Critical Ingestions

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Pediatric Surgery

Inova™

Goals

-History of kids doing the darndest things

-Initial approach to the patient with suspected ingestion

-Management of Button Battery Ingestions

Chevalier Jackson, 1865-1958

-Pennsylvania surgeon, innovator in flexible bronchoscopy/laryngoscopy

-President of Women's Medical College of Pennsylvania

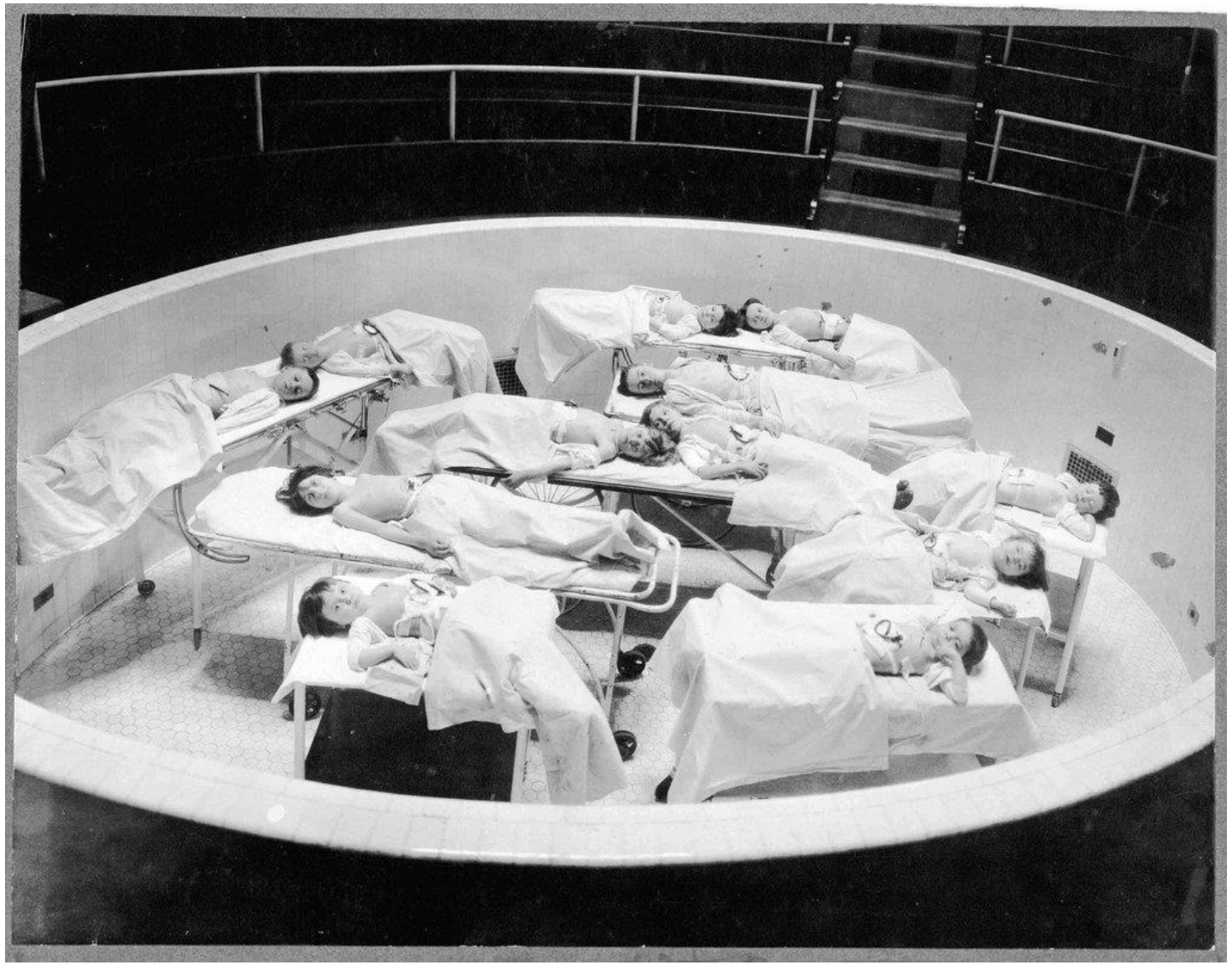
-Founding member of American College of Surgeons

-Removed at least 2374 foreign bodies from airway and esophagus in children, pretty much kept all of them (Mutter museum)

-Improved safety of tracheostomy

-Lobbied for passage of Federal Caustic Poison Act of 1927, which mandated labeling of poisonous substances

Nath-Critical Ingestions



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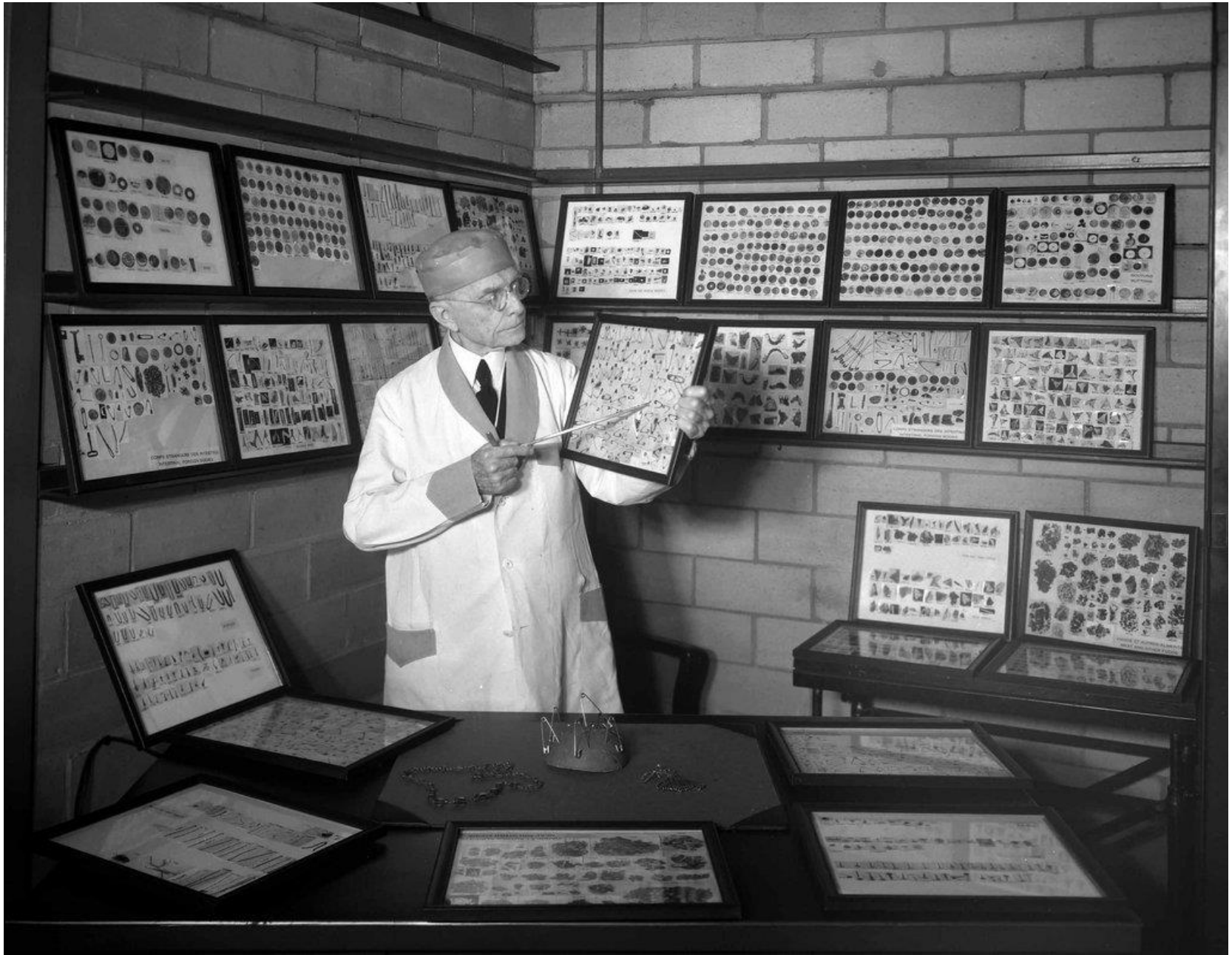


Nath-Critical Ingestions

Initial approach to the patient with suspected ingestion

-airway stabilization, assessment of breathing and circulation
-dyspnea, odynophagia, sialorrhea, hoarseness, and stridor portends airway obstruction
-nausea or emesis, chest/abdominal pain → ?perforation
-early imaging should include chest film and KUB
-ABG is critical as may reflect evolving metabolic component
-pH <7.22, base excess <-12, WBC>20, CRP predict mortality and emergency operation in adults
-Detailed history with container of ingested agent if possible
-Early involvement of consultants including surgery, gastroenterology, otolaryngology, and toxicology

Caustic Ingestions

American Association of Poison Control:

- 60,000 cases of exposure to corrosive agents

  48,000 bleach

  7500 acidic ingestions

  4000 alkali ingestions

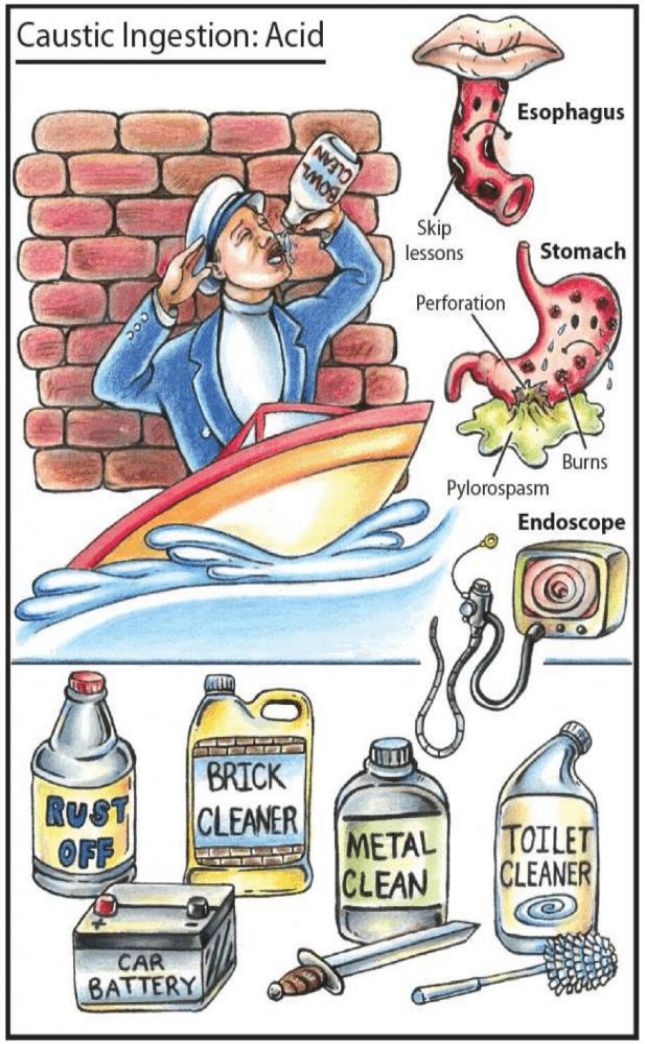
- Children (2-6yrs) account for up to 80% of caustic ingestion cases

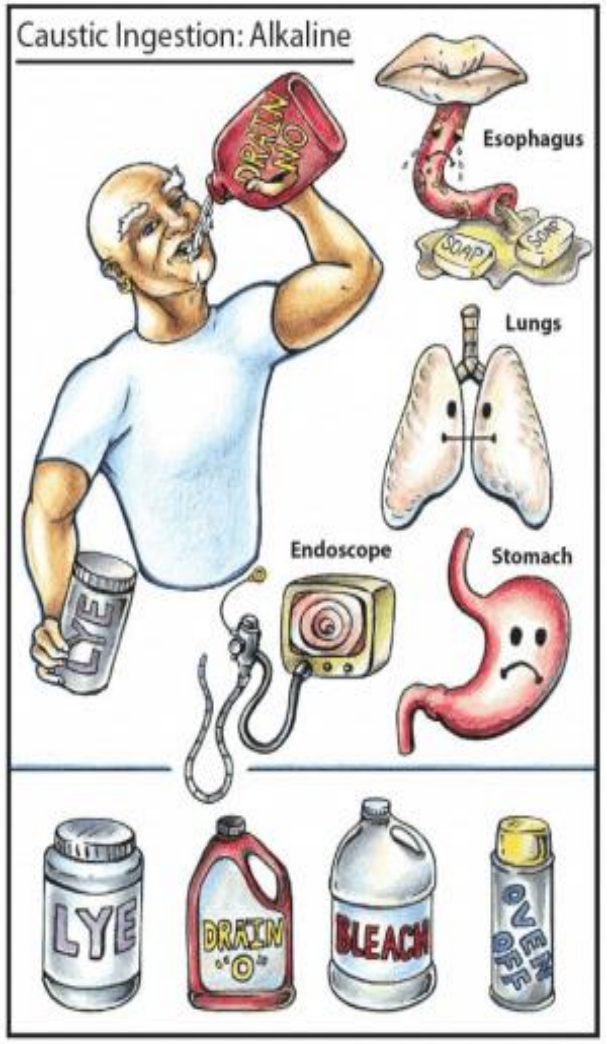
Clinical Presentation: dysphagia, retrosternal pain, drooling, +/- airway symptoms or oral burns

Clinical history details:

- Type of chemical ingestion (Acidic or Alkali)
- Physical form of substance (liquid, gel, powder or solid)
- Substance concentration (diluted substance)
- Volume (systemic effects)
- Time of Ingestion

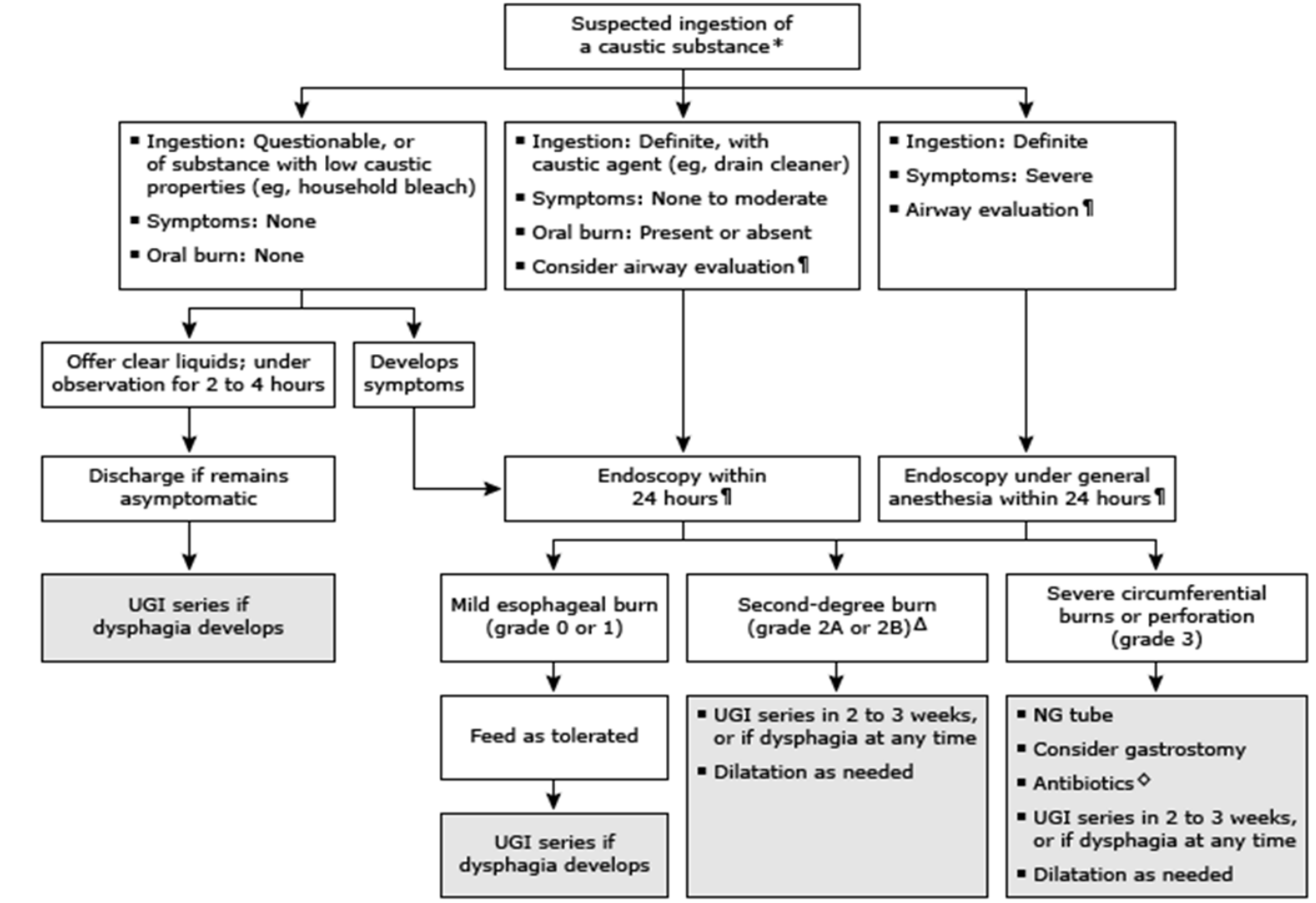
- Bitter taste
- Coagulation Necrosis
- Eschar formation
- Esophagus Spared in most cases





- Odorless Tasteless
- Liquefactive Necrosis
- Esophagus damaged

Evaluation of a patient with suspected ingestion of caustic substances



Damage from caustic ingestions occurs in stages

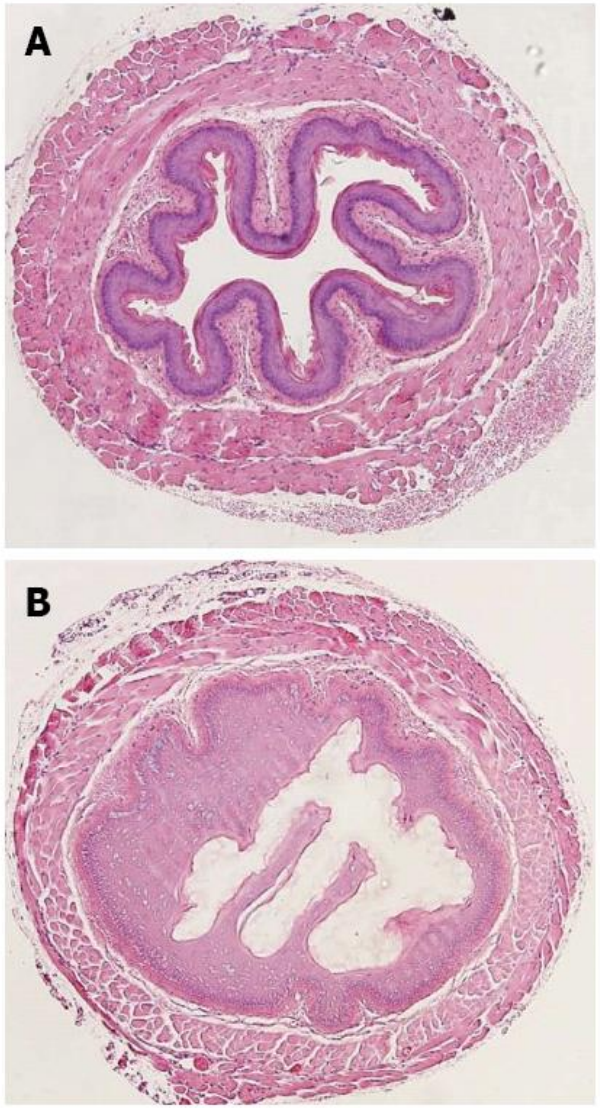
-Necrotic changes observed within 10 minutes after exposure to 10% NaOH

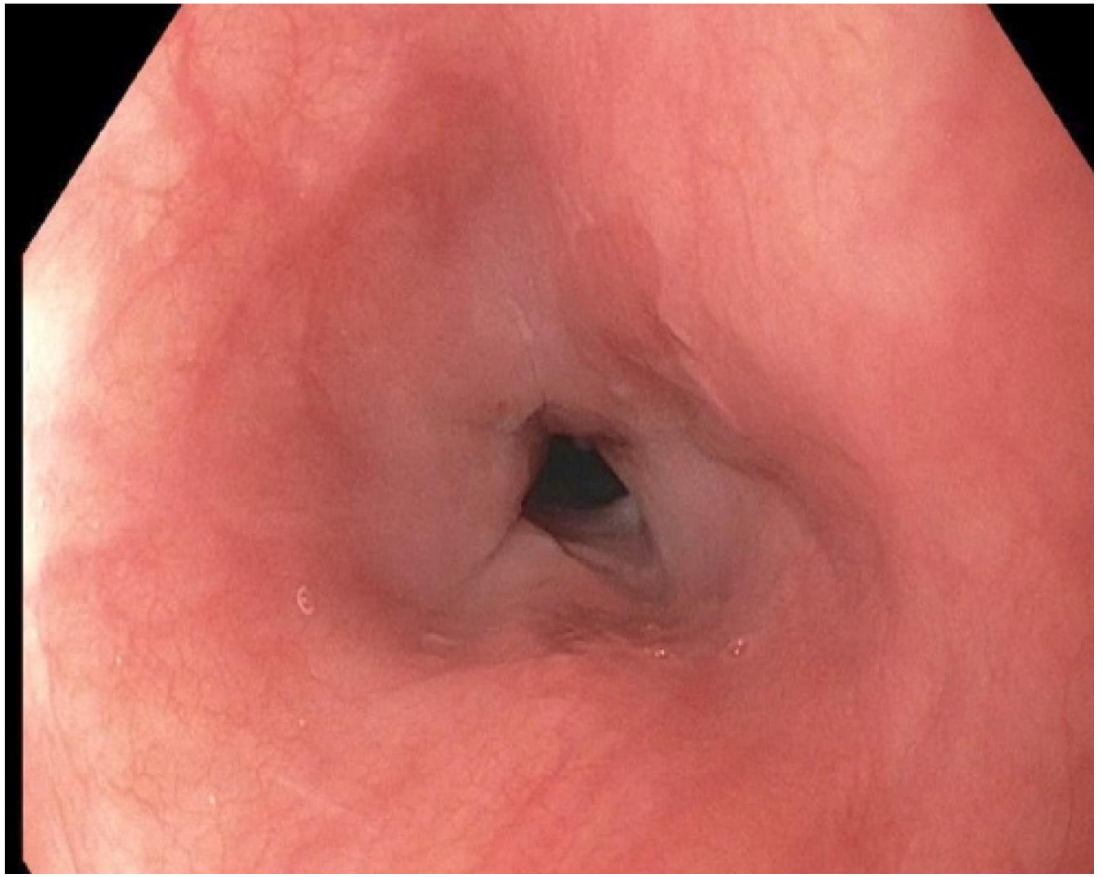
-4-7day, mucosal sloughing and bacterial entry with creation of fibrin and granulation

-Fibroblast remodeling, low tensile strength as collagen deposition begins in second week

-Scar retraction and stricture formation begins at 3rd week

-Liquid ingestions tend to cause more distal damage

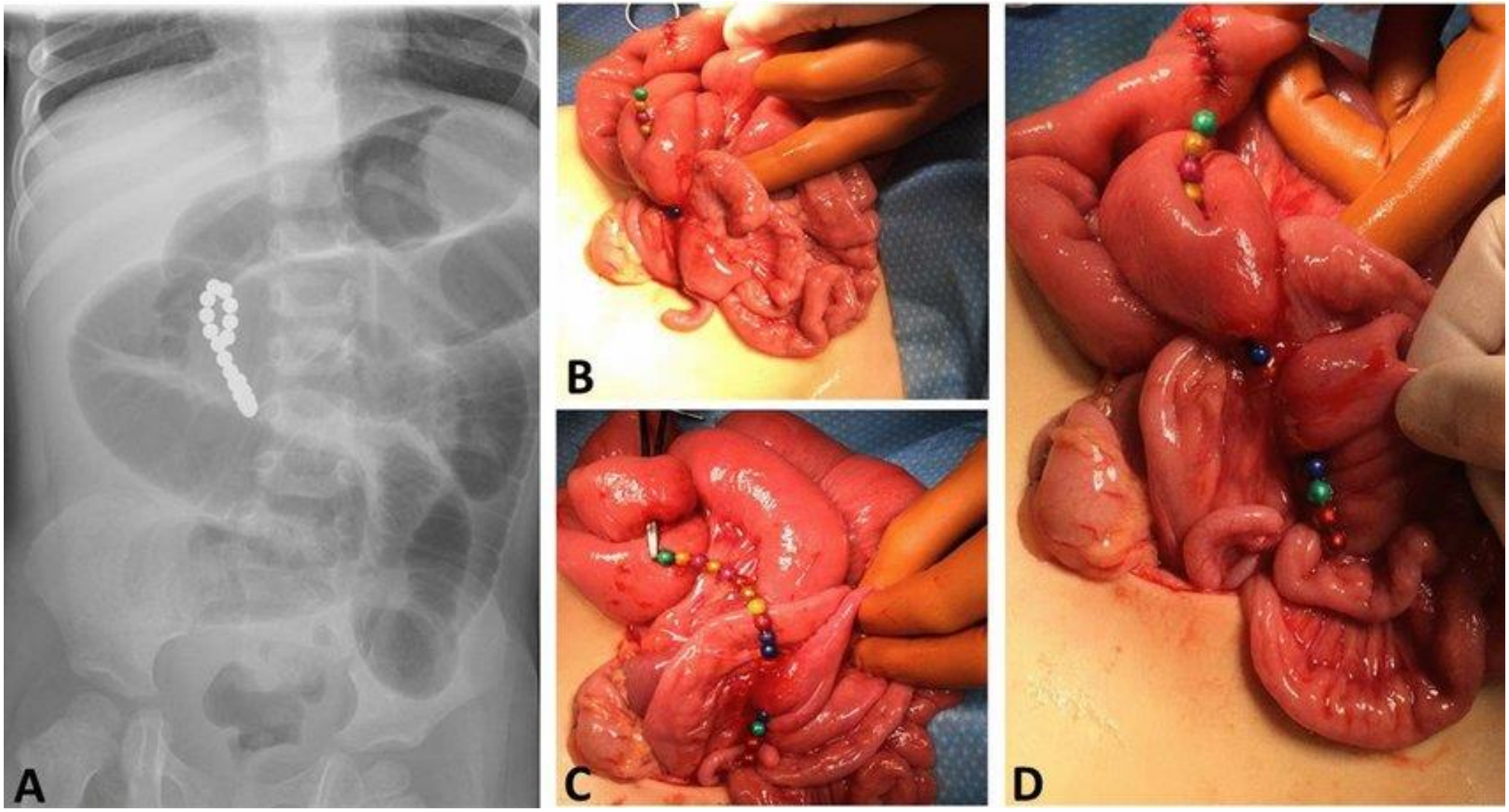




Late Complications of Critical Ingestions

- Late complication of ingestion
  - Esophageal cancer
    - Squamous cell carcinoma & adenocarcinoma
    - Reported 1000-3000 times higher than the normal population
    - Time to presentation 10-30 years from ingestion
    - Most common location is area of stenosis

- Role for long-term EGD monitoring
  - Surveillance 20 years post ingestion?



Mostafa, Mohamed, Darwish, Ahmed
Magnet ingestion in children and its implications: tertiary centre experience. PY - 2021/07/01 10.1007/s00383-021-04889-z, Pediatric Surgery International

Button batteries-a perfect danger

- Ubiquitous in every home
- Easily removed from devices
- Sized perfectly to be trapped in the esophagus
- Injury is enabled by electrolyte-rich fluid in saliva
- Injury is rapid
- Symptoms may be nonspecific, high index of suspicion particularly if unwitnessed
- In children <6y, 13% had severe complication after button battery ingestion

Jatana, K.R., Rhoades, K., Milkovich, S. and Jacobs, I.N. (2017), Basic mechanism of button battery ingestion injuries and novel mitigation strategies after diagnosis and removal. The Laryngoscope, 127: 1276-1282. https://doi.org/10.1002/lary.26362

National Battery Ingestion Hotline

- Created in 1982
- Consumer safety product commission issued warning in 1983
- Seven fold increase in injury severity between 2010 and 2017
- 20mm lithium batteries account for majority of severe injuries
- Smaller 1.5v non lithium batteries also have caused severe injuries, particularly in infants
- Major complications include perforation, tracheoesophageal fistula, vascular fistula, strictures, vocal cord paralysis

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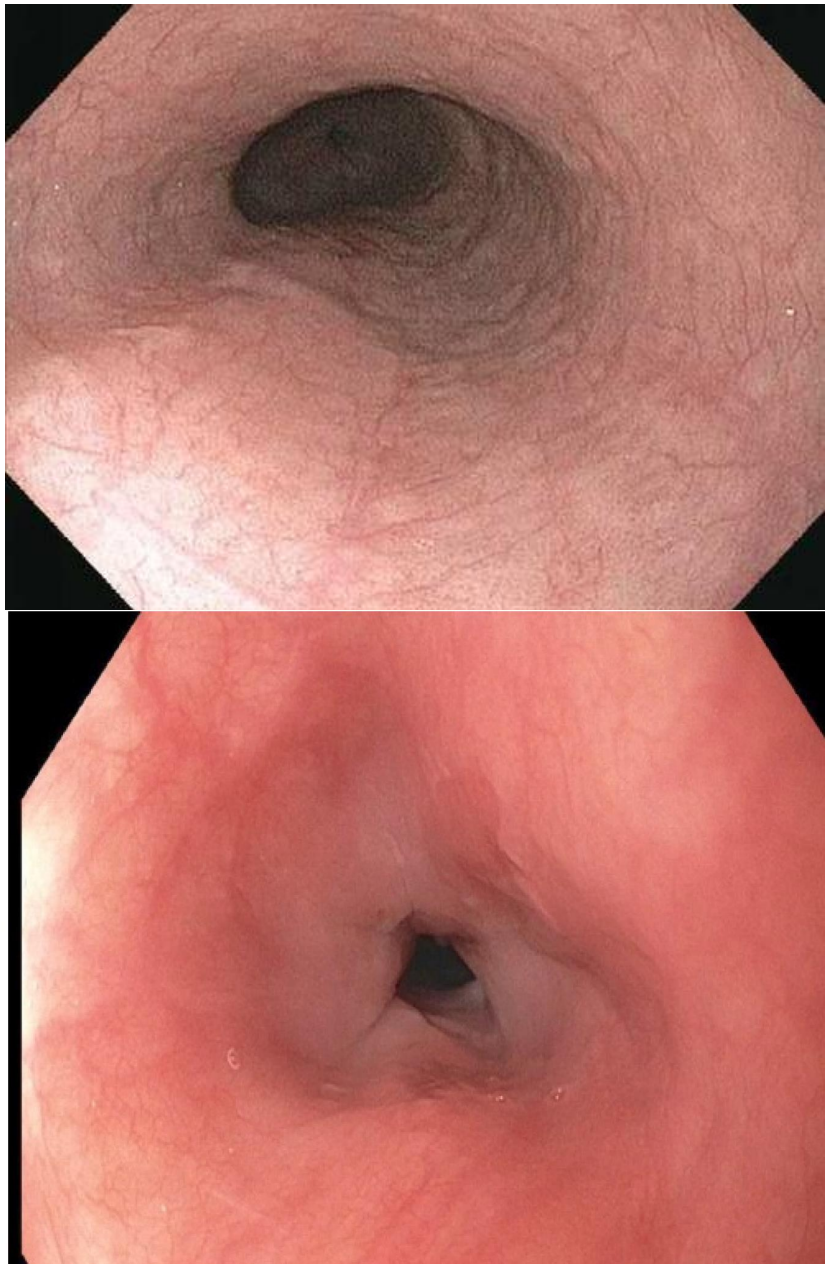
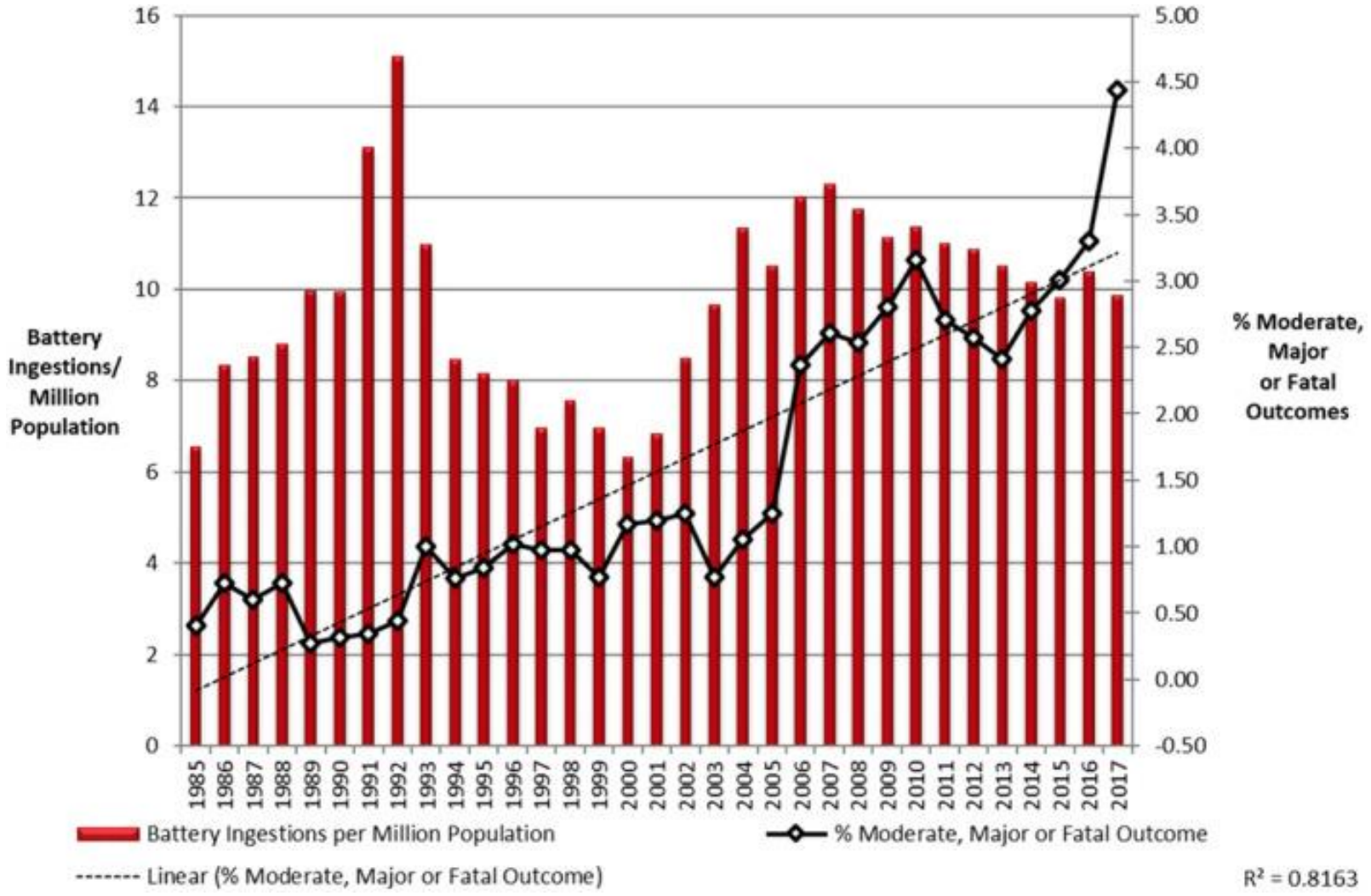
Nath-Critical Ingestions



Incidence of ingestion and severe outcomes of battery ingestion is increasing

- www.poison.org/battery



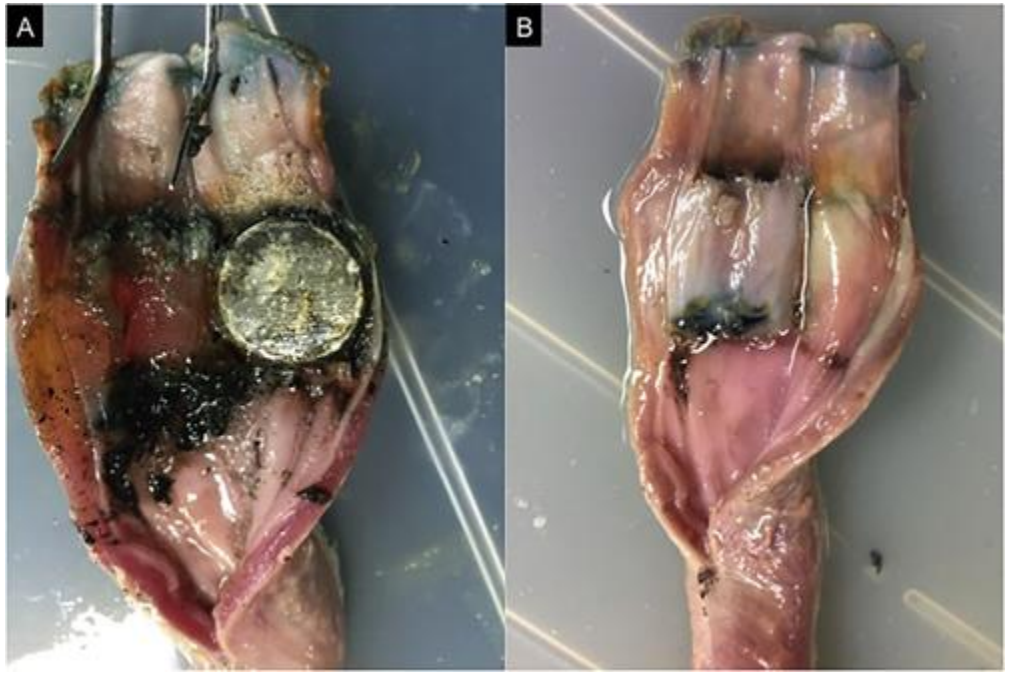
Prehospital Management

- Honey administration (10ml every 10 minutes, maximum of 6 times) if battery ingestion is suspected less than 12 hours
- Coats battery and decreases current discharge
- Carafate (sucralfate) is an anti-ulcer medication which forms a barrier over the mucosa, and can mitigate injury when administered prior to endoscopy
- In porcine and in vitro trials, honey had significant protective effects

Schmidt YM, Muensterer O, Wendling-Keim D. The use of honey in button battery ingestions: a systematic review. Front Pediatr. 2023 Sep 28;11:1259780. doi: 10.3389/fped.2023.1259780. PMID: 37842023; PMCID: PMC10569471.

Acetic acid washing mitigates tissue injury

- Mechanism of injury: water is hydrolyzed into hydrogen gas an hydroxide (OH-) ions, creating an alkaline environment
- Additional mechanisms include pressure necrosis, leakage of battery fluids, and metal toxicity
- Injury after 24 hours from CR2032 battery, versus after irrigation with dilute acidic solution
- Has led to practice of immediate acetic acid washing in operating room after endoscopic removal



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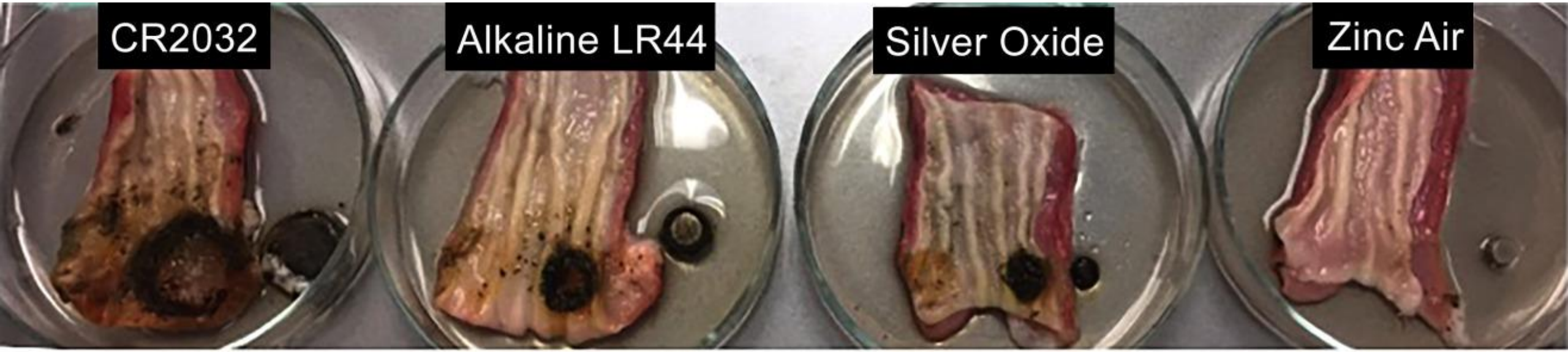
Every Second Counts

- Children diagnosed at non-pediatric facilities have delay in removal
- Injury progresses rapidly over hours
- Further tissue injury can occur over days to weeks even after removal



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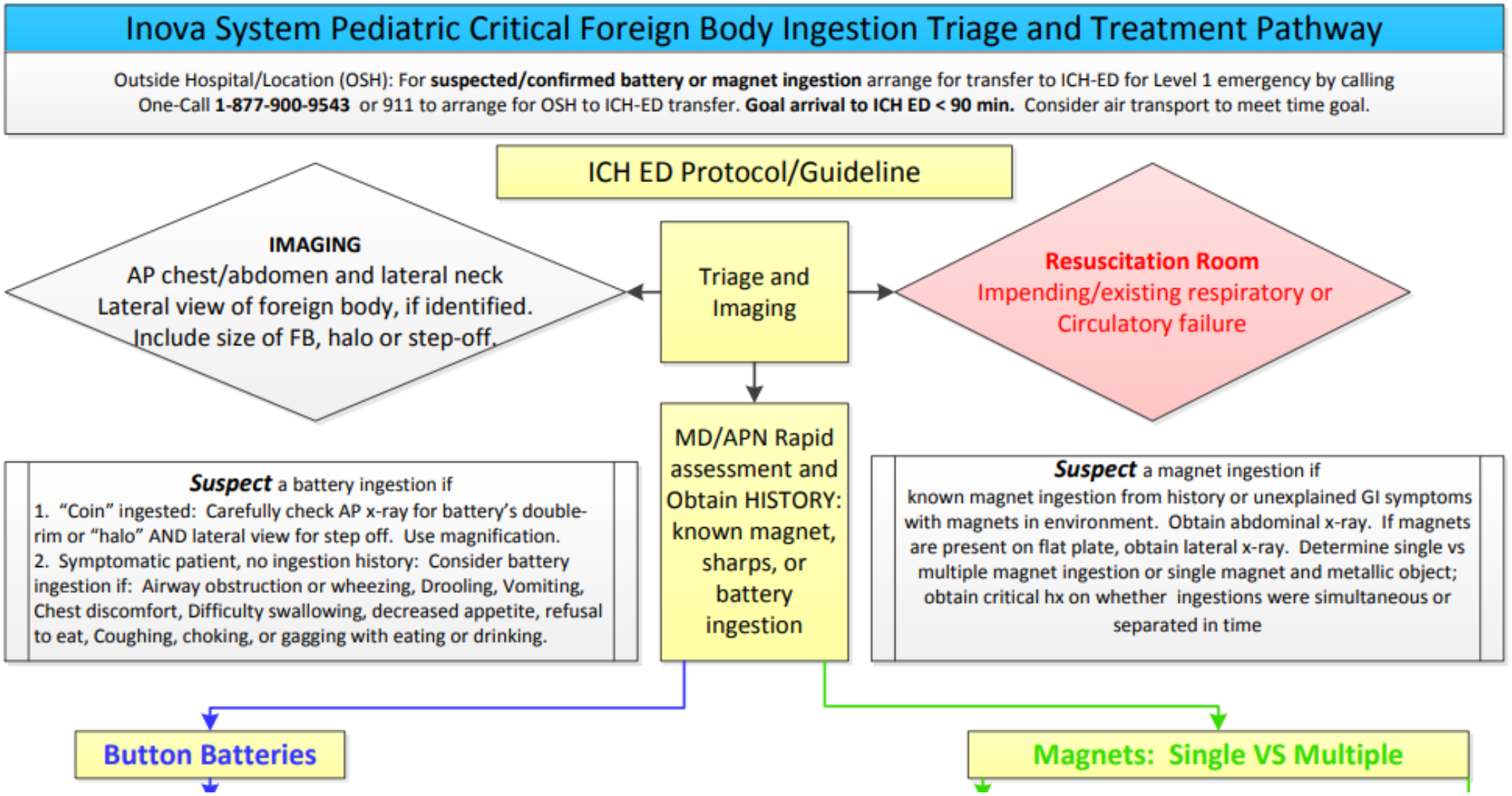

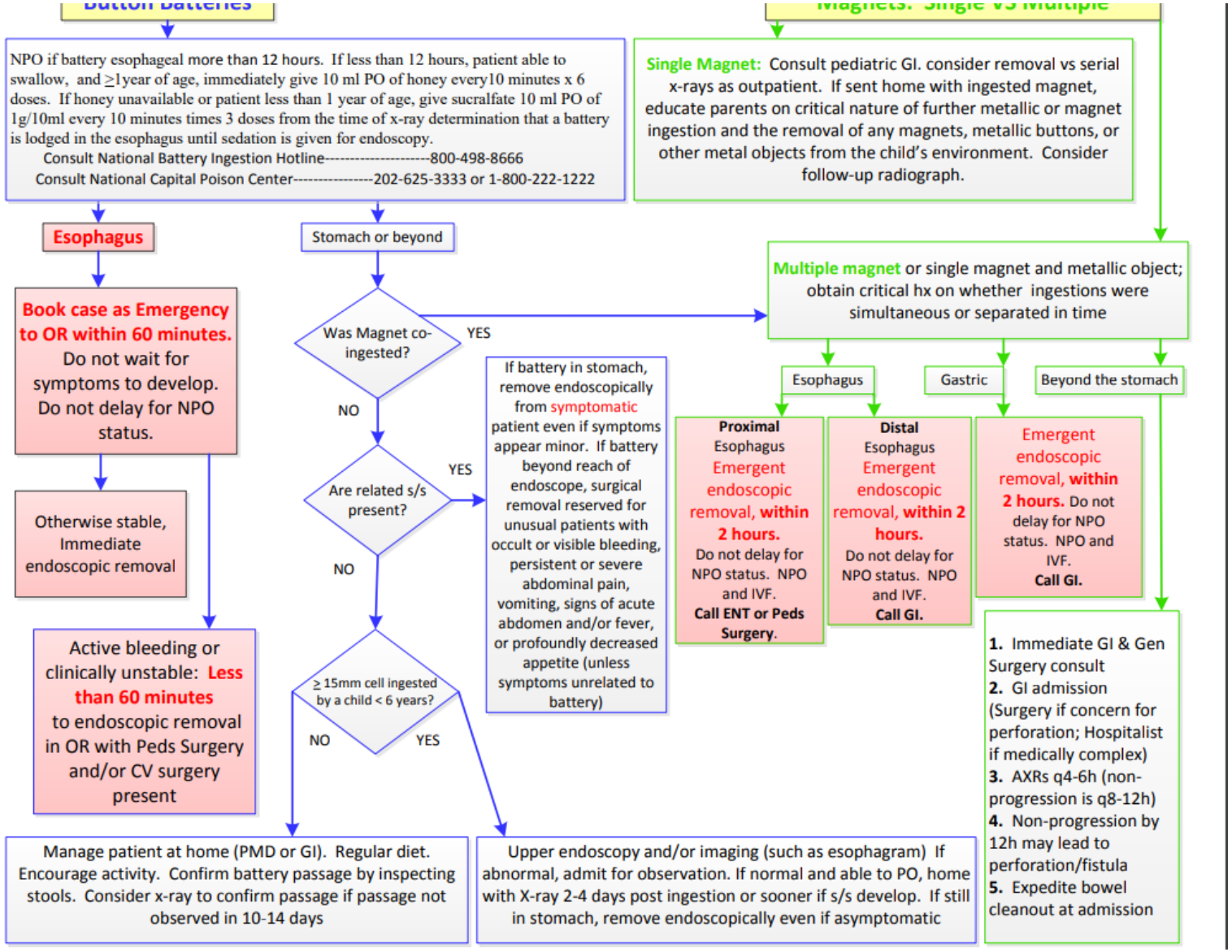

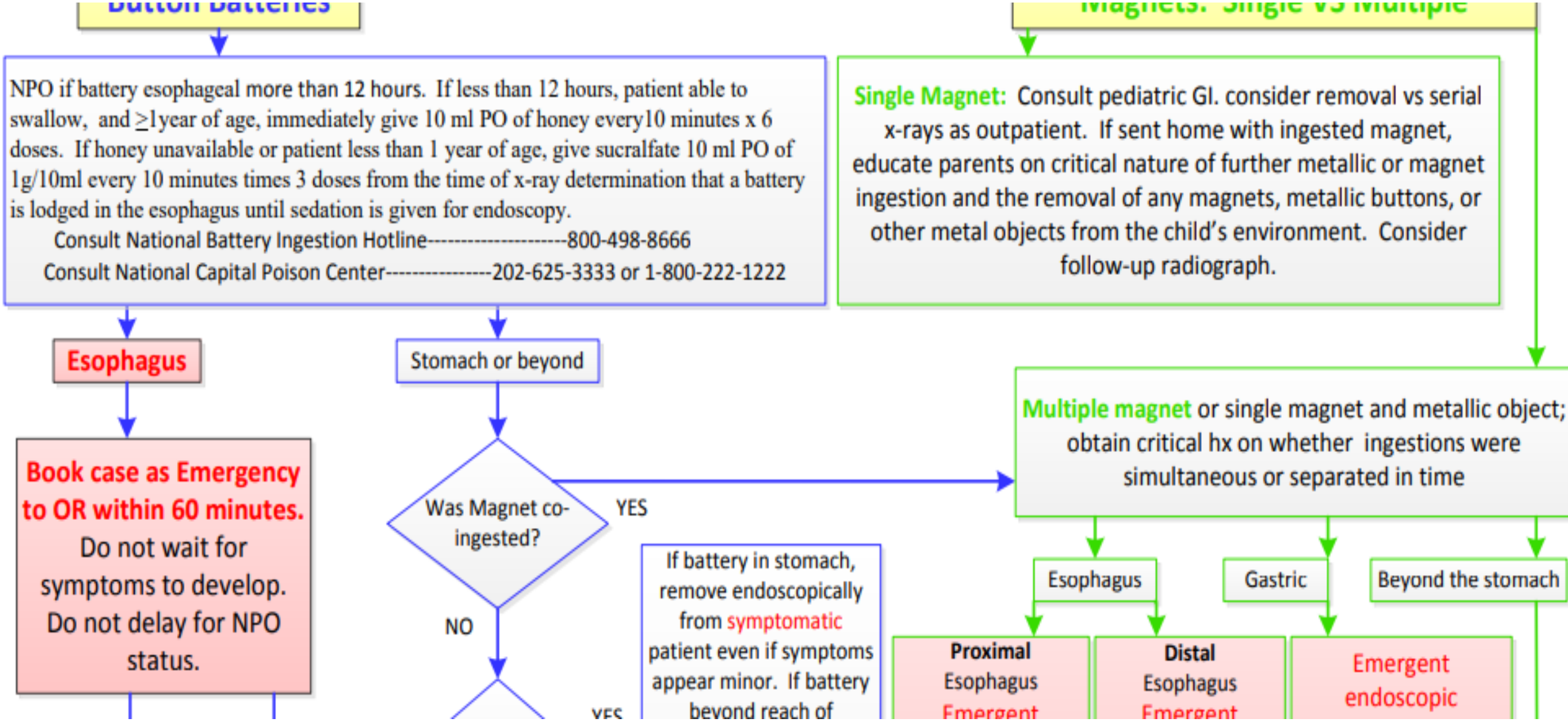

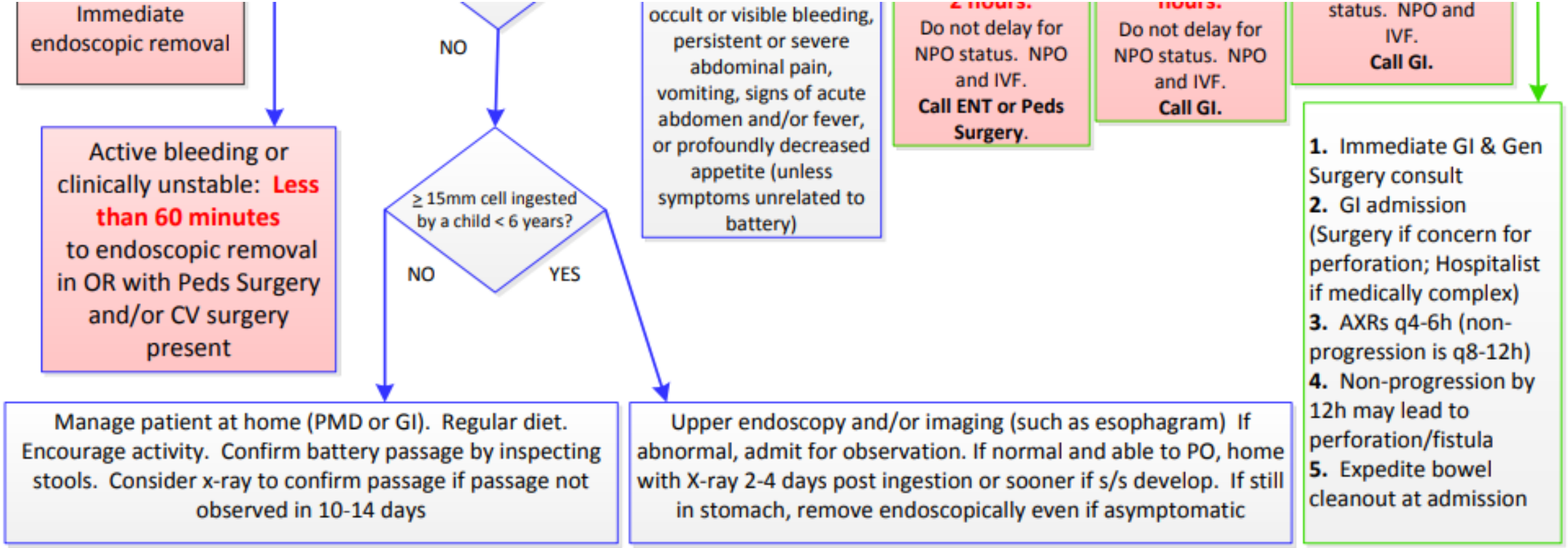

Critical Ingestions Pathway: Addendum

- Care of the patient with a critical ingestion is improved by excellent, highly reliable communication between all members of the health care team
- Care of the patient with a critical ingestion is anticipated to require multidisciplinary participation
- In cases where interventions from multiple specialties represent best practice, efforts should be made to accommodate those interventions under a single anesthetic where possible and where doing so does not result in any meaningful delay in care
- For esophageal button battery ingestions, removal of the battery by pediatric surgery or ENT with a rigid scope should be followed by flexible endoscopy by GI, with acetic acid wash and feeding tube placement. Wash with 50 to 150 ml of 0.25% sterile acetic acid. Acetic acid wash should not be used if evidence of perforation is present. The expeditious availability of acetic acid has been confirmed with hospital pharmacy

Critical Ingestions Pathway: Post-Procedural observation

- Chest film in PACU
- All patients should be admitted for observation.
- ICU admission should be considered on a case by case basis.
- Antibiotics should be considered post procedurally for all cases, but are required in cases of full thickness injury or concern for perforation. Mucosal injury is known to progress.
- Esophagram is recommended prior to feeding
- In cases where the foreign body has passed beyond the stomach and can no longer be retrieved by standard means:
  - Push enteroscopy may be available on a case-by-case basis and should be considered
  - Aggressive bowel cleanout with magnesium citrate or similar agent is preferred in the patient with a benign abdominal examination

Surgical Management

- These ingestions require overall management, and risk physiologic instability owing to anatomic cause
- Surgical management essentially falls into three stages:
- (1) Early surgical management may be involved in setting of acute perforation, mediastinitis, or need for gastric access
- (2) Surgery for delayed complications including tracheoesophageal fistula, aortoenteric fistula, esophageal stricture
- (3) Ultimately esophageal replacement required depending on degree of injury

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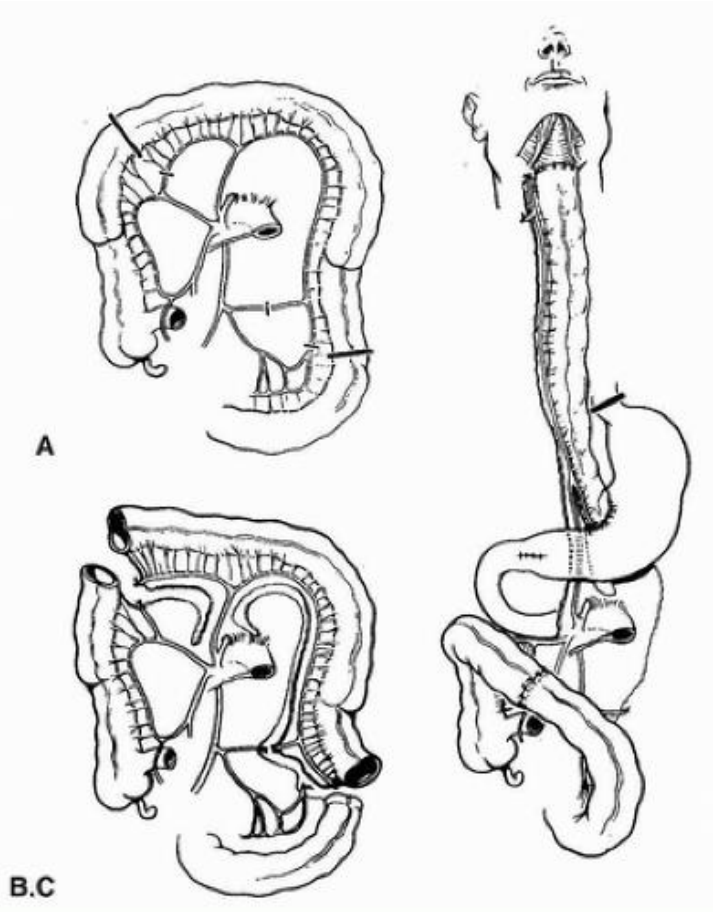
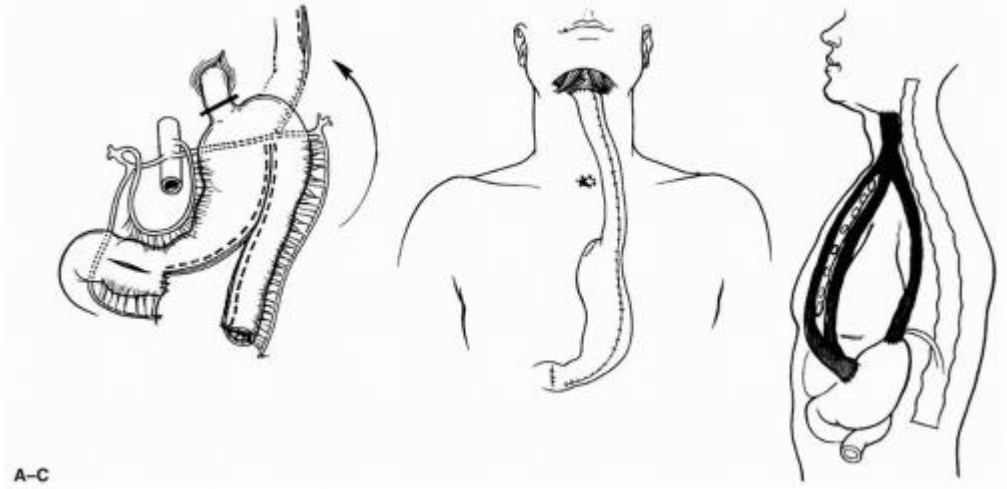
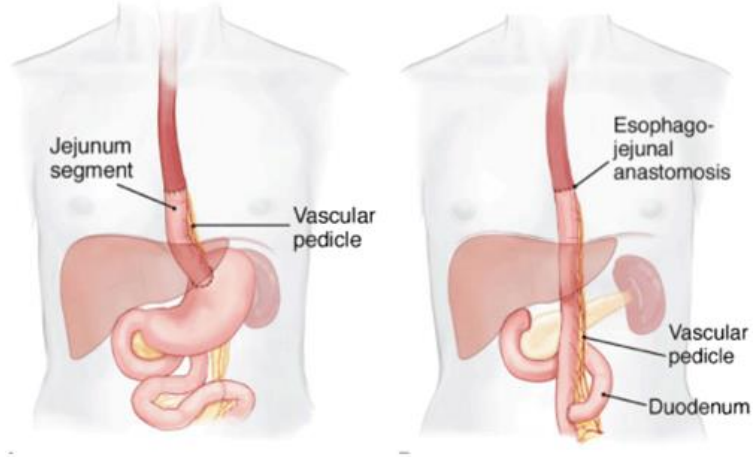
Esophageal Replacement







Method	Advantages	Disadvantages
Gastric transposition	Adequate length, easy to obtain	Loss of reservoir
	Excellent blood supply	Reflux common early on
	Single anastomosis	Poor gastric emptying
	Ease of procedure	Can affect pulmonary function
Gastric tube	Adequate length	Long suture line
	Good blood supply	High incidence of leaks
	Size of conduit appropriate	High incidence of strictures
	Rapid transit	Significant reflux and risk of Barrett's
Colon interposition	Adequate length	Precarious blood supply
		Graft necrosis
		High incidence of leaks
		High incidence of strictures
	Reflux seldom occurs	Involves three anastomoses
		Redundancy over long term
		Slow transit of food
Jejunal interposition	Appropriate size	Precarious blood supply
		Length can be a problem
		Involves three anastomoses
	Retention of peristaltic activity	Graft necrosis
		Microvascular anastomosis
		Prolonged operating room time

Gastric Transposition

- Gastric transposition is the most widely performed procedure
- Intrathoracic stomach most often functions as conduit rather than reservoir
- High incidence of restricted pulmonary function (99%) with 68% predicted FCV
- Leak rate can be 40% though often resolve without further procedure
- In setting of caustic injury, stricture rate can be as high as 50%
- Posterior mediastinal dissection can be performed without requiring thoracotomy

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Esophageal replacement

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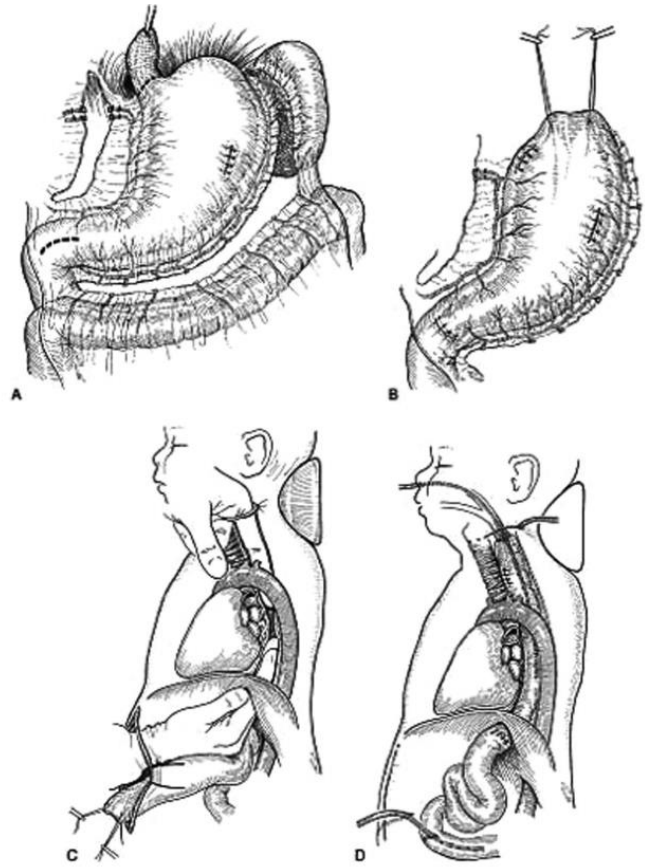

Gastric Tube

- Tubularized segment of stomach dependent on gastroepiploic pedicle
- Recent series of 50 patients with 10% mortality, 44% leak rate, and 36% stricture
- Strictures and leaks are common, in recent series no leaks at suture line
- Tube does not generally retain peristalsis and empties by gravity
- Section of antrum is brought close to pharynx, and hence acid reflux/nighttime cough can be quite high

Journal of Pediatric Surgery 52 (2017) 657–662

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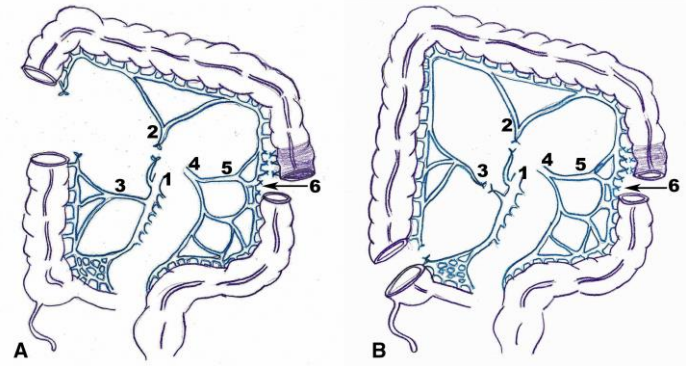
Operative Technique

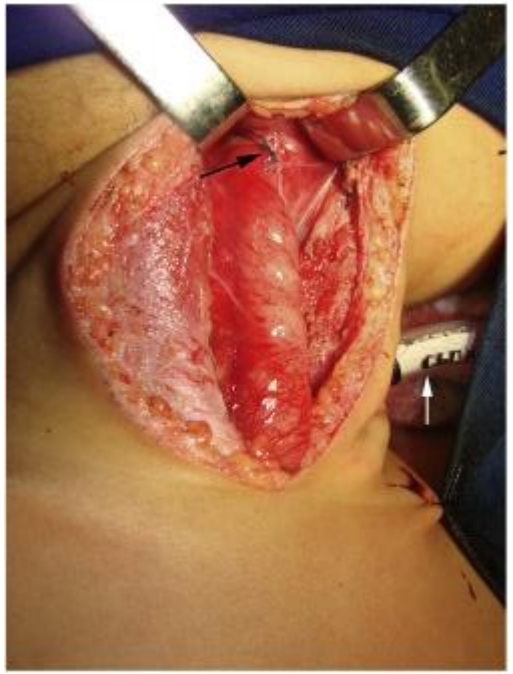
Gastric tube esophagoplasty for pediatric esophageal replacement

Mahmoud M.A. Elfiky *, Gamal El Tagy, Wissam Mohamed, Osama Abdel Azim, Mohamed A. Elfiky

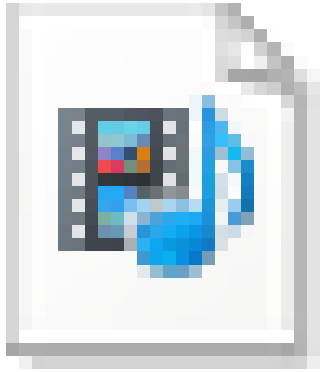
Colonic Interposition

- Technically less arduous than jejunal interposition
- Colon may be mobilized on vascular pedicle to reach high into neck (without free graft)
- Interposed colonic segment is usually aperistaltic
- Strictures common particularly in cervical region, usually respond to dilations
- One series of 32 patients noted abnormal lung function in 58%, feeding diificulties in 50%, nutritional deficiency in 25%
- With time, interposed colon can develop redundancy and worsening stasis





Jejunal Interposition



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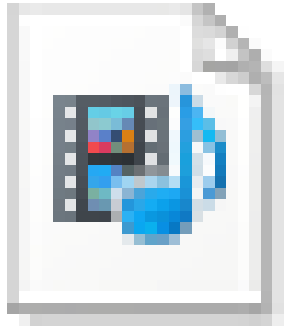

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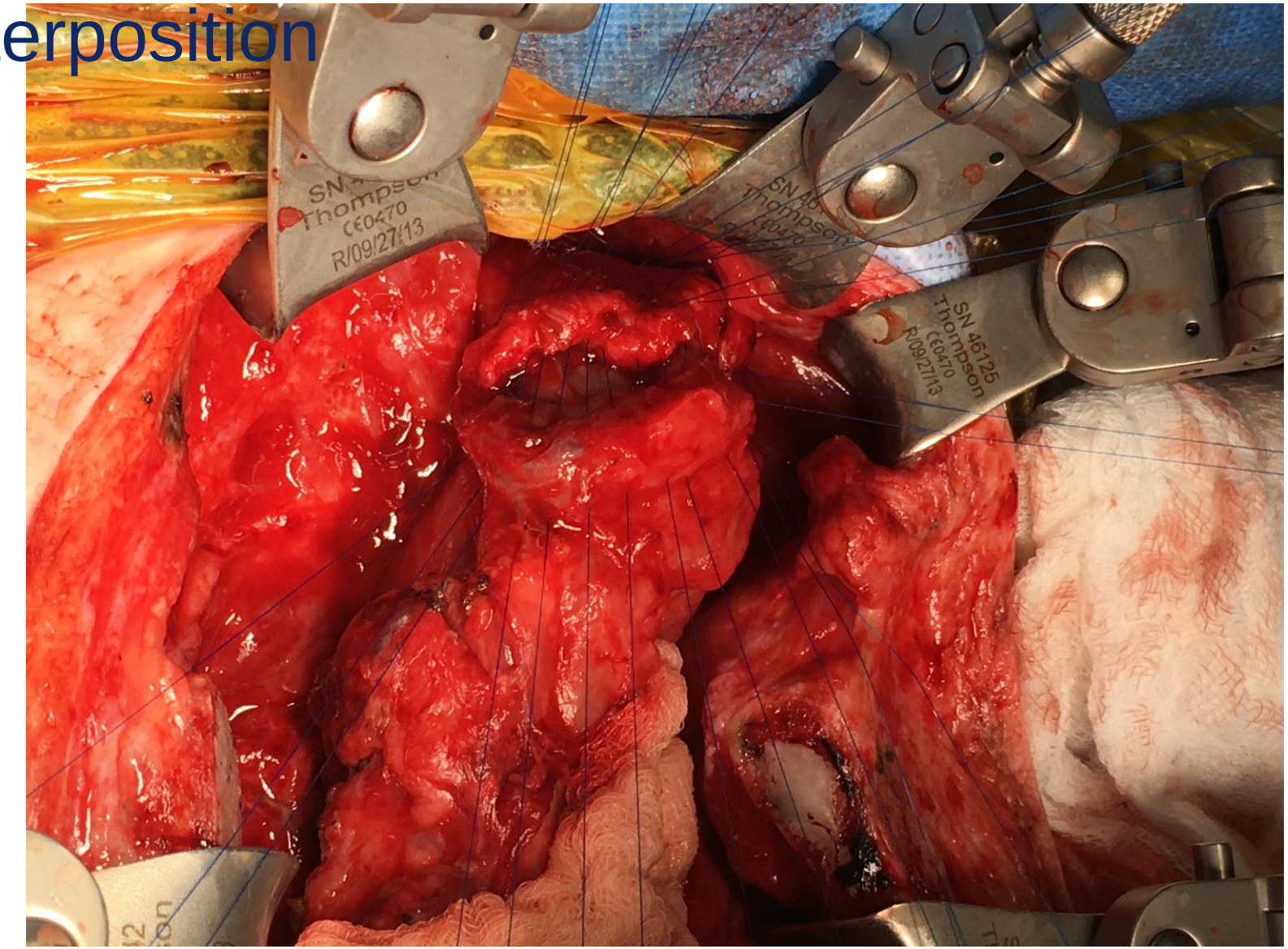
Jejunal Interposition



Summary

- Kids do the darndest things
- Every second counts
- Prehospital management is critical to mitigate injury
- Consequences of critical ingestions can be fatal or lead to lifelong consequences
- Your role is vital

Simply stated, the great efficacy of the Federal Caustic Poison Law derives from the obvious fact that no mother would put a can of poison in her kitchen now that she can just as easily get from the grocer a package of a harmless powerful grease-cutting solvent that is even more powerful than lye.

In submitting this report upon this piece of public health legislation your Committee wishes to call attention to the fact that its enactment was due to the initial foresight of the Section on Laryngology, Otology and Rhinology and to the powerful prestige of the American Medical Association. Your Committee encountered everywhere, prompt recognition of the fact that the Association's sole interest in this legislation was that of public health.

Though your Committee does not arrogate to itself any of the credit for driving household lye out of the kitchen and replacing it with harmless detergents more powerful grease-cutters than soap, your Committee does believe that there remains nothing for it to do to protect little children from the dangers of lye burns, and therefore it asks to be discharged.

Respectfully submitted,
(Signed) Chevalier Jackson, Chairman.

After the reading of the foregoing Report, the Committee on Lye Legislation was discharged with a vote of thanks.

CHEVALIER JACKSON, M.D.
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Philadelphia 3

Thank you!

Thank you

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