

Case Presentations:  
Pediatric Anesthesia Emergencies,  
Your Questions Answered.

Megan Brockel MD  
Raj Singhal MD  
Rich Ing MBBCh FCA(SA)

No disclosures



Dr. Megan Brockel

Describe recent updates in the anesthetic management for tonsillectomy (30 mins)



On a busy day in an ENT room, you are scheduled for many cases of ear tubes and adenotonsillectomies. Your first patient for adenotonsillectomy is a five-year-old girl.

- ▶ PMH
  - ▶ Obesity
  - ▶ Obstructive Sleep Apnea



Society for Pediatric Anesthesia

Section Editor: Peter J. Davis

**CME** **Death or Neurologic Injury after Tonsillectomy in Children with a Focus on Obstructive Sleep Apnea: Houston, We Have a Problem!**

Charles J. Coté, MD,\* Karen L. Posner, PhD,† and Karen B. Domino, MD, MPH†



Death or Neurologic Injury After Tonsillectomy

- ▶ 111 cases 1990-2010, more than half occurred in 2004 or later
- ▶ 57% of children met criteria for “at risk for OSA”
  - ▶ Predisposing physical characteristics
  - ▶ Airway obstruction during sleep
  - ▶ Somnolence
- ▶ Death was the most common outcome (73/111, 66%)
  - ▶ Permanent neurologic injury (13/111, 11%)

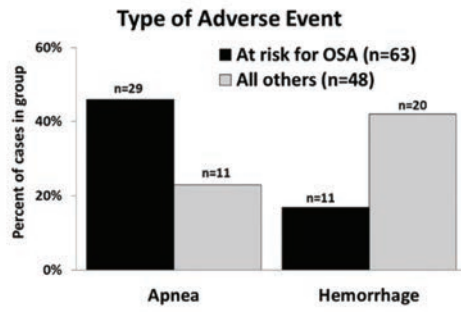


“One 5-year-old child in a first-stage PACU who received morphine and midazolam to treat emergence agitation was left in his father’s arms without monitors and the father thought his child was sleeping. The second death was a 3-year-old in a second-stage PACU without monitoring. The mother was reclining in the same stretcher as her child, and this parent also thought her child was sleeping. One child with known OSA was admitted overnight and discharged the following morning but was found dead approximately 48 hours after surgery.”

**Table 4. Sample Cases Describing Surgical and Anesthesia Adverse Events**

Case	Narrative
Anesthesia event	3 year old was extubated, there was no blood pressure or oxygen saturation on arrival in PACU; the child died.
Anesthesia event	After extubation, a 3 year old developed laryngospasm, postobstructive pulmonary edema, required ECMO and died.
Possible rapid codeine metabolizer	A 9 year old was discharged after overnight observation and found dead that night, high morphine levels found; possible rapid codeine metabolizer.
Anesthesia event	A 4 year old developed apnea in PACU, was given multiple doses of naloxone, and discharged on codeine. Apnea spells occurred at home but the parents decided not to go to the hospital and he was found dead the next morning.
Surgical/anesthesia event	A 5 year old suffered cardiac arrest in the operating room due to kinking of tracheal tube by Dingman retractor; permanent neurologic injury resulted.
Nursing event	A 6 year old developed apnea and respiratory arrest 10 h after surgery on the ward with death as the outcome.
Anesthesia event	A morbidly obese 15-year-old 250-kg teenager arrested on induction of anesthesia; death.
Anesthesia/surgical event	An obese 2-year-old child with a positive OSA history was found dead at home 2 h after discharge. The child left with the grandmother's boyfriend while the mother and grandmother went shopping.
Anesthesia/surgical event	An 8-year-old obese child with a positive history for OSA spent the first night in the pediatric intensive care unit, was discharged home the next morning, and found dead that night.

PACU = postanesthesia care unit; ECMO = extracorporeal circulation membrane oxygenation; OSA = obstructive sleep apnea.



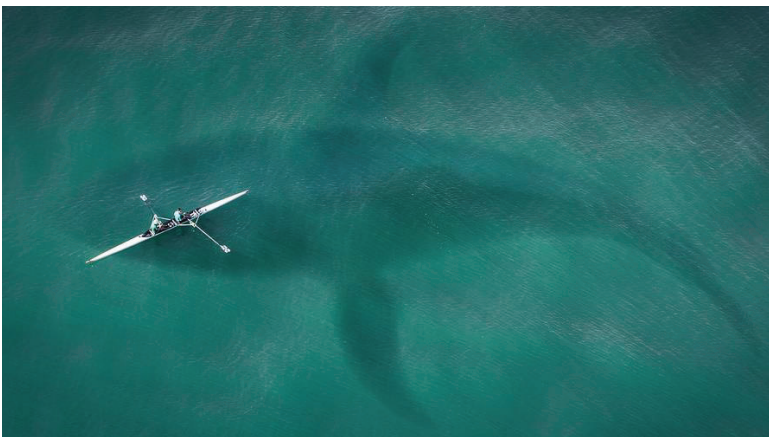
**Recurrent Hypoxemia in Young Children with Obstructive Sleep Apnea Is Associated with Reduced Opioid Requirement for Analgesia**

Karen A. Brown, M.D.,\* André Laferrière, B.A.,† Immanuela Ravé Moss, M.D., Ph.D.‡

**Recurrent Hypoxemia in Children Is Associated with Increased Analgesic Sensitivity to Opiates**

Karen A. Brown, M.D.,\* André Laferrière, B.A.,† Indrani Lakheeram, M.D.,‡ Immanuela Ravé Moss, M.D., Ph.D.§

**FDA restricts use of prescription codeine pain and cough medicines and tramadol pain medicines in children; recommends against use in breastfeeding women**



**Obstructive Sleep Apnea (OSA)**

- ▶ Most severe end of the spectrum of sleep disordered breathing
- ▶ Intermittent interruption of airflow during sleep
- ▶ May be partial or complete
- ▶ Usually accompanied by episodes of snoring, desaturation, hypercapnia, and arousals



Isalah A, Pereira KD. Outcomes after adenotonsillectomy using a fixed anesthesia protocol in children with obstructive sleep apnea. International Journal of Pediatric Otorhinolaryngology 2015;79:638-643.

## Childhood OSA

- ▶ OSA can potentially impact all aspects of childhood development
  - ▶ Neurobehavioral dysfunction
  - ▶ Failure to thrive
  - ▶ Cardiovascular sequelae
    - ▶ Systemic hypertension
    - ▶ Right and left ventricular dysfunction
    - ▶ Cor pulmonale

Oguh SJ, Elden L, Swanson J, Tapia I, Subramanyam R. New treatments for obstructive sleep apnea in children. *Pediatric Anesthesia* 2020;30:232-240.

## Childhood OSA

- ▶ Well-known risk factor for adverse perioperative outcomes
- ▶ Bronchospasm, laryngospasm, airway obstruction, pulmonary edema, desaturation <95%
- ▶ The risk of significant respiratory morbidity following tonsillectomy in the general pediatric population is 1% but increases to around 20% in patients with OSA
  - ▶ Suppression of pharyngeal dilator tone occurs during sleep and anesthesia
  - ▶ Chronic hypercapnia and disrupted central respiratory reflexes
  - ▶ Increased sensitivity to opioids

Ohn M, Eastwood P, von Ungern-Sternberg BS. Preoperative identification of children at high risk of obstructive sleep apnea. *Pediatric Anesthesia* 2020;30:221-231.

## Childhood OSA

- ▶ Prevalence of 3-5% in the general population
- ▶ Prevalence up to 50% in obese children
- ▶ Incidence peaks between 2 and 8 years old
- ▶ Most common cause of OSA in children is adenotonsillar hypertrophy
- ▶ Adenotonsillectomy is able to reduce OSA by approximately 70%
- ▶ One of the most frequently performed surgical procedures in children (over 500,000 per year)

Cote C. Anesthesiological considerations for children with obstructive sleep apnea. *Curr Opin Anaesthesiol.* 2015;28(3):327-332.  
Oguh SJ, Elden L, Swanson J, Tapia I, Subramanyam R. New treatments for obstructive sleep apnea in children. *Pediatric Anesthesia* 2020;30:232-240.  
Ohn M, Eastwood P, von Ungern-Sternberg BS. Preoperative identification of children at high risk of obstructive sleep apnea. *Pediatric Anesthesia* 2020;30:221-231.

## Diagnosis

- ▶ The gold standard for diagnosis is a formal sleep study (polysomnogram, PSG)
- ▶ Obstructive apnea-hypopnea index (OAH)
- ▶ Oxygen saturation nadir



**Table 1. Assessing severity of OSA with polysomnography with the apnea/hypopnea index**

OSA severity	Number of apneas <sup>a</sup> /hypopneas <sup>b</sup> per hour <sup>c</sup>
None	0
Mild	1-5
Moderate	5-10
Severe	>10

OSA, obstructive sleep apnea.  
<sup>a</sup>Apnea is defined as a cessation of breathing for 10 s or longer.  
<sup>b</sup>Hypopnea is defined as a partial airway obstruction.  
<sup>c</sup>Each polysomnography facility may have a similar but different scoring system.

Cote C. Anesthesiological considerations for children with obstructive sleep apnea. *Curr Opin Anaesthesiol.* 2015;28(3):327-332.

TABLE 2 Symptoms and Signs of OSAS

History	
Frequent snoring ( $\geq 3$ nights/wk)	
Labored breathing during sleep	
Gasps/snorting noises/observed episodes of apnea	
Sleep enuresis (especially secondary enuresis)*	
Sleeping in a seated position or with the neck hyperextended	
Physical examination	
Underweight or overweight	
Tonsillar hypertrophy	
Adenoidal facies	
Micrognathia/retrognathia	
High-arched palate	
Failure to thrive	
Hypertension	

\* Enuresis after at least 6 mo of continence.

Marcus CL, Brooks LJ, Draper KA, et al. Diagnosis and management of childhood obstructive sleep apnea syndrome. *Pediatrics* 2012; 130:576-584.

## Screening tools

- ▶ STBUR
  - ▶ Snore more than half the time
  - ▶ Snore loudly
  - ▶ Trouble breathing
  - ▶ Witnessed apnea
  - ▶ Wake up feeling un-refreshed

Ohn M, Eastwood P, von Ungern-Sternberg BS. Preoperative identification of children at high risk of obstructive sleep apnea. *Pediatric Anesthesia* 2020; 30:221-231.

## RESEARCH REPORT

### The performance of a postinduction fentanyl test in identifying severe obstructive sleep apnea syndrome

Ru Wu | Xuan Wang | Peijun Zhuang | Zhijian Zhou | Yihang Li | Fan Zhang

Pediatric Anesthesia WILEY

Anesthesiology  
UNIVERSITY OF COLORADO  
ANSCHUTZ MEDICAL CAMPUS

- ▶ Prospective, observational, assessor-blinded study
- ▶ 104 sleep study assessed children undergoing elective adenotonsillectomy
- ▶ 1 mcg/kg IV fentanyl administered as a test
- ▶ Non pre-medicated, spontaneously breathing, sevoflurane-induced patients before intubation
- ▶ Respiratory rates before and after fentanyl administration were studied
- ▶ Primary outcome was the sensitivity and specificity of the postinduction fentanyl test in identifying severe OSA compared with PSG

- ▶ Using a reduction in respiratory rate of  $>50\%$ , the postinduction fentanyl test detected severe OSA with a
  - ▶ Sensitivity of 87%
  - ▶ Specificity of 88%
  - ▶ Positive predictive value of 85%
  - ▶ Negative predictive value of 89%



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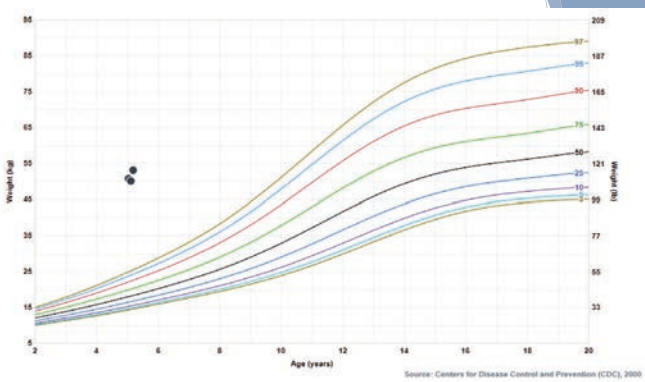
	Positive (n = 47)	Negative (n = 57)	P
AHI	17.5 ± 14.8	6.1 ± 4.1	.000
The nadir O <sub>2</sub> level (%)	84.7 ± 7.7	89.5 ± 5.4	.000
Cumulated hydromorphone requirement (μg/kg)	3.2 ± 2.5	5.3 ± 2.8	.000
Incidence of desaturation in PACU (%)	27.7	1.8	.000
Patient experienced other respiratory events	0	0	-
Duration in PACU (min)	51.1 ± 12.1	50.5 ± 6.0	.720

Note: Data are presented as mean ± SD and frequency (%).

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On a busy day in an ENT room, you are scheduled for many cases of ear tubes and adenotonsillectomies. Your first patient for adenotonsillectomy is a five-year-old girl.

- ▶ PMH
  - ▶ Obesity
  - ▶ Obstructive Sleep Apnea



### Our five-year-old patient's sleep study

- ▶ History: The patient has a history of elevated BMI in the 99th percentile, asthma, adenotonsillar hypertrophy and witnessed apneas. Additional sleep symptoms as reported by POC include snoring, bed wetting, frequent awakening and repositioning.



### Our five-year-old patient's sleep study

- ▶ Assessment: This sleep study is abnormal for obstructive sleep apnea, hypoxemia and elevated TCM CO<sub>2</sub>.  
**RESPIRATORY EVENTS:** The obstructive apnea hypopnea index is 24 events/hour and increased to 64.8 events/hour during REM sleep. The central apnea-hypopnea index is 0.2 events/hour. The end-tidal CO<sub>2</sub> mean is 47 mmHg with 11.3% of total sleep time > 50 mmHg. The TCM CO<sub>2</sub> mean is 50 mmHg with 10% of total sleep time > 50 mmHg.
- ▶ OXYGEN: The mean SpO<sub>2</sub> is 89%, with a adir of 69%, and 20.6% of total sleep time spent less than 88%.



How should we manage our patient preoperatively?



## Effect of Albuterol Premedication vs Placebo on the Occurrence of Respiratory Adverse Events in Children Undergoing Tonsillectomies The REACT Randomized Clinical Trial

Britta S. von Ungern-Sternberg, MD, PhD; David Sommerfield, MD; Liana Slevin, BSc; Thomas F. E. Drake-Brockman, BPhil; Guicheng Zhang, PhD; Graham L. Hall, PhD



## Reducing Anesthetic Complications in Children Undergoing Tonsillectomies

- ▶ 484 children aged 0 to 8 years undergoing anesthesia for tonsillectomy
- ▶ Participants randomized to receive either albuterol (2 actuations, 200 mcg) or placebo before surgery
- ▶ Occurrence of perioperative respiratory adverse events (PRAE) until discharge from PACU
  - ▶ Bronchospasm
  - ▶ Laryngospasm
  - ▶ Airway obstruction
  - ▶ Desaturation
  - ▶ Coughing
  - ▶ Stridor



## Reducing Anesthetic Complications in Children Undergoing Tonsillectomies (REACT)

- ▶ Median age [range] 5.6 [1.6-8.9] years
- ▶ 479 data sets available for intention-to-treat analysis
- ▶ PRAE in 67 of 241 children (27.8%) receiving albuterol and 114 of 238 children (47.9%) receiving placebo
- ▶ After adjusting for age, type of airway device, and severity of OSA, likelihood of PRAE remained significantly higher in the placebo group (OR 2.8,  $P < 0.001$ )
- ▶ Significant differences were seen in children receiving placebo vs. albuterol in laryngospasm (11.8% vs. 5.0%), coughing (33.2% vs. 11.2%), and oxygen desaturation (22.7% vs. 14.9%)



## How should we manage our patient intraoperatively?



## How Pediatric Anesthesiologists Manage Children with OSA Undergoing Tonsillectomy

Annals of Otolaryngology, Rhinology & Laryngology  
2020, Vol. 129(1) 55-62  
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sagepub.com/journals-permissions  
DOI: 10.1177/0003489419874371  
journals.sagepub.com/home/aor  
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Christopher Roberts, MD<sup>1</sup>, Raihanah Al Sayegh, MD<sup>2</sup>,  
Pavithra Ranganathan Ellison, MD, FASA<sup>3</sup>, Khaled Sedeek, MD<sup>4</sup>,  
and Michele M. Carr, DDS, MD, PhD, FRCS<sup>1</sup>



## How should we manage our patient postoperatively?



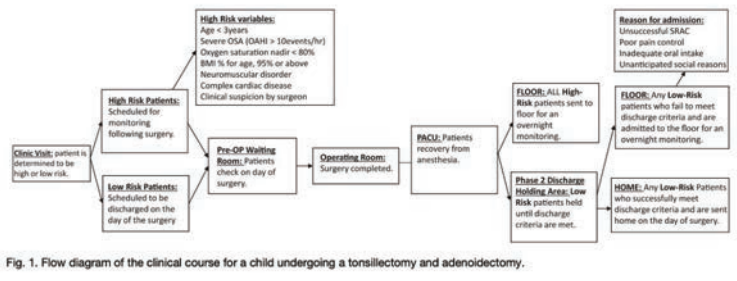


Fig. 1. Flow diagram of the clinical course for a child undergoing a tonsillectomy and adenoidectomy.

Friedman NR, Meier M, Tholen K, et al. Tonsillectomy for Obstructive Sleep-Disordered Breathing: Should They Stay, or Could They Go? Laryngoscope 2022;132(8):1675-1681.

## Beyond the PACU

- ▶ **PRIOR TO DISCHARGE:** All children require a successful sleep room air challenge defined as maintaining a SpO2 of  $\geq 90\%$  for a minimum of 20 minutes.



Friedman NR, Meier M, Tholen K, et al. Tonsillectomy for Obstructive Sleep-Disordered Breathing: Should They Stay, or Could They Go? Laryngoscope 2022;132(8):1675-1681.

One week later, you are on call and your patient returns to the operating room in the middle of the night for control of post-tonsillectomy hemorrhage.

## Post-tonsillectomy hemorrhage

- ▶ Primary bleeding
  - ▶ Occurring within the first 24 hours, <1%
- ▶ Secondary bleeding
  - ▶ 5-12 days following the initial tonsillectomy, up to 4%
- ▶ Risk factors
  - ▶ Surgical technique
  - ▶ Age >5 years
  - ▶ Chronic tonsillar infection
  - ▶ Preoperative use of aspirin and NSAIDs

Fields RG, Gencorelli FJ, Litman RS. Anesthetic management of the pediatric bleeding tonsil. Pediatric Anesthesia 2010;20:962-966.

## Post-tonsillectomy hemorrhage



- ▶ Complications
  - ▶ Hematemesis
  - ▶ Anemia
  - ▶ Hypovolemia
  - ▶ Death

## Post-tonsillectomy hemorrhage

- ▶ Anesthetic challenges
  - ▶ Anemia
  - ▶ Hypovolemia
  - ▶ Intra-gastric blood
  - ▶ Oropharyngeal blood
- ▶ Anesthetic considerations
  - ▶ IV access
  - ▶ Fluid resuscitation
  - ▶ RSI
  - ▶ Suction (and backup)
  - ▶ Careful opioid titration
  - ▶ Gastric decompression
  - ▶ Awake extubation

## Management of the child with post-tonsillectomy hemorrhage

- ▶ Retrospective cohort study
- ▶ 475 patients (2.9%)
  - ▶ IV RSI in 401 (84.4%)
  - ▶ Modified RSI in 26 (5.5%)
  - ▶ Succinylcholine in 420 (88%)
- ▶ Most common adverse event was hypoxemia (9.9%)
  - ▶ Most events occurred during emergence or extubation
- ▶ Bradycardia during induction in 20 (4.2%), Hypotension in 12 (2.5%)
- ▶ Difficult to intubate in 13 (2.7%)
  - ▶ None of whom were difficult to intubate during the initial tonsillectomy



Fields RG, Gencorelli FJ, Litman RS. Anesthetic management of the pediatric bleeding tonsil. *Pediatric Anesthesia* 2010;20:982-986.

## Dr. Raj Singhal

Anticipate an unusual complication of craniectomy when delivering anesthetic management for myringotomy (20 mins)

Describe the anesthetic treatment strategy for dental restoration requiring urgent cardiac surgery (20 mins)



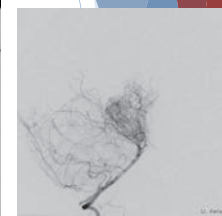
## Myringotomy Tube Disaster

- ▶ 11 Year old with Moyamoya
- ▶ 700cc of blood loss on BMT
- ▶ Ear packed, patient sent home
- ▶ One day later, coughing episode led to hemorrhage from ear
- ▶ Presented urgently to the ER
- ▶ Required blood transfusions



## Myringotomy Tube Disaster

- ▶ Angiography scheduled
- ▶ Internal carotid artery found to be damaged
- ▶ Balloon occlusion showed loss of MEP and SSEP's



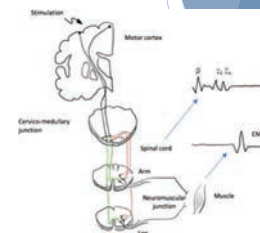
## Aberrant Internal Carotid Artery

- ▶ Seen in approximately 1%
- ▶ Complications with underlying vascular disease
- ▶ Patient required a radial artery graft and an internal carotid to MCA bypass
- ▶ Craniectomy required to repair the lesion



## How to put this child to sleep?

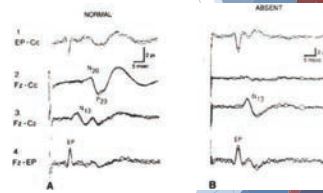
- ▶ Patient is deaf in the left ear, hemorrhaging out of right
- ▶ Besides Moyamoya and mild obesity, otherwise healthy
- ▶ SSEP and MEP monitoring requires sedation or TIVA, avoid volatile
- ▶ If nondepolarizing blocker is used, consider reversal with sugammadex





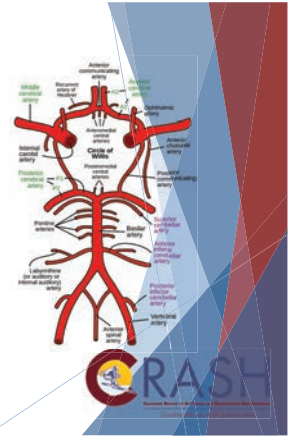
## Where would you see changes?

- ▶ Defect is on right side, left side of body would be affected
- ▶ Due to Moyamoya disease, Circle of Willis is not intact
- ▶ Balloon occlusion of right internal carotid led to absent evoked potentials on the left side



## Consent, procedure, lines...

- ▶ Given urgency and reduction of MEP's, SSEP's, consent for new procedure obtained with patient still under anesthesia
- ▶ CVC was able to be placed, veins are still patent
- ▶ Extracranial arterial involvement can occur, radial artery was occluded for several minutes before grafting



## So what happened?

- ▶ Right ICA was grafted to MCA
- ▶ Right ICA tied above graft
- ▶ Hearing returned in right ear
- ▶ Patient recovered well



## Moving on to Dental Adventures

- ▶ 9 year old female with a history of a d-TGA, requiring a switch after birth
- ▶ Came in for outpatient dental restorations
- ▶ Echo from 3 months ago with good function and carotid flow



## After induction, patient decompensated

- ▶ After intubation, patient had arrhythmias occur
- ▶ First with minor issues, proceeded to bigeminy, ischemia, and ventricular dysfunction
- ▶ What would you do next?



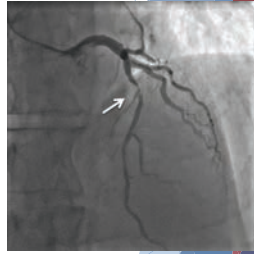
## Transfer to the CVICU

- ▶ Patient transferred to CVICU
- ▶ More arrhythmias occurred while under direct observation
- ▶ Cardiology Consulted to weigh in, including electrophysiology
- ▶ Given history of switch, primary thought was coronary artery stenosis



## More Angiography

- ▶ Decision made to proceed to cardiac catheterization lab
- ▶ Pressures and functions were encouraging
- ▶ Angiography performed to see patency of coronary arteries
- ▶ Bilateral stenosis noted
- ▶ Upon injection of dye, patient went into cardiac arrest



## Time for ECMO

- ▶ ECPR started
- ▶ Cardiothoracic Surgery on hand
- ▶ From arrest to ECMO was 30 minutes
- ▶ Patient moved from cardiac catheterization to CVOR
- ▶ Redo sternotomy and re-implantation of coronary arteries performed



## Clinical Outcomes for Patient

- ▶ Patient had a short bypass run
- ▶ Neurologically intact
- ▶ Was extubated on POD 2
- ▶ Dancing in bed on POD 1
- ▶ Successfully discharged from the hospital in 8 days
- ▶ Has made a full recovery



## Dr. Rich Ing

Discuss your anesthetic approach for a pericardial drain, a supraclavicular lymph node biopsy and a tunneled central line in a 16-year-old with a suspected mediastinal neoplastic mass in radiology. (10 mins)

Fast and Furious in the nuclear med scan in a 4-year-old under anesthesia. (10 mins)

Describe recent trends in pediatric anesthesia literature that pertain to my clinical practice (20 mins)



## Fast and Furious in the Nuclear Med Scanner

Rich Ing  
Richard.ing@childrenscolorado.org

## History

Three year old 9kg child with Trisomy 21

Atrial-Ventricular-Septal-Defect (AVSD) and anomalous pulmonary venous connection repair

Presented for a repeat nuclear med scan as part of a study for follow up Left v2 Right lung perfusion. ( 40 min anesthetic )



## History

Undergone 3 previous uneventful  
30 min anesthetics :

Nuclear Med scans over last 8 months



You are called 20 mins before the case and informed  
of your assignment.

Scan the electronic record, seems straight forward  
enough, you make your notes and  
meet the family with their well looking child  
in her mother's arms.

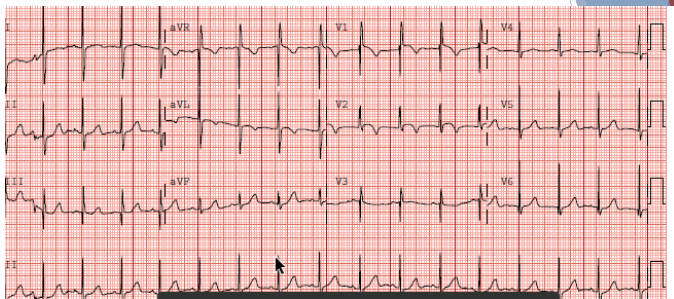


- ▶ Heart rate 135/min good color, no cyanosis,
- ▶ no labored breathing, chest clear, looks great ,no fever.

- ▶ Mother of child when asked about her child's normal heart rate explains it usually is in the 115-120/ min range.



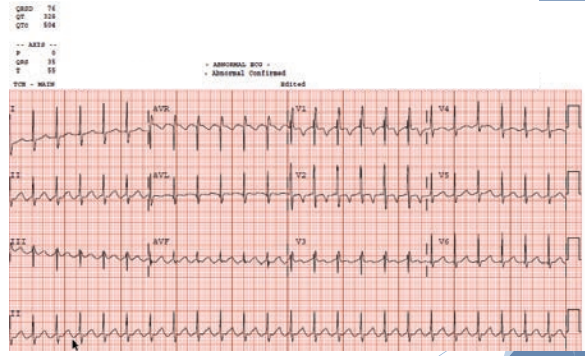
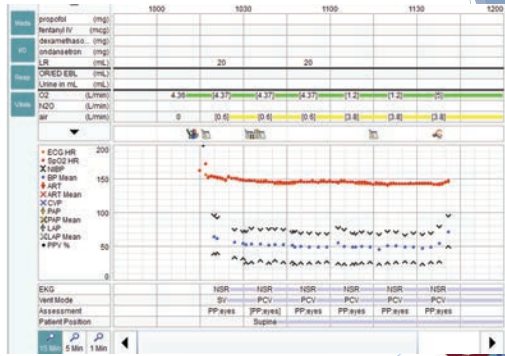
- ▶ We concluded perhaps the child is a bit dry,
- ▶ HR appears to be in sinus rhythm on the ECG monitor.
- ▶ No history of arrhythmias and a normal ECG is on file.



## Now what?

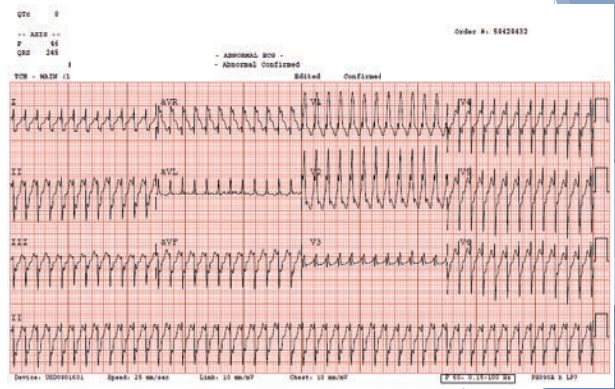
- ▶ Off to sleep sevoflurane, before ECG placed on the child, parental presence,
- ▶ During induction pulse oximeter is recording a saturation of 100%
- ▶ But rapid HR by the number of pulsatile oscillations you can see on the waveform.





What you going to do next?

- ▶ Echo?
- ▶ Send home?
- ▶ Repeat ECG?
- ▶ Admit?



What will you do now?

- Admit/ NPO
- Prepare for TEE and cardioversion
- GA no 2
- ETT
- Back board and CPR prep
- Epinephrine

Case 2 Suspected Neoplasia

- In Radiology
- 17-year-old 60 kg boy
- Scheduled in radiology intervention
- Drainage of pericardial effusion (cardiology)
- Placement of a tunneled central line
- Supraclavicular lymph node biopsy (IR)

## Anesthetic Approach?

- ▶ Spontaneous Ventilation to optimize mediastinal mass CVS Respiratory Physiology
- ▶ LMA
- ▶ Pericardial drain into the RV of the heart, bleeding out.
- ▶ ETT, art line, CVP, (rij), blood,
- ▶ Second pericardial drain.
- ▶ Stable, lymph node biopsy supra clavicular, Tunneled Central line.
- ▶ TO CVOR stable, removal of RV pericardial drain, prep for sternotomy.



## Recent 2023 Literature in Pediatric Anesthesia That Impacts Clinical Practice

Richard Ing MBBCh FCA(SA)  
No Disclosures  
Richard.ing@childdrenscolorado.org

## Outline : January 2<sup>nd</sup> 2024

- ▶ Non- operating room Anesthesia
- ▶ Medication Errors under General Anesthesia
- ▶ Age stratified Propofol dosages
- ▶ Adolescent dissent
- ▶ Anaphylaxis
- ▶ 100 years of anesthesia
- ▶ Debriefings
- ▶ Button Battery Ingestions



## Non-operating Room Anesthesia

National Anesthesia Clinical Outcomes Registry data from 2015-2019.

2 236 788 pediatric anesthetic encounters (patient age <18 y.o.) were analyzed revealing 507000 (22.7%) of all these pediatric anesthetics occur in non-operating room Gastroenterological and Radiology. Higher ASA classifications

Louer et al. Pediatric Anesthesia. 2023;00:1-8.



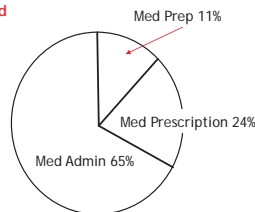
## Medication Errors under anesthesia in Pediatric Patients

MEs account for approximately 13 million injuries per year and 1 death every day the United States.

Anesthesia Patient Safety Foundation and Wake Up Safe, two safety organizations that have led the call to decrease medication errors in children.

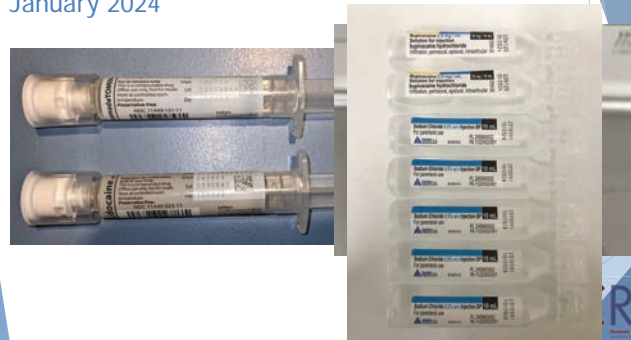
Pediatric Anesthesiologists UK, 60% of anesthesia providers have experienced at least one ME every year, and 15% reported at least one error per month.

Only 1/3 would report it if it caused patient harm



Wahr JA, et al. Medication safety in the operating room: literature and expert-based recommendations. Br J Anaesth. 2017;118:32-43.  
Jones-Ogih S et al. Medication safety in pediatric anesthesia: An educational review and a call to action. Pediatric Anesthesia. 2023;33:17-23.

<https://www.apsf.org/look-alike-drugs/>  
January 2024





## Age Stratified Propofol Dosage for Pediatric Procedural Sedation and Analgesia

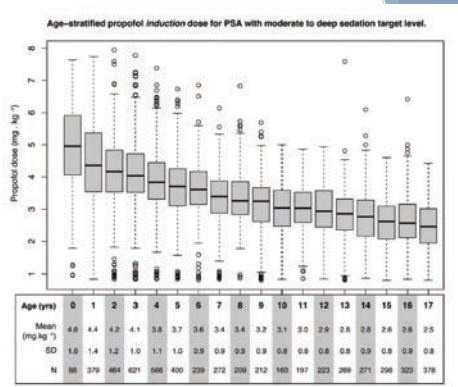
6438 patients one institution retrospective study.  
 5567 induction records  
 5420 maintenance records  
 Complications: 7 laryngospasm, 3 hypoxia, 1 bronchospasm,  
 3 bradycardia, 1 hypotension, 3 aspiration vomit, 2 iv subcut.

Researchers found they used more Propofol in smaller children

van Dijk, H, et al. Anesthesia and Analgesia March 2023 • Volume 136 • Number 3

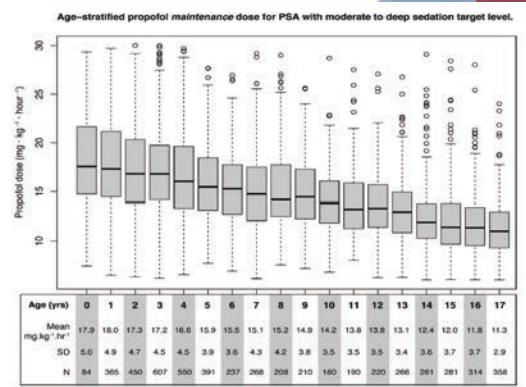


### Induction



### Maintenance

300 mcg/kg/min  
 200 mcg/kg/min



“You can’t make me!”  
 Managing adolescent dissent  
 to anesthesia

### Dissent

15-year-old, assents, mother written consent,  
 agrees to colonoscopy for familial adenomatous  
 polyposis.

Options offered mask or iv induction.

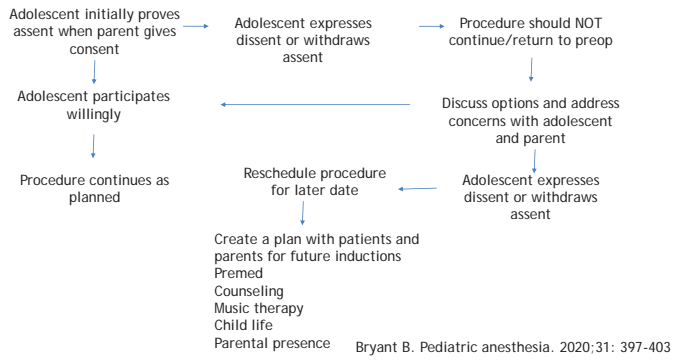
Adolescent chooses mask

In operating room

As mask comes towards her face “ I don’t want the  
 procedure anymore. You can’t make me !”

Bryant B. Pediatric anesthesia. 2020;31: 397-403





## Voluntary administration of annual Influenza Vaccinations Under Anesthesia



## Anaphylaxis in Pediatric Anesthesia

The incidence of anaphylactic reactions is

1:37 000 pediatric anesthetics.  
1:10 000 to 1:20 000 incidence in the adults

Neuromuscular blocking agents,  
Latex  
Antibiotics, opioids  
most frequently cited triggers

Wakimoto M et al. Perioperative anaphylaxis in children: A report from the Wake-Up Safe collaborative. *Pediatric Anesthesia*. 2021;31:205–212.



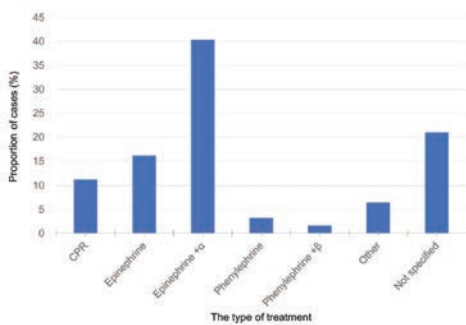
## Anaphylaxis pediatrics

2010-2017

2,261,749 anesthetics . 62 cases of anaphylaxis.  
1:36479

Need for cardiopulmonary resuscitation in 11% of cases and estimated fatality of 1.6%.

Delayed use of epinephrine



Wakimoto M et al. Perioperative anaphylaxis in children: A report from the Wake-Up Safe collaborative. *Pediatric Anesthesia*. 2021;31:205–212.



**Pedi Crisis 2.0**

Call for Help! Notify Surgeon!

- 1 Air Embolism
- 2 Anaphylaxis
- 3 Anterior Mediastinal Mass
- 4 Bradycardia
- 5 Bronchospasm
- 6 Cardiac Arrest
- 7 Chest Compressions: Supine/Prone
- 8 Difficult Airway
- 9 Fire: Airway
- 10 Fire: OR (non-airway)

**Anaphylaxis**

Verify DX

May have:

- Hypotension
- Rash
- Bronchospasm

Common Causative Agents:

- IV contrast
- Antibiotics
- Latex
- Neuromuscular blockers
- Chlorhexidine prep solution

**Anaphylaxis**

Drug / Dosage Summary

- **Epinephrine**
  - 1-10 MICROgrams/kg IV/IO
  - Consider infusion 0.02-0.2 MICROgrams/kg/min IV
- **Vasopressin**
  - 10 MICROunits/kg IV
- **Albuterol**
  - 4-10 puffs as needed
- **Methylprednisolone**
  - 2 mg/kg IV/IO, MAX 100 mg
- **Diphenhydramine**
  - 1 mg/kg IV/IO MAX 50 mg
- **Famotidine**
  - 0.25 mg/kg IV MAX 20 mg
- **Ranitidine**
  - 1 mg/kg IV MAX 50 mg

## Pedi Crisis App QR Code instructions



## Anesthesia & Analgesia (A&A) 100 years

**"We can't see where we are going unless we understand where we have emerged from"**

Pediatric Anesthesiology

"Children are just small adults" quoted by Elmer I. McKesson, MD,

"In regard to the use of nitrous oxide-oxygen in children, age has no influence at all in the selection of anesthesia and besides there is not much variation in the technic of administering a babe and anesthetic from the technic for adults"

Haines FE. Anesthesia in children: safest methods and agents. *Curr Res Anesth Analg.* 1922;1:50-54.

Coleman ML et al. 100 Years of Pediatric Anesthesia With Anesthesia & Analgesia: Growing Together. *Anesth Analg.* 2022 Aug 1;135(2S Suppl 1):S31-S36.

## 1925 Charles H. Robson, MD

"Beginning to rescue children from being "small adults."

Robson C. Anesthesia in children. *Curr Res Anesth Analg.* 1925;4:235-240



M. Digby Leigh, MD, and M. Kathleen Belton, MD, CM, advocated experienced anesthesiologists caring for children, premedication, and endotracheal intubation in pediatric ear, nose, and throat (ENT) procedures.

Leigh MD, Fitzgerald RR. Endotracheal anesthesia supplementing avertin in cleft palate operations. *Curr Research Anesth Analg.* 1937;16:64-65.

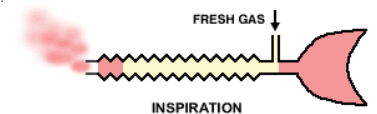
Leigh MD, Belton MK. Anesthesia for ear, nose and throat operations in infants and children. *Curr Res Anesth Analg.* 1948;27:41-48.

T. Philip Ayre, MRCS, an anesthesiologist who cared for children making a significant contribution.

His 1937 article in A&A introduced his famous "T-piece"

Coleman ML et al. 100 Years of Pediatric Anesthesia With Anesthesia & Analgesia: Growing Together. *Anesth Analg.* 2022 Aug 1;135(2S Suppl 1):S31-S36.

Ayre P. Endotracheal anesthesia for babies with special reference to hare-lip and cleft palate operations. *Curr Res Anesth Analg.* 1937;16:330-333.



## The Director of the Division of Anesthesia at Babies Hospital Virginia Apgar, MD

Developed

Appearance

Pulse

Grimace

Activity

Respiration (APGAR) score

Evaluating newborn babies

and helped establish a specialized

unit for neonates.



Apgar V. A proposal for a new method of evaluation of the newborn infant. *Curr Res Anesth Analg.* 1953;32:260-267.

## Debriefings following critical incidents in pediatric anesthesiology

79 % academic,  
30% debrief within 24 hrs

Question	0-10 yrs in practice	> 10 yrs
Root cause analysis helpful?	N=65	N=100
Not	6	6
A little	26	11
A moderate amount	17	36
A lot	11	28
A great deal	5	19

Sullivan L et al. *Pediatric Anesthesia* 2023; 33:319-320



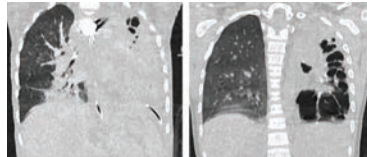
## Button battery ingestion

Stilwell R et al. Pneumonectomy in a child with necrotic lung after ingestion of a button battery. 2023 Oct;58(10):2966-2968.



## Button Battery ingestion

3-yr-old girl from Africa  
 1-yr history of recurrent vomiting,  
 coughing, growth arrest  
 No left breath sounds  
 Abundant purulent respiratory  
 secretions



Tracheoesophageal fistula  
 Left main bronchus  
 stenosis  
 Chronic mediastinitis  
 Bronchiectasis  
 Left lung fibrosis  
 Right lung preserved

Stilwell R et al. Pneumonectomy in a child with necrotic lung after ingestion of a button battery. 2023 Oct;58(10):2966-2968.

## Utilizing a critical airway response team(CART) expedites esophageal button battery removal.

2015 -2022 12 patients  
 2022 CART  
 Decreased  $73 \pm 32$  min (n=6) to  $35 \pm 11$  min (n=7) ( $p < 0.05$ )

Brandt K. J Pediatr Surg . 2023 May;58(5):810-813.  
 doi: 10.1016/j.jpedsurg.2023.01.037.



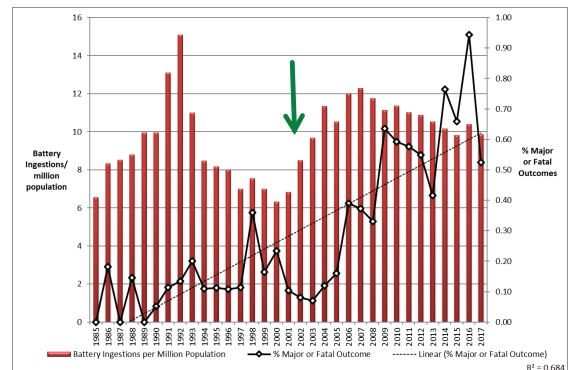
## 3 Volt 20 mm Lithium Battery



Severity of button battery-associated injury parallels ubiquitous presence of lithium cell production

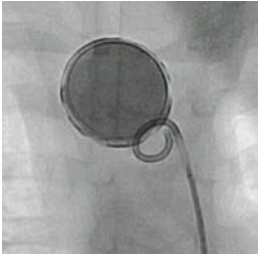
Decreased production costs  
 Previously 1.5V Manganese dioxide or silver oxide

Now > 20mm—larger and stronger voltage  
 Esophageal impaction in toddlers <5 yrs of age

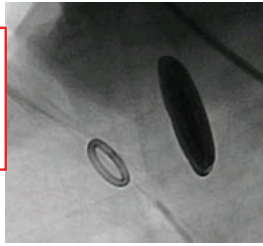


battery-ingestion hazard: clinical implications. *Pediatrics*. 2010; 125: 1168-77. [www.poison.org/battery/stats](http://www.poison.org/battery/stats) Accessed October 2023

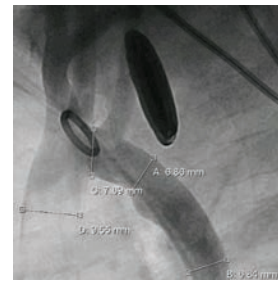
Where should these BB be removed?



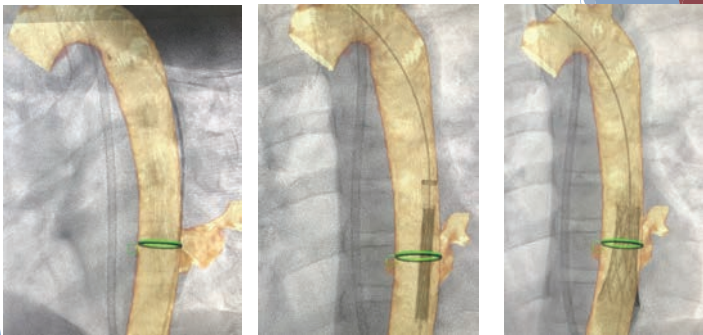
3 yr-old  
>12 hrs ingested  
Bloody Saliva  
>20 mm BB  
Below Thoracic Inlet



Outpatient Endoscopy Suite?  
Main Operating Room? Radiology? Cath Lab?



Ing RJ, et al. The anesthetic management of button battery ingestion in children. Can J Anaesth. 2018 Mar;65(3):309-318.

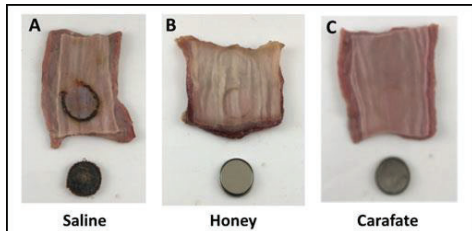


Post CT and MRI reconstructed images to determine exact site in cath lab for covered stent deployment 6/17/21

Double shadow "Halo Sign"



3 Ns = Negative Pole  
Narrowest  
Necrotic injury



Patient >12 months old AND lithium battery ingested within 12 hours  
Give honey 10 mL every 10 minutes (max 6 doses)  
Use commercial honey, rather than specialized or artisanal honey

Anfang RR et al. pH-neutralizing esophageal irrigations as a novel mitigation strategy for button battery injury. Laryngoscope. 2019 Jan;129(1):49-57.

**NEW LAW**  
**H.R. 5313**  
**Reese's Law**

**Button & Coin Batteries**

Products using these batteries will require special child-resistant access to the battery compartment.

2022

Thank you!

[Richard.ing@childrenscolorado.org](mailto:Richard.ing@childrenscolorado.org)

