

A stylized sun graphic on the left side of the slide. It features a large, solid yellow circle representing the sun's disk, with several short, thick yellow dashes of varying lengths radiating from its top-left edge. The background is split: the top-left corner is orange, and the rest is white, separated by a large white curved shape that also frames the title.

# Anesthesia for Pediatric Surgical Emergencies

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# Objectives

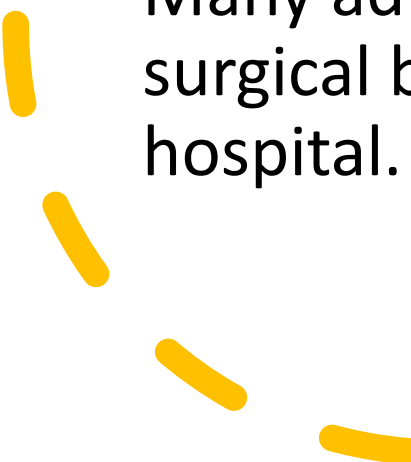
- To highlight the dangers and difficulties in providing pediatric care in a non-children's hospital.
  - To provide strategies for anticipating and managing pediatric anesthetic difficulties when there is minimal staff support and resource availability.
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# What is unique about pediatric anesthesia?

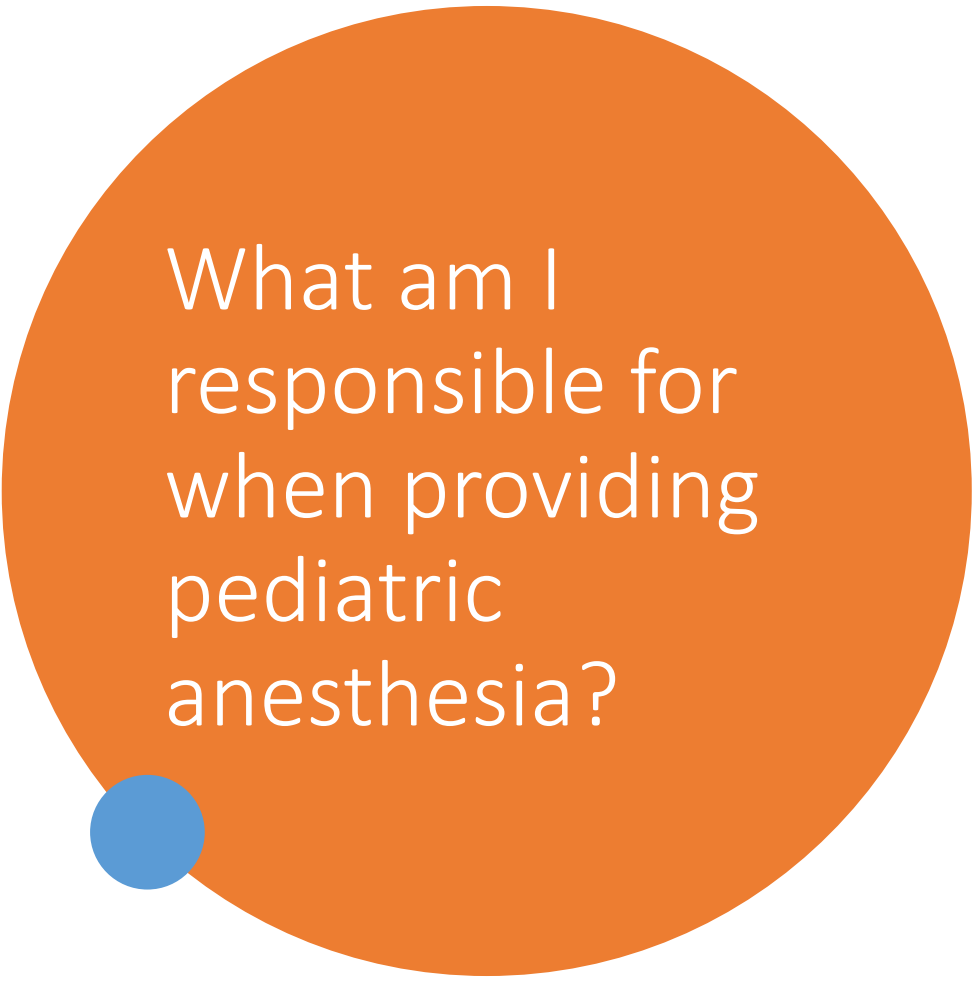
- There's not enough room in a half-hour talk to cover the nuances of pediatric anesthesia...
- Ultimately, you need to be cautious. You need to have constant vigilance.
- Children/infants/neonates are NOT mini-adults...but if it helps you mentally to do the case, then sure, think of them as mini-adults...
  - We all need blood pressure and flow to perfuse end-organs.
  - We all need oxygenation and ventilation.
- ...with some caveats in pediatrics:
  - There is very little room for error.
  - Their organ systems are immature.
  - Pediatrics has its own set of congenital abnormalities and syndromes.
  - There can be different physiology especially for neonates.



# When would I, a non-pediatric anesthesiologist, ever be asked to care for a pediatric patient?

- If you work in any hospital that has the following:
    - Emergency Room
    - Trauma Center
    - Labor and Delivery, +/- a Neonatal Intensive Care Unit, +/- in-house neonatologist
  - Many adult/general hospitals also perform pediatric cases. The surgical breadth, age range, and ASA class vary depending on the hospital.
- 



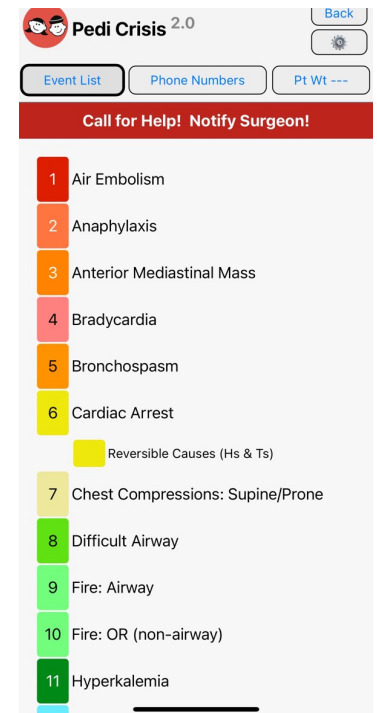
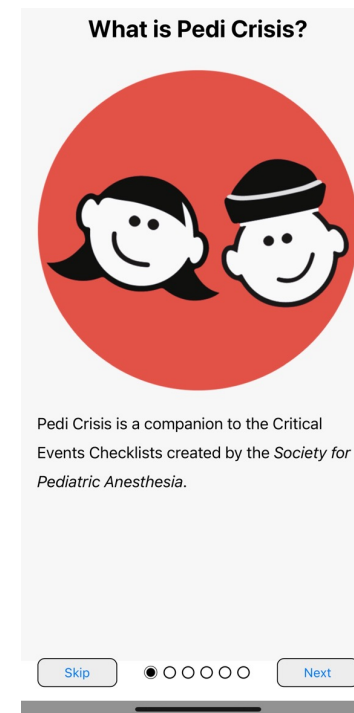
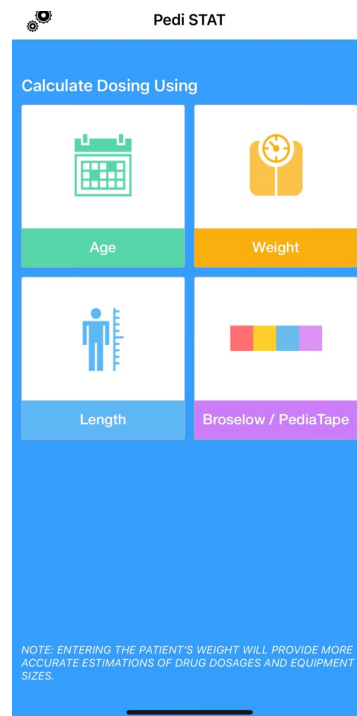
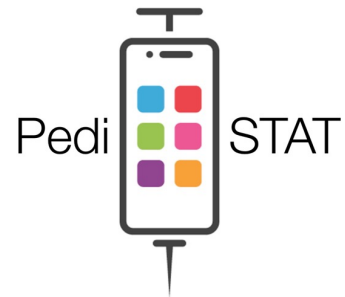


What am I  
responsible for  
when providing  
pediatric  
anesthesia?

- As the anesthesiologist, you are responsible for the pre-operative, intra-operative, and post-operative care of this child.
- It is possible that no one else knows how to anticipate or manage any potential complications.
- Regardless of the hospital setup or staffing, every child deserves a safe, high quality perioperative experience.

# How do I prepare my operating room for a pediatric case?

- Medications
  - Know your pediatric drug dosing – reference tables, smartphone applications.



# Airway Emergencies

# Examples of Airway Emergencies

- Foreign body – esophagus vs. trachea
- Bleeding – post-surgical, trauma
- Epiglottitis

# Airway Foreign Body

# How could a child aspirate/ingest a foreign body?

- ▶ Kids are sneaky.
- ▶ Kids are curious.
- ▶ Examples:
  - ▶ Food: peanuts, zucchini, grapes, tortilla chips.
  - ▶ Electronics: batteries, magnets.
  - ▶ Misc: beads, buttons, coins.
  - ▶ Sharp objects: safety pins, earrings.



What do you  
want to  
know pre-  
op?

Age and weight of patient?

Vital signs?

Current airway status?

Urgency: intubate in ED vs. OR?

Does ENT know?

Esophageal vs. airway foreign body?

Story/timeline?

IV access?

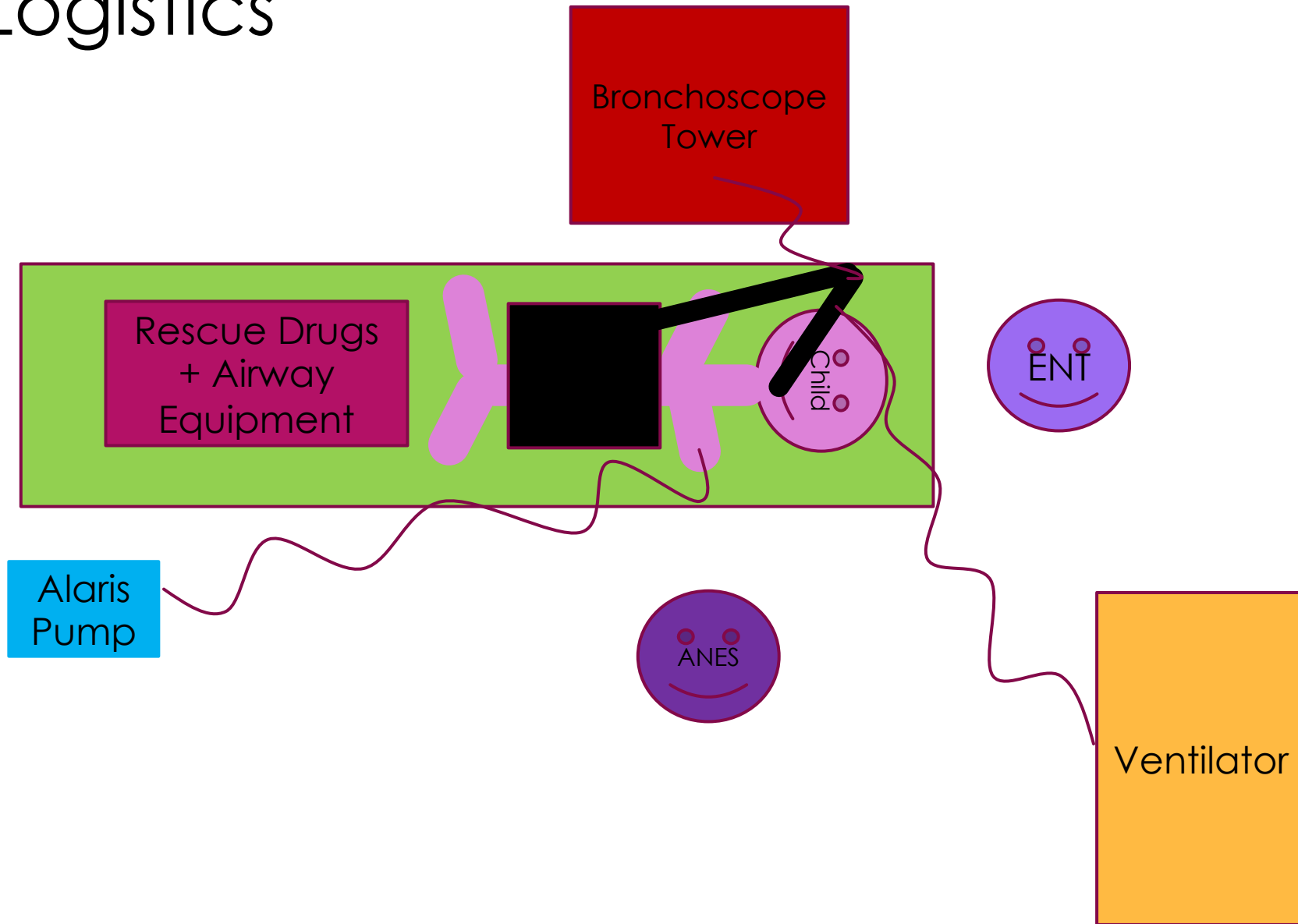
Imaging?

# Intraoperative Management

- General anesthetic
- Maintain spontaneous ventilation
  - Highly stimulating but not painful; short duration (hopefully)
  - Deep enough that avoid coughing/bucking, laryngospasm, bronchospasm, dislodgement of foreign body
  - No ETCO<sub>2</sub> available; visualize chest rise
  - O<sub>2</sub> sources: nasal cannula, ventilator circuit to side port of bronchoscope, ETT in oropharynx
- Drugs of choice
  - No volatile anesthetic
  - Propofol infusion (200-250 mcg/kg/min) + boluses in line
  - Dexmedetomidine boluses
  - Ketamine boluses
  - Spray vocal cords w/ lidocaine



# Logistics





Sounds simple, right?



# What could possibly go wrong?

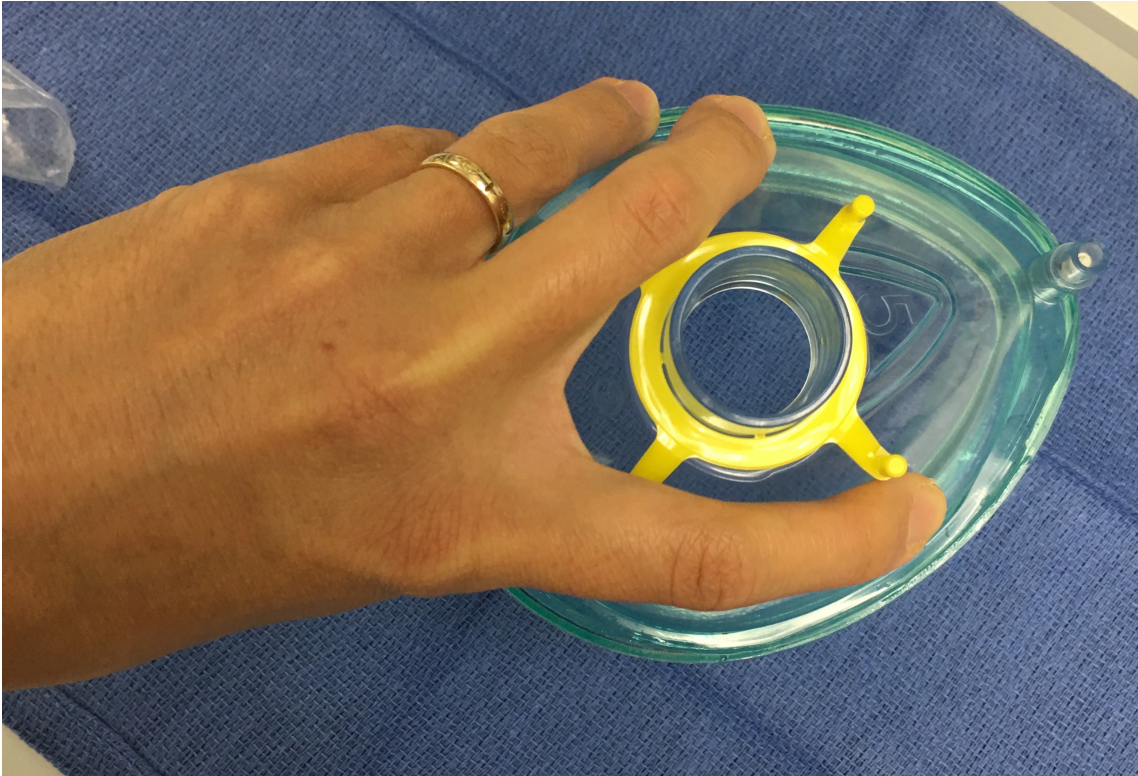
Problem	Solution
Coughing/bucking → laryngospasm, bronchospasm → desaturation	<p>Albuterol – how do you administer?</p> <p>EPINEPHRINE – how much do you give? 10 mcg/kg? 1 mcg/kg? 0.1 mcg/kg</p> <p>Succinylcholine – how much? how do you ventilate if you paralyze?</p> <p>Supplemental O2 – what route? Nasal cannula, side port bronchoscope, ETT, face mask</p>
Apnea	<p>Intubate – what happens to foreign body?</p> <p>Mask ventilate – full stomach; foreign body still in airway; table turned 90 degrees</p> <p>Jet ventilate – what pressures in kid?</p>

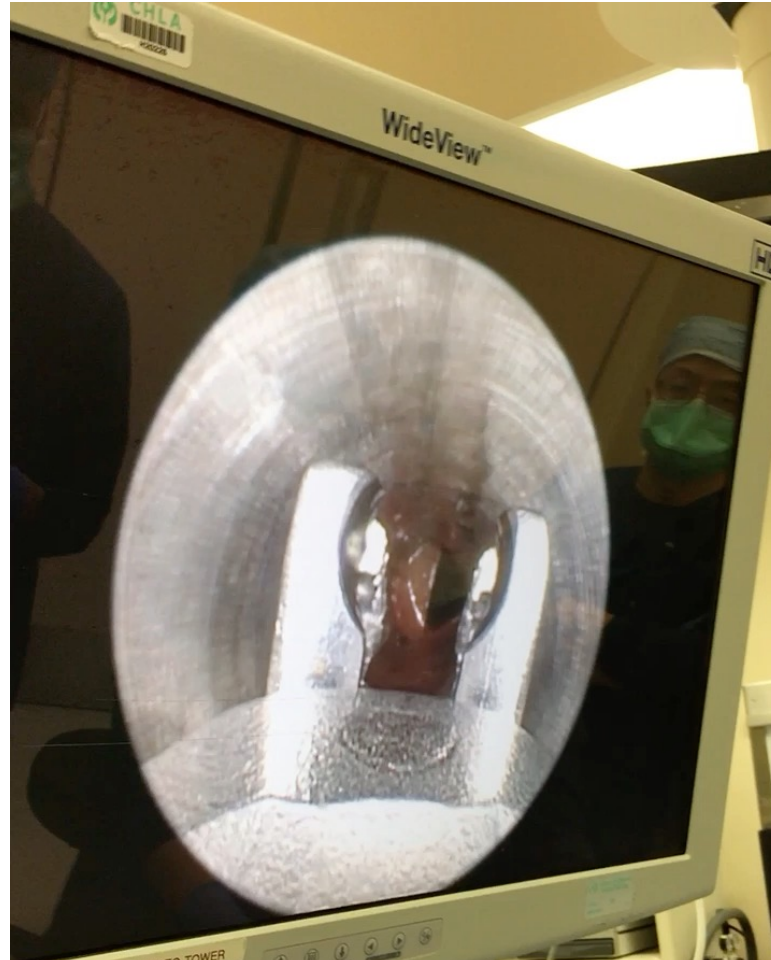
# What could possibly go wrong?

Problem	Solution
Foreign body / bodies difficult to remove	Pray?
Foreign body completely occludes trachea → no ventilation, no oxygenation	Tell ENT to R mainstem the foreign body
Failure to ventilate. Failure to oxygenate. → Cardiac arrest	PALS – chest compressions w/ table turned 90 degrees?



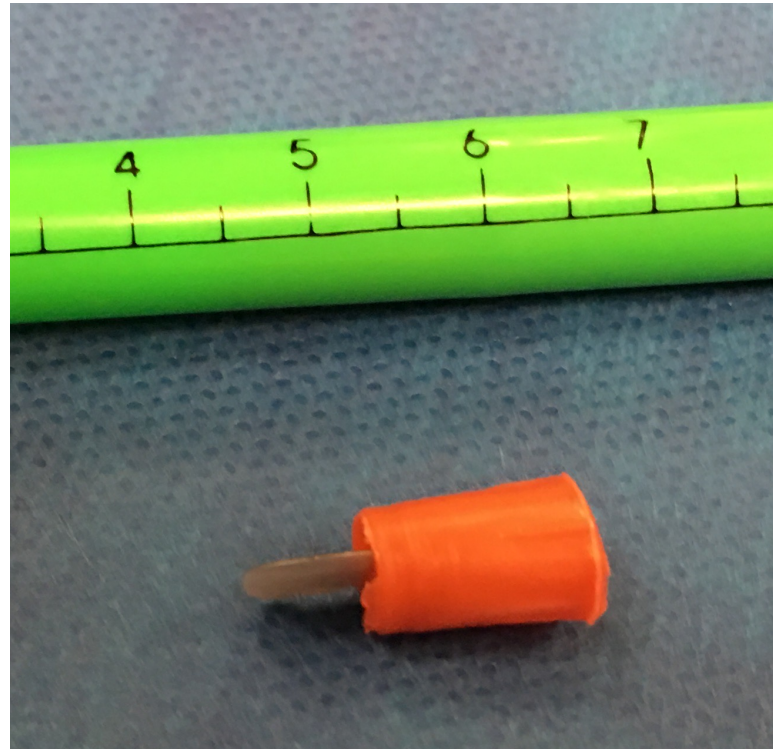
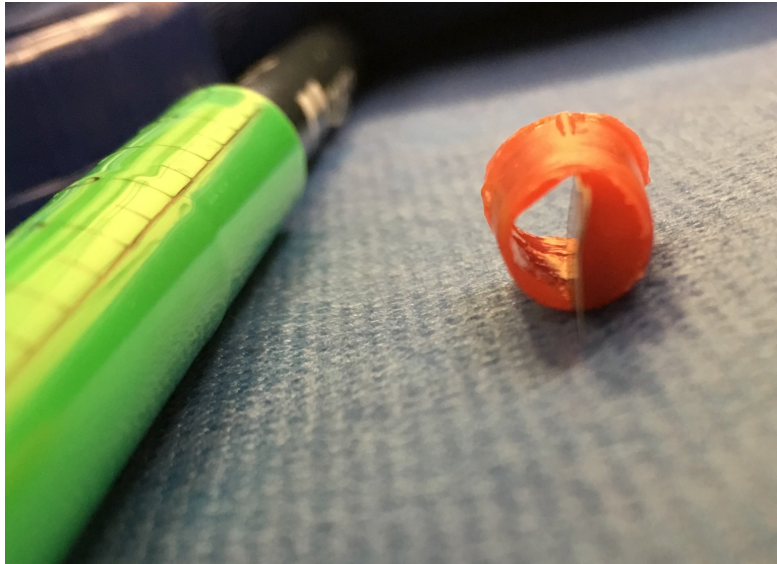
# Sideways mask ventilation





Easter  
Pancake  
Breakfast



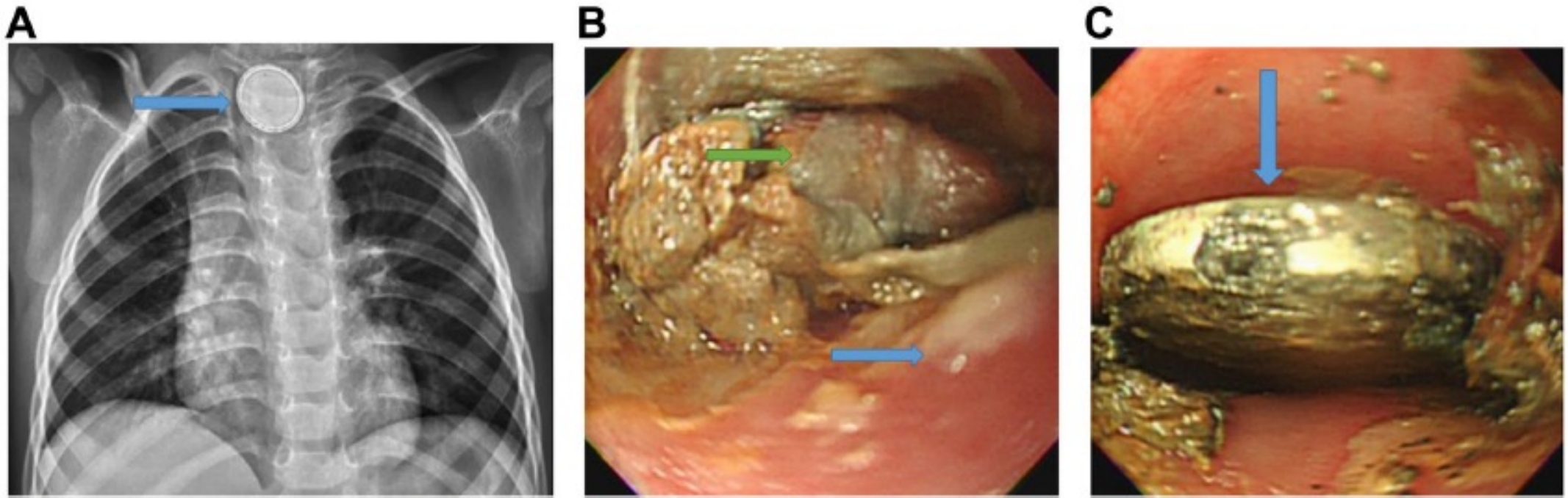


Whistle

# Esophageal Foreign Body



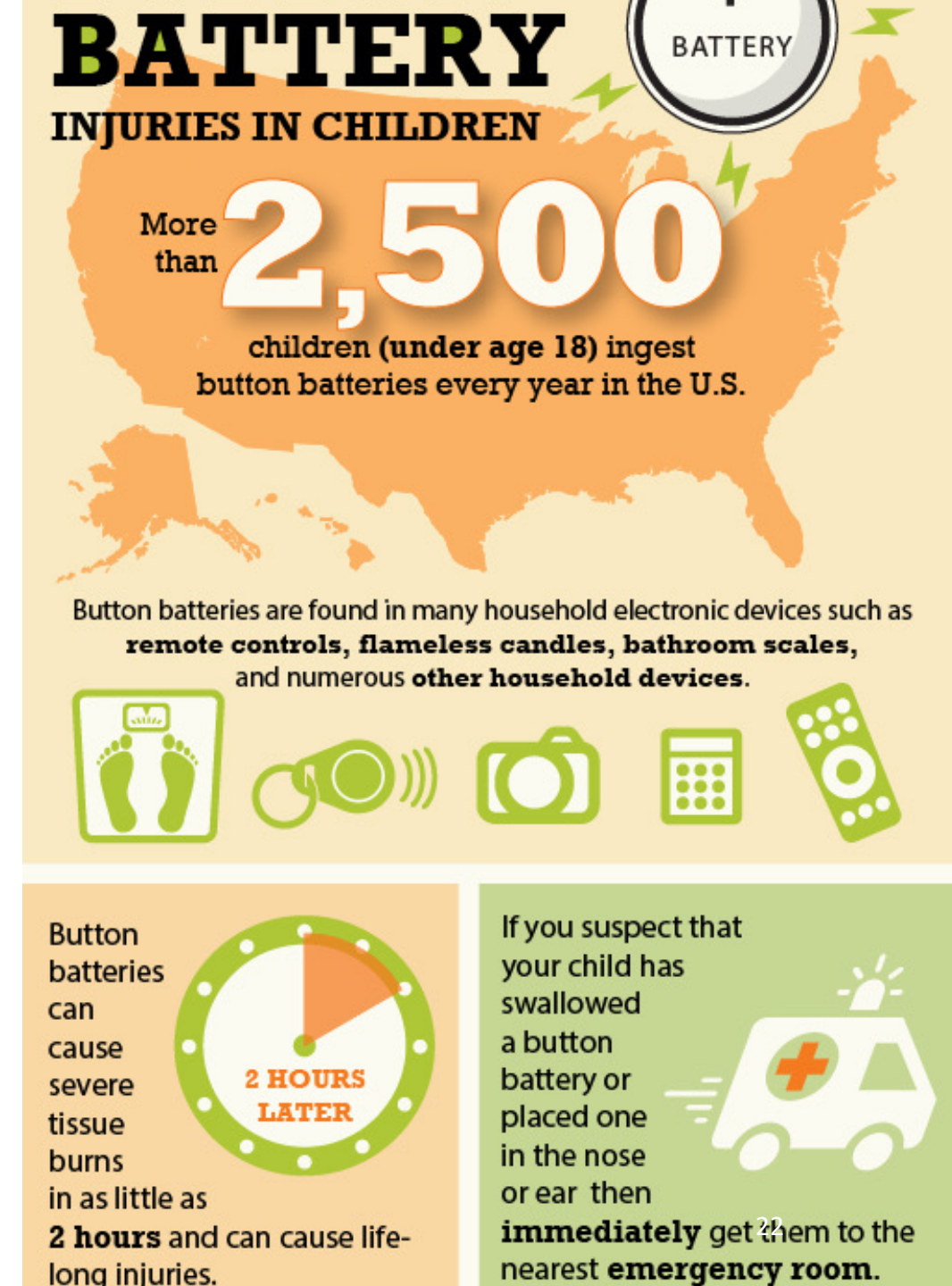
# Button Battery Specifics



**Fig. 1** **a** A 21-mm round, foreign body with double ring halo sign (arrow) in the upper esophagus. **b** A round foreign body (green arrow) is covered with a mixture of ingested food and necrotic tissue of the esophagus (blue arrow). **c** The round metal foreign body (arrow) is observed after removing the ingested food

# How dangerous is button battery ingestion?

- > 3,500 cases/year reported to U.S. poison control centers
- Incidence of serious injury/death quadrupled from 2006 to 2010
- Easily accessible
- Within hours: tissue injury, necrosis, perforation, nerve damage → TEF, VC paralysis, mediastinitis, death
- Symptoms: wheezing, drooling, abdominal/chest pain, coughing, gagging, choking





Routinely check and secure battery compartments, such as those that require a tool to access the battery. If the compartment is not secure, remove that product from a child's environment.



Store replacement batteries in a secured or locked container, out of the sight and reach of children.



If your child swallows a button battery, immediately call the 24-hour National Battery Ingestion Hotline at 800-498-8666. Head to the closest emergency room.



If your child is 1 year or older and may have swallowed a button battery in the last 12 hours, give 2 teaspoons of honey every 10 minutes (up to 6 doses) until your child can get to the emergency room. Do not let your child eat or drink anything else in the meantime. If not honey is not immediately available, do not delay getting to the closest emergency room to obtain it.

Nationwide Children's Hospital





**Saline**



**Honey**



**Carafate®**

Children's Hospital of Philadelphia

A. Mucosal surface of cadaveric piglet esophagus exposed to lithium button battery with serial irrigations of (A) saline, (B) honey, (C) carafate.

# Post-Tonsillectomy Bleeding

# What happens in a tonsillectomy?

## Indications

- Obstructive, sleep-disordered breathing
- Recurrent throat infections

## Tonsillectomy is traumatic

- Removes tonsils completely
- Relatively large wound w/ exposed muscle and blood vessels
- Edema of uvula, tonsillar pillars, and tongue

## Healing process

- Fibrin clot on tonsillar fossae w/in 24 hours
- By POD#5, fibrin clot proliferates
- By POD#7, mucosa at wound periphery grows inward. Clot separates from underlying tissue --> highest risk of secondary bleeding
- Wound healing takes ~ 2 weeks

# What is post-tonsillectomy hemorrhage?

## Variable definition

- Incidence: 0.28 to 20%

## High risk of bleeding

- Robust vascular supply (5 primary arteries)
- Complications: hemorrhagic shock, airway obstruction, death

## Primary hemorrhage

- Within 24 hours postop
- Most common cause of post-tonsillectomy mortality

## Secondary hemorrhage

- After 24 hours postop, most commonly POD #5-10
- Causes: sloughing of eschar, trauma 2/2 solid food ingestion, tonsil bed infection, postop NSAID use

# Classification of Pediatric Hemorrhagic Shock




System	Very Mild <15% TBV Loss	Mild 15-25% TBV Loss	Moderate 26-39% TBV Loss	Severe >40% TBV
Cardiovascular	HR nL or mildly increased Normal pulses Normal pH	Tachycardia Diminished peripheral pulses Normal pH	Significant tachycardia Thready peripheral pulses Metabolic acidosis	Severe tachycardia Thready central pulses Significant acidosis
Respiratory	RR nL	Tachypnea	Moderate tachypnea	Severe tachypnea
Neurologic	Slightly anxious	Irritable, confused Combative	Irritable or lethargic Diminished pain response	Lethargic Coma
Skin	Warm, pink Brisk capillary refill	Cool extremities, mottling Delayed capillary refill	Cool extremities, mottling, or pallor Prolonged capillary refill	Cold extremities, pallor, or cyanosis
Renal	Normal urine output	Oliguria, increased specific gravity	Oliguria, increased BUN	Anuria



# What do you need to know?

History	Physical
Tonsillectomy +/- adenoidectomy?	Vital signs?
POD #?	Appearance of bleeding? (frank blood, oozing, clot, eschar)
Intraoperative or postoperative complications?	Respiratory status?
Prior bleeding?	Mental status?
Indications for T&A?	IV access?
Presentation of bleeding at home? (degree of blood loss, signs of hypotension)	Recent CBC?

# Anesthetic Concerns

Category	Challenge	Management
Airway	High aspiration risk	 Ideally, awake PIV for true RSI – succinylcholine 2 mg/kg IV or rocuronium 1.2 mg/kg IV
	Full stomach	
	Severity of bleeding → obscuring airway visualization	 Difficult airway equipment available. Prefer direct laryngoscopy to video laryngoscopy (C-Mac, Glidescope, etc.). Good working suctions x 2. ENT standby.
	Oropharyngeal swelling, obesity → difficult mask ventilation	 Awake extubation

# Anesthetic Concerns

Category	Challenge	Management
Breathing	<p>Obstructive sleep apnea which may not have resolved</p> <p>Higher sensitivity to opioids</p> <p>Dispo planning: re-bleed, risk of obstructed breathing postop</p>	<p>✓ Non-opioid analgesics: dexmedetomidine; acetaminophen</p> <p>✓ Caution w/ narcotics</p>
Circulation	<p>Difficult to quantify EBL preop: limited history, uncooperative child</p> <p>Children can mask symptoms of shock</p>	<p>✓ Awake PIV. Fluid resuscitation preop: &gt;20 cc/kg bolus crystalloid.</p> <p>✓ Type &amp; Cross PRBC PRN.</p>

# Epiglottitis

# How common is epiglottitis?

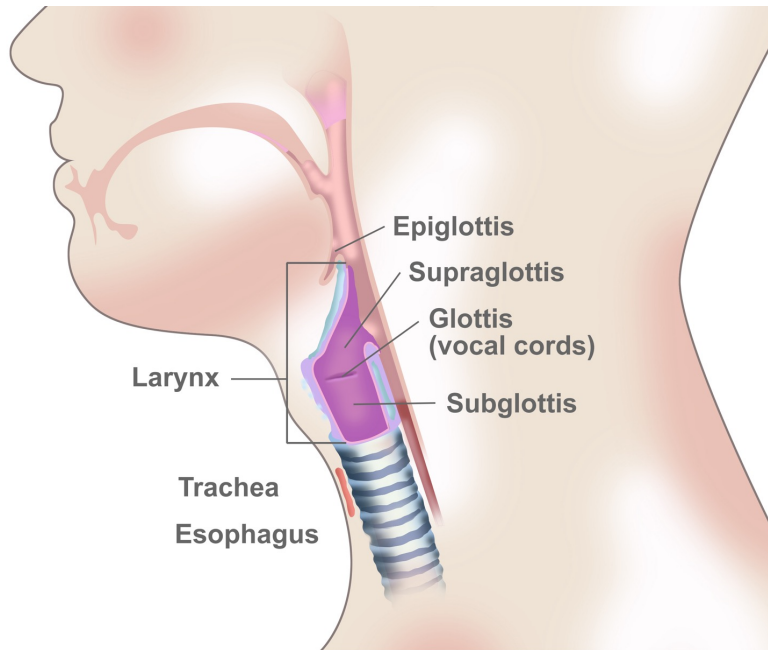
## Demographics

- Previously stereotype kids 3-5 years old
- Now more common in adults (3.1 per 100,000 adults) than children (<1 case per 100,000 children)

## Etiology

- Group A beta-hemolytic Streptococci now more common than Haemophilus influenza type B
- Noninfectious causes: trauma from foreign objects, inhalation, chemical burns, chemotherapy

# Epiglottitis Clinical Presentation



[www.ArizonaOncology.com](http://www.ArizonaOncology.com)

Adults	Children
Underlying medical conditions	Healthy prior to symptom onset
Might not show signs of airway obstruction	Disease confined to epiglottitis and aryepiglottic folds
Supraglottitis – inflammation mostly affecting structures surrounding supraglottis including pharynx, uvula, base of tongue, aryepiglottic folds, and false vocal cords	Stridor, difficulty breathing
Common pathogens: Streptococcus pneumoniae, Staphylococcus aureus, and Klebsiella pneumoniae	Haemophilus influenzae type b
	“Cherry-red” appearance of epiglottitis
	High risk of airway closure

What do  
they look  
like on  
exam?

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Generalized toxemia, high fevers, severe  
sore throat, difficulty swallowing

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Inspiratory stridor

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Tripod: sitting up, leaning forward in sniffing  
position, open mouth, protruding tongue

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Often drooling b/c difficult and painful to  
swallow

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Inability to lie flat, voice changes (muffled  
voice), dysphagia

# How do you approach a kid with epiglottitis?

Do not make them upset!

X-ray of neck soft tissue  
only if an experienced  
physician stays with the  
child

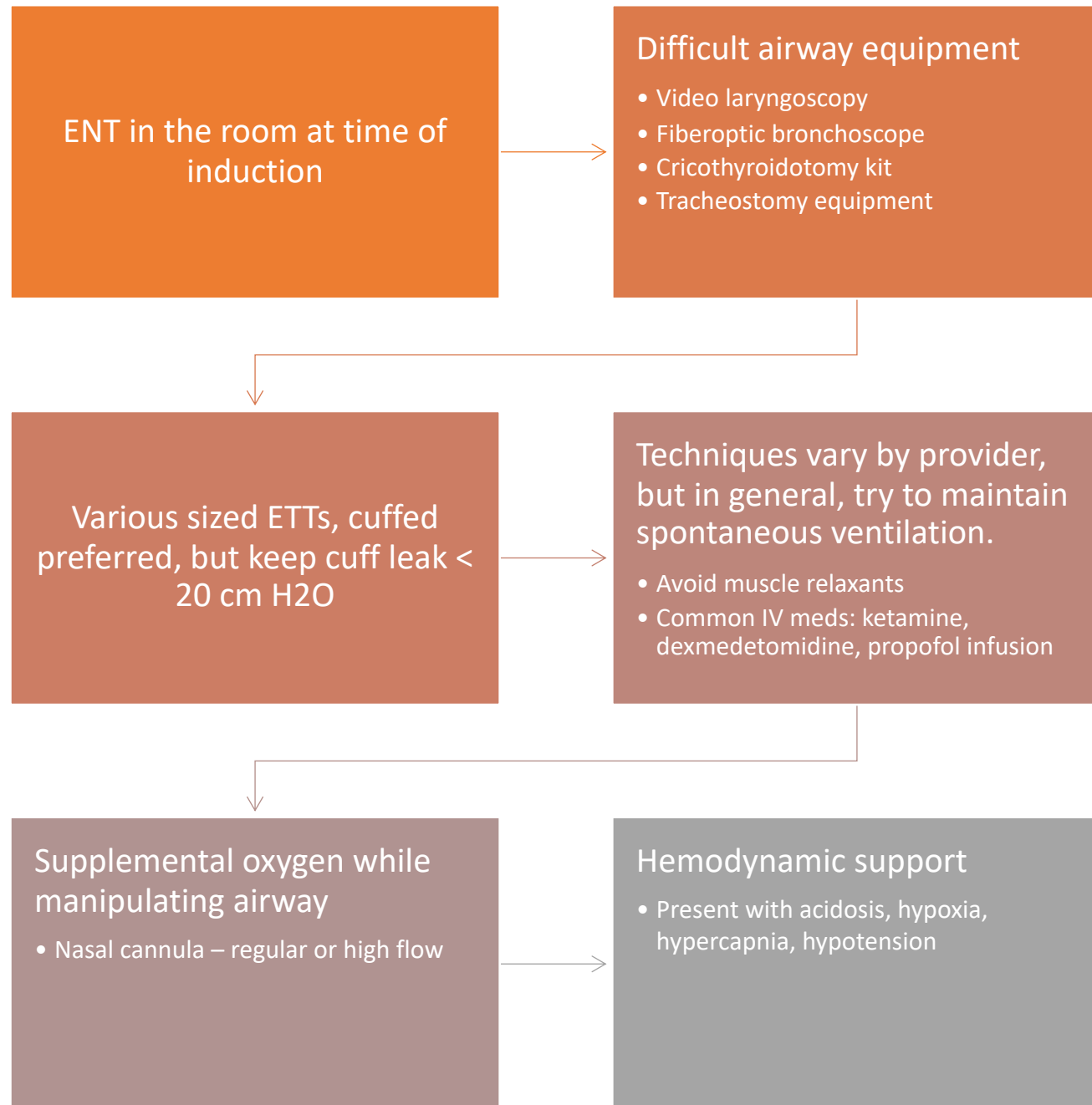
If suspected in ED, place  
patient in sitting position  
and may consider obtaining  
IV access – optimize setup,  
best first attempt

Safety first: depends on skill  
and judgment of the  
provider

If unable to obtain IV  
smoothly, perform  
inhalation induction w/  
child sitting upright in  
parent's lap



# Management of a dangerous airway



# Abdominal and Genito- Urinary Emergencies

# Examples of Abdominal, Urologic, and Gynecologic Emergencies

- Acute appendicitis
- Bowel obstruction
- Perforated bowel
- Incarcerated hernia
- Intestinal malrotation
- Intussusception
- Infantile hypertrophic pyloric stenosis
- Ovarian torsion
- Scrotal torsion

# Anesthetic Management

- Same as adults.
- Rapid sequence induction and awake extubation if concern for full stomach / high aspiration risk.
- RSI doses of muscle relaxants:
  - Rocuronium 1.2 mg/kg.
  - Succinylcholine 1-2 mg/kg.
    - Black box warning primarily for ages < 8 yo, higher risk for M > F, due to concern for undiagnosed neuromuscular disorder → unclear risk of rhabdomyolysis or malignant hyperthermia susceptibility.
    - Ok to use cautiously for true RSI.
- Adequate volume resuscitation.
  - Good starting point: crystalloid bolus 20-40 cc/kg and additional as needed.
  - Insensible losses: large exposure like exploratory laparotomy loses >8-10 cc/kg/hr.

# What if the patient vomits during induction?

Adult	Infant
Head of bed down	Turn on side – RLD, LLD
Suction oropharynx well	Suction oropharynx well
Intubate as fast as possible	Intubate as fast as possible
PEEP	PEEP
Consider FOB – survey, saline irrigation	
Consider CXR	
Consider severity of possible aspiration – extubate-able?	

# Traumas



# Examples of Trauma Emergencies

- Accidental vs. Non-Accidental
- Burns – stove, housefire, electrical
- Mechanical – car accident, playground, falls





# Pre-Operative Preparation

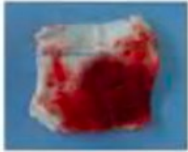





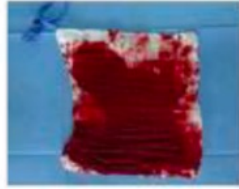


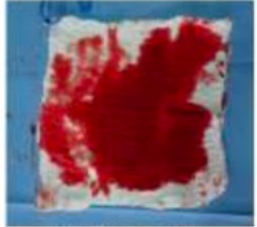
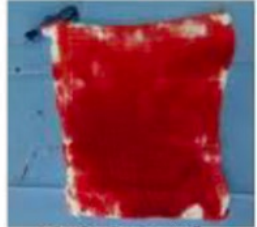

## Estimated Blood Volume

Age	EBV (cc/kg)
Preterm Neonate	100
Full-term Neonate	90
Infant	80
Child	75
Teenager	70
Adult	70

## Estimating Blood Loss

- 1 wet lap = 100 cc
- Suction canister volume minus irrigant volume (ask circulator RN)
- Back-calculate EBL by change in Hb/Hct
- $MABL = [ (\text{Starting Hct} - \text{Lowest Hct}) / \text{Starting Hct} ] \times \text{Estimated Blood Volume}$

# Visual guide for determining blood loss for 3 different sizes of gauze

		Percentage of Saturation			
		25%	50%	50%	100%
Gauze Size	10×10 cm	 <p>3 mL</p>	 <p>6 mL</p>	 <p>6 mL</p>	 <p>12 mL</p>
	30×30 cm	 <p>25 mL</p>	 <p>50 mL</p>	 <p>75 mL</p>	 <p>100 mL</p>
	45×45 cm	 <p>40 mL</p>	 <p>80 mL</p>	 <p>120 mL</p>	 <p>160 mL</p>

# How to Transfuse a Child

Blood Product	Special Preparation	When to Give	How Much to Give	Expected Change
PRBCs	Fresh: < 7 days old Washed if patient < 1 year old or < 10 kg	Hb < 8 Hct < 25 Clinically indicated	10-15 cc/kg	Increase Hb 2-3 / Hct 6-9
FFP		½ x blood volume has been replaced w/ PRBCs Excessive oozing w/o known cause	10-15 cc/kg	Increase factors 15-20%
Platelets		EBL > 1-2 x blood volumes Platelet count <100K w/ further blood loss anticipated	5-10 cc/kg	Increases platelet count 50-100K

# How to Transfuse a Child

Blood Product	Special Preparation	When to Give	How Much to Give	Expected Change
Cryoprecipitate		Extensive blood loss replaced w/ PRBC and FFP Clinical/laboratory evidence of coagulopathy Hypofibrinogenemia	5-10 cc/kg	Increase fibrinogen 60-100 mg/dL
Whole blood	< 7 days old		Replace blood loss “cc per cc”	
Reconstituted blood	Mix donor-matched PRBCs and FFP Irradiated Washed if > 7 days old		Replace blood loss “cc per cc”	
Crystalloid	NS, LR, Plasmalyte		20 cc/kg	
Colloid	5% albumin		10 cc/kg	

# Summary

- Be cautious. Be vigilant. Know your resources. Prepare as much as you can.
- Children/infants/neonates are NOT mini-adults, but they do have the same basic requirements:
  - Blood pressure and blood flow to perfuse end-organs.
  - Adequate oxygenation and ventilation.
- Some extra challenges:
  - Very little room for error.
  - Immature organ systems.
  - Potential congenital abnormalities and syndromes.
  - Potentially different physiology especially for neonates.
- Questions/comments: [cssoria@health.ucsd.edu](mailto:cssoria@health.ucsd.edu)