies in Children: A Clinical Report of the NASPGHAN Endoscopy Committee



Kramer RE, Lerner DG, Lin T et al. JPGN 2015;60: 562–574

2. National Capital Poison Center guideline - June 2018 <https://www.poison.org/battery/guideline>

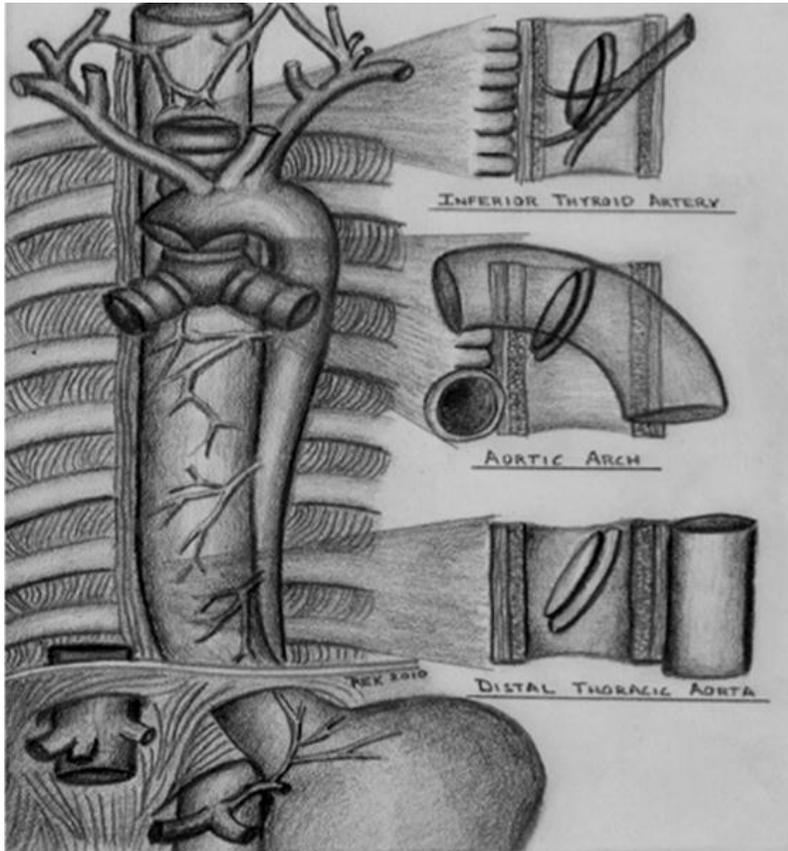


3. Children's Hospital of Colorado pathway

<https://www.childrenscolorado.org/globalassets/healthcare-professionals/clinical-pathways/ingested-button-battery.pdf>

Appendix B - Additional Resources

B1. Position of Impaction Has Important Bearing on Potential Injuries



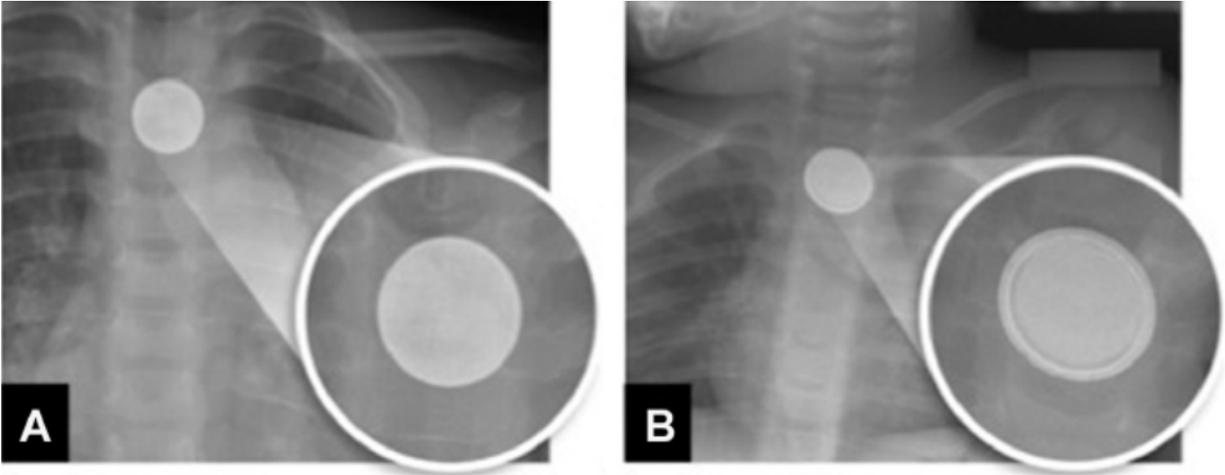
Leinwand K et al Gastrointest Endosc 2016⁹

Direction of negative pole is the focus of greatest injury:

- Anteriorly --> esophago-tracheal injury
- Posteriorly/Laterally --> discitis, vertebritis, vascular injuries
- Proximal esophagus --> Inferior thyroid artery injury
- Mid esophagus --> aortic arch (aorto-esophageal fistula)
- Distal esophagus --> distal thoracic aorto-esophageal fistula

- Circumferential injury higher risk for esophageal structuring

B2. "Halo Sign" indicative of BB



A= Coin; B= Button battery with characteristic "halo sign"

Jatana KR et al 2013.¹⁰

B3. 0.25% acetic acid protocol (ACH GI recipe)

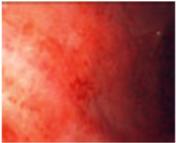
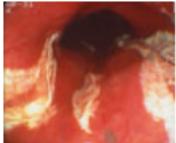
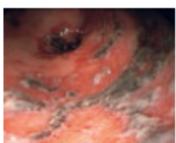
INTERIM ACETIC ACID IRRIGATION PROTOCOL
BUTTON BATTERY INGESTIONS

March 13, 2019

1. Obtain standard white vinegar from grocery store
2. This is 5% acetic acid and should be diluted as follows:
3. Draw up 10 mls vinegar into a 10 ml syringe.
4. Attach a 0.2 um filter to the syringe.
5. Inject, through the filter, 2.5 mls of vinegar into each of two 60 ml syringes.
6. Draw up sterile water into the syringes to a final volume of 50 mls
7. Infuse in aliquots into the working channel of the endoscope and allow to lavage the battery site to a total of 100 mls
8. Remove residual vinegar from the stomach before withdrawing the scope.

B4. Zargar classification of caustic esophageal injury

Table 1 Endoscopic classification of corrosive injuries according to Zargar et al. [8]

Grade	Description	Endoscopy
Grade I	Edema and hyperemia of the mucosa	
Grade IIa	Superficial localized ulcerations, friability, and blisters	
Grade IIb	Circumferential and deep ulcerations	
Grade IIIa	Multiple and deep ulcerations and small scattered areas of necrosis	
Grade IIIb	Extensive necrosis	
Grade IV	Perforation	

Cabral et al Surgical Endoscopy 2012¹¹

B5. Blakemore Tube Insertion in BB–related bleed

- Patient should be intubated
- **Do not use if battery is present in esophagus**

Required materials

Pediatric size 12F is stored in the workroom opposite OR 10 at ACH

Orogastric tube

1L bag saline

3-way stopcocks

Manometer

Preparation

- Insert 3-way stopcock into gastric balloon port (using Christmas Tree adapter)
- Insert 3-way stopcock into esophageal balloon port (using Christmas Tree adapter)
- Line up the OG tube so that the tip is just above the gastric balloon
 - Label the OG tube with a “G” at the 50cm mark of the Blakemore tube
- Line up the OG tube so that the tip is just above the esophageal balloon
 - Label the OG tube with an “E” at the 50cm mark of the Blakemore tube
- Test the balloons
 - Attach a 60cc syringe (full of air) to the gastric balloon stopcock
 - Immerse the balloon in a container of water
 - Inflate to ensure no leaks
 - Repeat this for the esophageal balloon to ensure no leaks.
 - Deflate balloons

Insertion

- Lubricate the tube and balloon with water-based lubricant
- Insert as an OG
- Confirm placement:
 - Insufflate air into the stomach (via the suction port) and auscultate for gastric sounds
 - Insert 50ml of air into gastric balloon
 - Obtain AXR to confirm placement, with air bubble below diaphragm
- Once confirmed, insert a final volume of 250ml of air into the gastric balloon

- Ensure that stopcock is OFF and place caps over the remaining two ports

Traction

- Use the bag of saline and the Kerlix gauze
- Tie a slip knot around the tube
- Push free ends of the gauze through the hole in the bag and knot
- Hang gauze over an IV pole for traction (1L = 1kg of traction)
- Connect low-intermittent suction to the gastric port and aspirate stomach contents

Esophageal balloon

- NOTE: for button battery-related aorto-esophageal fistula this manoeuvre (a) is not required, proceed to (b).
- (a) Insert OG tube so that the “G” mark lines up with the 50cm mark on the Blakemore (tube just above gastric balloon, at GE junction)
 - Clamp the gastric suction port
 - Move the suction to the OG tube
 - If there is residual ongoing bleeding, then you will need to inflate the esophageal balloon for hemostasis
- (b) Pull the OG back so that the “E” mark is at the 50cm mark on the Blakemore tube
 - Tape the tubes together to prevent movement
- Attach manometer to 3-way stopcock on esophageal balloon port
- Place a cap over the other port on the 3-way stopcock
- Inflate the balloon to 40cm H₂O Hg (Can go as high as 60 if inadequate tamponade)
- Close the stopcock
- Remove manometer
- Cap the open port on the esophageal stopcock
 - Attach suction to the OG tube to ensure hemostasis

Appendix C

Button Battery Ingestion

Information for Parents and Caregivers

- Your child has been discharged from hospital after swallowing a button battery.
- Damage can continue for many weeks after the battery has been removed. Depending on how long the battery was stuck and where it was located, a number of serious complications may occur, some of which are life-threatening. These include:
 - Massive intestinal bleeding caused by a hole between the esophagus and a major artery.
 - A hole between the esophagus and the trachea or breathing tube (trachea-esophageal fistula)
 - Narrowing of the esophagus (stricture)
 - Vocal cord paralysis or damage
 - Inflammation of the chest (mediastinitis)
 - Inflammation of the spinal column (spondylo-discitis)
- Complications may occur as long as six weeks after button battery removal

Recommendations:

1. You must not plan to travel for six weeks after the battery was removed
2. If your child vomits or coughs up any brown or red-coloured liquid, has any black, tarry-appearing stools or fainting or collapsing you must take him/her immediately to the nearest hospital emergency room. Present this document to the nurse or doctor.
3. If your child experiences any difficulty swallowing, excessive drooling, vomiting, breathing difficulties or chest pain you must immediately contact:

Name: _____ Phone: _____

4. Follow-up visit has been arranged with:

Name: _____ Phone: _____

5. Follow up X rays/Scans have been arranged for: _____

Appendix D

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Provincial Button Battery Pathway

Provincial Button Battery Pathway developed by Dr Steven Martin and Dr Matthew Carroll with the provincial Button Battery Working group.

Review and Approval by MNCY SCN Child and Youth Standing Committee on February 25th, 2021

APPROVAL

May 5, 2021

Date



Dr. David Wyatt – Johnson
Senior Medical Director Maternal

APPROVAL

May 5, 2021

Date



Shelley Valaire
Senior Provincial Director,
CvHS & MNCY Strategic Clinical Network

Provincial Button Battery Pathway

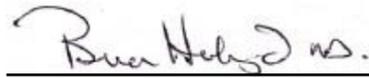
Provincial Button Battery Pathway developed by Dr Steven Martin and Dr Matthew Carroll with the provincial Button Battery Working group.

Review and Approval by the Emergency Strategic Clinical Network™.

APPROVAL

May 26, 2021

Date



Dr. Brian Holroyd
Senior Medical Director,
Emergency Strategic Clinical Network™

APPROVAL

May 26, 2021

Date



Sherri Kashuba
Senior Provincial Director,
Emergency Strategic Clinical Network™