Update on Non-Operating Room Anesthesia Across the Ages

Salon E&F

February 27, 4-6pm

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- No Disclosures

Learning Objectives

- Discuss alternatives to general anesthesia for pediatric patients requiring procedures outside of the OR
- Compare the differences in anesthetic approaches for pediatric versus adult patients in non-operating room settings.
- Summarize the risks and benefits of common anesthetic options for various non-operating room anesthetics.

NORA Adult Demographics vs OR

- Patients are 3.5 yrs older than OR patients
- 37.6% ASA 3 & 4 vs 33.0% for OR cases
- Monitoring techniques during sedations by non-anesthesia providers demonstrated inconsistent application of basic monitoring principles.

NORA: Closed claims

- Claims for death are twice as high for NORA than OR (Woodward et al. (2017) *Anesthesiol Clin* 35:569-581)
- 10% are patients <16 years of age
- 51% are in the GI suite
- 53% related to respiratory events

Anesthesia Quality Institute®
American Society of Anesthesiologists®

Pediatric NORA also growing

Lower overall mortality for NORA than OR anesthesia (0.02% vs 0.04%, p<0.0001 - Chang et al. (2018) *J Patient Saf* 14(1):9-16)	Anesthesia in non operating room locations more commonly requested for pediatric patients	Pediatric patients require GA when adult patients do not
Even if not a painful procedure, infants and children often cannot cooperate or lay still	Need for GA due to anxiety, noncooperativity, need for immobility	Repeated radiation exposure due to failed image acquisition must be minimized in children

Case – Pediatric MRI

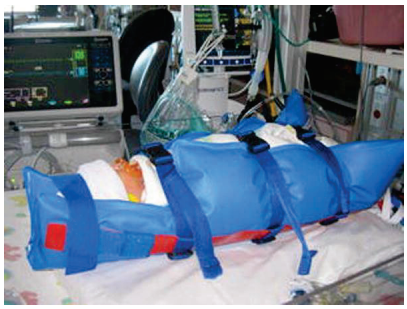
- A 3 month old term infant presents for “head MRI” and you are requested to provide anesthesia. What is your response?

Shorter/low resolution scans often do not require GA

Quick CT scans often do not require GA	If cooperation (breath holds) required, children >6 years can often cooperate
MRI sometimes preferred over CT due to decreased radiation exposure	
MRI sometimes requires GA due to length of scan/noise/need for strict immobility	
MRI scans can vary in length depending on the clinical question	-bump on head -hydrocephalus in patient with known VP shunt -concern for seizures -evaluate petrous bones

Case

- A 3 month old term infant presents for “head MRI” and you are requested to provide anesthesia. What is your response?
- Quick MRI to evaluate superficial head mass
  - Consider “feed and swaddle”



From Barkovich et al (2018) *Pediatr Radiol* 48(1):50-55

Case

- A 3 month old term infant presents for “head MRI” and you are requested to provide anesthesia. What is your response?
- Quick MRI to evaluate superficial head mass
  - Consider “feed and swaddle”
  - Younger infant (i.e., neonates) can usually tolerate longer scans
  - Consider sedation if “feed and swaddle” insufficient

Case

- A 3 year old child presents for “head MRI” and you are requested to provide anesthesia. What is your response?
- Children 1-5 years of age are the most challenging to scan without sedation
- 5-6 year olds can sometimes tolerate MRI scans
  - Can stay still for about 20 minutes
  - Better if can be schedule during child’s usual nap time
  - Use parental presence, movies, etc
  - Need a 15-30 minute break for longer scans
  - Likely will have some motion artifact
  - Tours in advance can help increase likelihood of success

Pediatric (relative) contraindications for unsedated MRI

- Anxiety, claustrophobia
- Developmental delay, limited communication, unable to follow directions
- Prior failed nonsedated scan
- Prior negative experiences with healthcare system
- Discomfort with laying flat
- Sensory sensitivity

Case

- An 8 year old child presents for “head MRI” and you are requested to provide anesthesia. What is your response?
- At 8 years, children can have a high likelihood of completing an MRI without sedation if developmentally normal
- Tours in advance help increase likelihood of success
- Some motion artifact can still occur so caution for high-resolution scans

Case

- A 68 year old female with extreme claustrophobia presents for an abdominal MRI to characterize and adrenal mass.
- She also has a history of epilepsy which is well controlled with a Medtronic DBS.

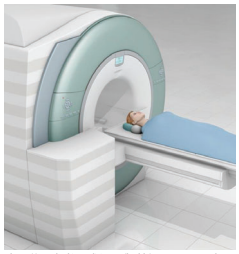
MRI Considerations: Device Labels

MR Conditional – Non-clinical testing has demonstrated that Medtronic DBS Systems have been found to be MR Conditional. If this patient is implanted with a Medtronic DBS System, MRI examinations of the head only or the entire body may be safely performed depending on the DBS system components implanted.

Medtronic DBS Systems that are eligible for MRI scans of the entire body (ie, full-body eligible) must be scanned under the following conditions:

- 1.5-tesla (T) horizontal closed bore
- Maximum spatial gradient of 19 T/m (1900 gauss/cm)
- RF transmit/receive body coil (built-in) or RF transmit/receive head coil
- Maximum RF power of 2.0 µT B1+rms (B1+ root mean squared)
- If B1+rms is not available, a maximum RF power of 0.1 W/kg (0.05 W/lb) whole body and head SAR (specific absorption rate). Using a SAR setting may result in a more restrictive MRI scan.
- Gradient slew rate limited to 200 T/m/s

MRI Considerations



https://www.hopkinsmedicine.org/health/treatment-tests-and-therapies/magnetic-resonance-imaging-mri

- Absolute Contraindications
  - Intraocular metal
  - Catheters with metallic components (e.g. Swan-Ganz catheters)
  - Cerebral artery aneurysm clips
- Relative Contraindications
  - Arterial stents
  - Programmable shunts
  - Tracheostomy tubes with metal reinforcements (exchange for plastic only)
  - Airway and esophageal stents
  - Medication patches
  - Multiple others

Case – Pediatric CT

- A 4 yo child presents for abdominal CT with PO contrast given 1 hour before the scan. The child is uncooperative with severe autism and will require general anesthesia. What is your response?

Oral contrast in pediatric anesthesia

- Oral contrast often required for CT scans in children due to lack of retroperitoneal fat to act as a "natural contrast"
- Imaging often must occur 1-2 hours after contrast ingestion
- Pediatric oral contrast can be diluted to a more iso-osmolar concentration (1.5% vs 3% Gastrografin), which can reduce aspiration complications
- Lower osmolar load of contrast beneficial or patients with limited cardiovascular reserve or patients sensitive to intravascular volume (e.g., sickle cell disease, arteriovenous shunts)
- There are no conclusive data to support firm recommendations for anesthesia in pediatric patients receiving oral contrast
- 35-year retrospective review: increased gastric volume, few aspiration events associated with acute abdomen and bowel obstruction
- Most common adverse reactions: nausea, vomiting, hives, flushing (more likely if prior contrast reaction, atopy, paraproteinemia)

Other special considerations for pediatric radiology

- Neuro-angiography
- Nuclear medicine
- Interventional Radiology

Neuro-angiography Adults

- Stroke Alert – Endovascular therapy
  - GA (n=1,275) vs MAC (n=1,387) literature review (Neurointervention, 2021)
    - 16 articles
    - 30 day outcome was worse for GA (OR 0.564, 95% CI, 0.354-0.899) for all articles combined
    - 30 day outcome was no different between GA and MAC in RCTs (OR, 1.101; 95% CI, 0.395-3.071)
    - No association with successful recanalization

Neuro-angiography Pediatrics

- GETA may be required if requirement for immobility, apnea requested, strict regulation of ETCO2.
- Unlike adults, sedation may be required afterward for compliance with lay flat precautions after removal of femoral arterial sheath (precedex commonly used)

Nuclear medicine Pediatrics

- SPECT and PET scans for seizure localization
- PO midazolam often given for premedication cannot be used for PET due to glucose content

Interventional Radiology - Adult

https://www.penumbrainc.com/products/peripheral-embolization/

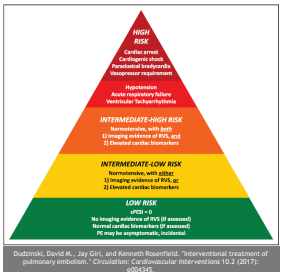
- Non-neuro embolization
  - Both MAC and GA are utilized
  - GA allows for more precise localization
  - GA may require more aggressive treatment of blood pressure

Interventional Radiology - Adult

- CT Lung Biopsy
  - Lateral decubitus is most common
  - MAC or GA (GA most common due to positioning)
  - Phrenic nerve blocks have been described to improve localization
- Percutaneous Nephrostomy Tube
  - Prone
  - MAC or GA (GA most common due to positioning)
- Percutaneous Biliary Drains
  - General (more common at CU) or MAC
  - Reports of Regional – Paravertebral
  - Procedure length dependent on whether bile duct is dilated
  - High risk of intra-operative sepsis

https://en.wikipedia.org/wiki/Lung_biopsy

Interventional Radiology – Adult PE



Dudzinski, David M., Jay Giri, and Kenneth Rosenfield. "Interventional treatment of pulmonary embolism." *Circulation: Cardiovascular Interventions* 10.2 (2017): e004345.

- High risk (anticoagulation + thrombolysis)
- Intermediate risk (anticoagulation + consider thrombolysis)
  - 10% of this group will hemodynamically decompensate (50% mortality)
  - 1.5% - 2.9% 7-day mortality
- Low risk (anticoagulation)
  - ~40% of PE patients

PE is the third most common cause of cardiovascular death in the US, with 60,000-100,000 deaths per year

Interventional Radiology – Adult PE

Avoid
- Hypotension, Hypoxia, Hypercarbia

Hemodynamic support is often needed, consider
- Vasopressin
- Norepinephrine
- Inotropy

Potential for complete heart block if there is a prior LBBB

Acute blood loss during clot retrieval

Very light MAC with hemodynamic support vs General anesthetic

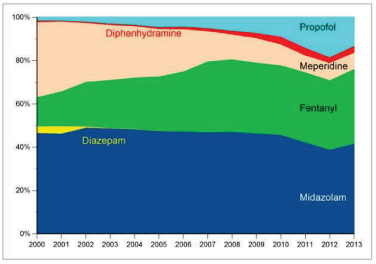
Interventional Radiology - Pediatrics

- No sedation or MAC sedation successful in adults is often inadequate for pediatric patients
  - Drainage catheters
  - Gastrostomy or gastrojejunostomy tubes
  - Biopsies
  - Lumbar punctures
  - Vascular access (e.g., PICC line)

Gastroenterology suite - Pediatrics

- Infants, children, and even teenagers are often uncooperative even with sufficient local topicalization
- Increased anxiety and disinhibition with minimal sedation can impede procedure
- Most complications are respiratory, similar to adults
- LMA ® Gastro™ for patients >30 kg
- Endoscope in airway may cause air compression, especially in infants <10kg

Gastroenterology suite - Adults



Sonnenberg A. Sedation in Colonoscopy. Gastroenterol Hepatol (N Y). 2016 May;12(5):327-9. PMID: 27499716; PMCID: PMC4973564.

- Colonoscopy
  - Database of 1.4 million colonoscopies performed between 2000 and 2013
  - Figure shows proportional rates of individual sedative usage between 2000 and 2013.
  - Similar pattern throughout US

Gastroenterology suite - Adults

- EGD
  - Potential Airway Compression
  - GI pathology impacting NPO and aspiration risk (SBO, GI bleed)
  - MAC or GA can be used (MAC with moderate to deep sedation and capnography is the most typical at CU)
- ERCP
  - Potential Airway Compression
  - Prone leading to suboptimal respiratory mechanics
  - MAC or GA can be used (GA almost exclusively at CU)
    - Limited airway access
    - Larger endoscope

Popular pediatric anesthetics for NORA

- Medications to preserve spontaneous ventilation
  - Volatile anesthesia
  - Remimazolam, midazolam
  - Dexmedetomidine
  - Ketamine
  - Propofol

Alternatives to general anesthesia

- Feed and swaddle
- Minimizing sedation with local (EMLA, local infiltration, regional)
- Tours
- Music, relaxation-guided imagery
- Child life assistant
- Immersive technologies: Augmented/virtual reality

Immersive technologies: Virtual Reality (VR)

- VR has lowered anxiety (as exposure – tour of OR- or as distraction tool)
- Systematic review of RCTs showed VR lowered preoperative anxiety scores (Alqudimat et al. (2021) *Current Anesthesiology Reports* 11:265-274)
- Oculus Rooms, Google Cardboard VR headsets that are single use
- Oculus Quest 2 - VR gaming experience for ages 7-14
  - Decreased anxiety and “acceptable” pain level (Gianuario et al. J Vasc Access 2022 June 30)
  - 1/10 failed but the patient had trouble at the beginning with removing the headset

Limitations of VR

- Hardware limitations – Oculus Go headset 500g, twice the weight of a bicycle helmet for a child 5-8 years old
- 1 in 5 preschool children noncompliant with VR
- VR has minimal customization for child to pick their preferred video or game
- Eye fatigue, disorientation, headache, dizziness, nausea

Immersive technologies: Augmented Reality (AR)

- AR unique in that it blends the unfamiliar periop surroundings with playful holograms
- Less like to have nausea (“cybersickness) due to visual contact with surroundings
- Prospective RCT (5-17 years, ASA I-II) – anxiety 43.8% vs 16.2% at time of induction as measured by the mYPAS scale (Chamberland et al. *Pediatr Anesth* (2024) 34(2):153:159)

Augmented Reality

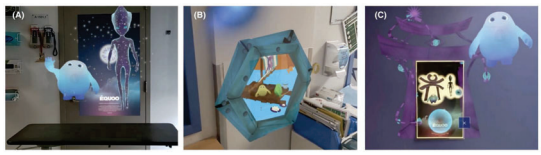


FIGURE 1 (A) Constellation (right side) and Equoo (left side) invited patients to perform progressive muscle relaxation. (B) When looking at a particular poster in the corridor, patients could see characters playing together on their planet through a cosmic window. (C) Patients were presented with a typical cardiac coherence exercise in the OR waiting area.

Consideration of Anesthetic on Procedural Success

- VT
  - No induction of VT is associated with elevated BIS
    - BIS<40 vs BIS>50 (OR 6.92; 95% CI, 1.47-32.56)
  - No induction of VT is an independent predictor of VT recurrence
    - OR 5.01; 95% CI, 1.88-13.83
  - Dong, H., Li, N. & Sun, Z. The effect of anesthesia depth on radiofrequency catheter ablation of ventricular tachycardia: a retrospective study. BMC Anesthesiol 21, 285 (2021). https://doi.org/10.1186/s12871-021-01503-6
- Afib
  - Balancing mapping accuracy, physiological homeostasis, and phrenic nerve mapping
    - High Frequency Jet Ventilation
    - Paralytic yes/no
    - Ventilation adjustments

Questions?