Non-Operating Room Anesthesia for Pediatric Patients

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Objectives

- Describe the common locations & environments outside of the OR where pediatric anesthesia is performed
- Recognize the anesthetic & systems considerations involved in pediatric non-operating room anesthesia
- Identify atraumatic anesthetic approaches & appropriate dosing for the pediatric population
- Deliver care to pediatric patients in offsite locations safely and confidently

Pediatric Offsite Anesthesia

- A large percentage of pediatric anesthesia takes place outside the traditional OR environment.
- Pediatric patients undergoing diagnostic or therapeutic procedures require sedation or even GA for brief or pain-free procedures to manage anxiety & maintain stillness necessary for diagnostic results.
- Anesthesia practice outside of the OR presents unique challenges due to
  - Unfamiliar surroundings
  - Lack of sufficient space & equipment
  - Ancillary personnel who are not familiar with the anesthesia considerations or comfortable with caring for pediatric patients
- A review of the National Anesthesia Clinical Outcomes Registry data found that
  - 22.7% of pediatric anesthesia within the U.S. occurs outside of the OR
  - The majority take place in GI and radiology suites
  - Patients were more likely to have higher ASA classification
- Although the physical location differs, care outside of the OR must be held to the same safety standards that are followed in the OR.
- **With the increasing need to provide anesthesia for children outside the OR, it is important to establish a systematic approach to appropriate patient selection, management, and recovery in order to enhance safety and minimize potential adverse outcomes.**

NORA Locations	Diagnostics & Procedures
• Magnetic Resonance Imaging (MRI) • Computerized Tomography (CT) • Radiation Therapy (RT) • Endoscopy/Bronchoscopy Suite • Interventional Radiology (IR) • Cath Lab	• Radiation therapy • Chemotherapy • Lumbar puncture • Bone marrow biopsy • Line placement • GT exchange • Chest tube insertion • Botox injection therapy • Exam under anesthesia • Suture removal • Dental restoration • Liver biopsy • Ocular cryotherapy • Esophagogastroduodenoscopy (EGD) • Colonoscopy • Bronchoscopy • Foreign body removal • Electrophysiology study/Ablation • Cardiac catheterization • Pacemaker placement/Battery replacement • Postictal spectroscopy

NORA Location Minimal Safety Requirements

Guidelines by ASA for minimal requirements at non-operating room locations
Reliable source of oxygen with backup
Suction apparatus
Waste gas scavenging unit
Standard monitoring
Electrical outlet
Adequate illumination of patient and anaesthesia work station
Staff trained to support the anaesthesiologist
Emergency cart - self-inflating bag, emergency drugs, anaesthesia drugs, defibrillator
Reliable source of communication to call for help
All applicable building and safety codes
Post anaesthesia/procedure care unit

Pediatric Refresher

NPO Guidelines

- Clear liquids: 2 hours
- Breast milk: 4 hours
- Formula/Nonhuman milk: 6 hours

Airway edema

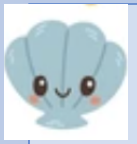
- Small amount of edema reduces the airway diameter = increases resistance
- Risk factors: < 4 years, too large ETT, too much air in cuff, Trisomy 21, recent URI
- Maintain air leak < 25 cm H2O

Prematurity

- Former pre-term infants have a greater risk for post op apnea & reactive airways

Higher anesthetic requirements

- MAC Sevoflurane:
  - 3.2% up to 6 months
  - 2.5% 6 months -12 years
- Propofol: greater clearance & volume of distribution than adults = larger doses



Reactive airways = prone to laryngospasm/bronchospasm

- Increased risk with asthma, prematurity, < 1 year of age, tobacco smoke exposure, recent URI
- Light anesthesia - ensure they are deep prior to start of procedure/instrumenting airway

Treating hypotension

- Almost always treated by correcting hypovolemia and/or decreasing anesthetic agent…not pressors
- 10 – 20 mL/kg of LR or NS

Larger tongues relative to oral volume = obstruct easily

- Prominent tonsils & adenoids
- Oral airway, jaw thrust/chin lift, or shoulder roll to relieve obstruction

Recent upper respiratory tract infection

- Increased risk of airway reactivity & pulmonary complications: bronchospasm, laryngospasm, mucous plugging, desaturation events, atelectasis, hypoxia/increased O2 requirements in PACU
- Delay anesthesia 2-4 weeks after onset of symptoms, risk of pulmonary complications persists up to 6-8 weeks

- Loose teeth (…if you pull a tooth, the tooth fairy must pay $ a visit!)
- First anesthetic exposure…should always be prepared for allergic reactions & malignant hyperthermia

Pediatric Refresher

Pediatric Respiratory Physiology

- The number of alveoli continue to rise until a child is around 8 to 10 years old
- The younger the child, the smaller the alveolar surface area (neonatal alveolar surface area is 1/3 of the adult) resulting in decreased functional residual capacity (FRC)

Supply & Demand: Experience oxygen desaturation much faster than adults…subsequent bradycardia

- Increased demand: increased O2 consumption to support higher metabolic demands
- **Increased supply**: increased alveolar ventilation to increase supply (**high respiratory rate**)
- Decreased reserve: slightly decreased FRC = reduced O2 reserve

Active Parasympathetic Nervous Systems

- Bradycardia can occur with hypoxia…essential to treat the hypoxia - cardiac output is dependent on heart rate!
- May respond to noxious stimuli with profound bradycardia

Safety & System Considerations in Offsites

PATIENT SELECTION

- Preanesthetic evaluation: regardless of the anesthetizing location the priorities of the assessment remain the same
  - Appropriate NPO status? Recent or current URI? Airway/Respiratory/Neuro status? Anticipated difficult airway/IV access?
- Comorbidities
  - Prematurity, Obesity, OSA, Autism/Developmental delays, Congenital heart disease, Asthma, Neuromuscular disease
- *Post-procedure disposition?*
- **Minimally invasive procedure does NOT equate to LESS anesthetic risk!!**

MONITORING & MANAGEMENT

- Unfamiliar environment & staff
  - comfort of providers caring for pediatric patients? (nursing staff, techs, proceduralists, residents, fellows)
- Not set up in a way that's conducive to delivering anesthesia or managing airway
- Equipment, supplies, & drugs not stored in the same place or at all
- Necessities: pulse oximetry, ETCO2 capnography, EKG, BP, temp, oxygen source, appropriate size Ambu bag & suction
- Pediatric specific: IV set up ready to go, epinephrine, atropine, succinylcholine (with IM needle), and emergency airway equipment.
- Limited resources & appropriate equipment for pediatric patient emergency - Peds or Broselow cart? MH cart? CMAC or Video scope? Ultrasound or vein finder?

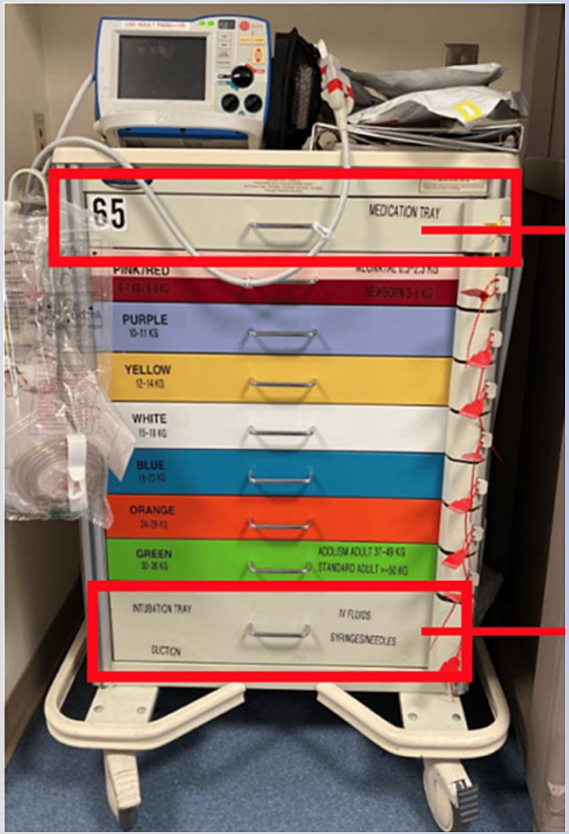
RISK MITIGATION

- People tend to panic very quickly in pediatric emergencies – have a plan BEFORE an emergency happens, who are they going to call and how?
- Educate & direct – do not touch the patient until PIV is in place or the airway is secure, ETT is taped, etc. – *respectfully communicate needs & expectations*
- Airway related events - most common causes of laryngospasm are going to be light anesthesia, secretions, & desaturation
- Treatment for a laryngospasm - 100% FiO2, jaw thrust/chin lift, oral/nasal airway, continuous positive pressure, deepen sedationwith propofol , minimize stimulation, Succinylcholine
- **Call for help early!**

PACU/RECOVERY

- Not typically comfortable with patients coming out deep with oral airways
- Emergence delirium?
- PACU often consist of only a couple of beds with limited nursing staff…cannot be giving everyone precedex
- Know your environment!

Broselow ColorCode Carts




SIEMENS
GNETOM Avanta

Pediatric Anesthetic Considerations NORA Locations

- Goals
  - Adequate anesthesia for procedure/imaging
  - Minimal or complete absence of movement
  - Quick onset
  - Fast wakeup
  - Minimal respiratory depression/obstruction
  - Easy to titrate to effect – less is more!

- Can this be accomplished without anesthesia?
  - Feed & wrap MRI
  - Mature enough to lay still with distraction/parents in room?

- How are you inducing this patient?
  - Do they have working IV access?
  - Do you have the ability to perform inhalation induction?
  - Can parents accompany the patient?
  - Do they need to be premedicated?

- What is required of this procedure/diagnostic test?
  - Does the patient need to be apneic? (ex: abdominal MRI)
  - Do they need complete absence of movement?

- How invasive/painful/stimulating is it going to be?
  - Can they be managed with a hypnotic agent or is analgesia required?

- Temperature measurement & management
  - Typically cold environments & children do not tolerate
  - Ability to measure temperature & how are you keeping them warm

- Are they working in the airway?
- Will you have access to the patient/airway?
- Duration
- Positioning
- Provider performing the procedure?
- Age of the patient chronologically & developmentally
- Comorbidities
- Is this patient a candidate for offsite anesthesia?
- Do I need to intubate this patient?
- Communication is key!

Procedure/ Imaging	Stimulation/Pain	Level of Anesthesia	Special Considerations
MRI/CT/RT	Not painful, analgesia not typically required	• Ideally propofol sedation (if the patient is a candidate) with O2 via NC • Consider midazolam if the patient is older & requires light sedation.	• Depending on scan, may require apnea (LMA or ETT) • GA with LMA/ETT may be required if a patient is an aspiration risk or has airway obstruction that cannot be corrected with positioning or nasal/oral airway • Greater physical distance between you & patient - **patient is far away, not easily accessible!** • Infusion pump tubing/oxygen tubing/circuit extension long enough to reach patient in scanner • Specific size angiocath for contrast? Oral contrast? • MRI-compatible equipment is required • Scans/therapy can be very fast
Endoscopy – EGD, colonoscopy	Not typically painful, *insertion of scope stimulating*	• Ideally propofol sedation (if the patient is a candidate) with O2 via NC • Consider adjunct of Fentanyl to decrease cough reflex with EGD	• GA with LMA/ETT may be needed if a patient is an aspiration risk or has airway obstruction that cannot be corrected with a chin lift or nasal or oral airway
IR - central line/PICC placements, GT exchange, chest tube insertions	Can be painful procedures	• May necessitate deep sedation or GA to manage pain • If propofol sedation with SV, adjuncts such as fentanyl & midazolam may be needed to decrease propofol requirement	• Consider midazolam/fentanyl if patient is older & requires light sedation • Procedures can range from simple to complex, & patients can have significant comorbidities
Oncology – BM biopsy, LP with intrathecal chemo	Stimulating/Painful procedures	• May necessitate deep sedation or GA to manage pain • If propofol sedation with SV, adjuncts such as fentanyl & midazolam may be needed to decrease propofol requirement	• Consider midazolam/fentanyl if patient is older & requires light sedation
Miscellaneous - Botox injection therapy, liver biopsy, EUA, suture removals	Stimulating/ Potentially painful	• May necessitate deep sedation or GA to manage pain • Ideally mask management with natural airway & spontaneous ventilation • Consider Fentanyl & multimodal agents	• GA with LMA/ETT may be needed if a patient is an aspiration risk or has airway obstruction that cannot be corrected with a chin lift or nasal or oral airway. • Typically very fast procedures/exams

APSF Closed Claims Data for NORA Procedures

- In more than half of NORA-related claims involving deaths, patients were deemed to have received **substandard anesthesia care *preventable by improved monitoring techniques.***
- **Suboptimal care** and **failure to provide safe practice** were seen as the ***leading cause of poor outcomes*.**
- Most claims were related to **respiratory events, specifically inadequate oxygenation** and**/or ventilation**.
- **Monitored anesthesia care** was the **most common anesthetic technique** used, contributing to *50% of claims*.
- **Oversedation** leading to **respiratory depression** was implicated in *a third of all claims.*

Does the anesthetic make a difference?

FEATURED ARTICLES: ORIGINAL CLINICAL RESEARCH REPORT

Respiratory Adverse Events After LMA® Mask Removal in Children: A Randomized Trial Comparing Propofol to Sevoflurane

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Anesthesia & Analgesia 136(1):p 25-33, January 2023. | **DOI:** 10.1213/ANE.0000000000005945

- Sevoflurane vs. Propofol and adverse respiratory events
  - *Anesthesia & Analgesia* January 2023
  - Prospective, randomized, double-blind clinical trial comparing respiratory adverse events after LMA removal in children 6 months to 7 years old who received general anesthesia using TIVA with Propofol vs Sevoflurane.
  - The respiratory adverse events were assessed by a blinded clinician who had no idea which anesthetic technique was used.
  - The study randomized 134 patients to the Sevoflurane vs Propofol groups and found that **children in the propofol group had significantly lower incidence of respiratory adverse events 10.8% vs 36.2% and lower severity.**
  - **There was less coughing, laryngospasm, & desaturation in the Propofol group.**
  - **The Sevo group had 7 cases of laryngospasm vs 1 in the propofol group.**
- Propofol attenuates airway reactivity & may reduce the risk of bronchospasm
- Other purported benefits of TIVA include less emergence agitation and less PONV

Review of Anesthetic Dosing for Pediatrics

Midazolam	**PO** for premedication: 0.5 – 0.75 mg/kg (max 20mg) **IV/IM:** 0.05 - 0.1 mg/kg	**Atropine**	**IV/ET:** 10 - 20 mcg/kg **IM:** 20 - 30 mcg/kg
Dexmedetomidine	**Intranasal:** 2.5 mcg/kg **IV**: 0.25 - 1 mcg/kg ***caution bradycardia*** **Infusion**: 0.5 - 1 mcg/kg/hr	**Epinephrine**	**IV:** 10 mcg/kg **ET:** 100 mcg/kg
Ketamine	**IM:** 3 - 4m g/kg **IV:** 0.5 - 2 mg/kg **Infusion:** 20 mcg/kg/min	**Succinylcholine**	**IV:** 1 - 2 mg/kg **IM:** 4 mg/kg
Propofol	**IV bolus:** 2 - 3 mg/kg **Infusion:** 50 up to **300 mcg/kg/min**	**Dexamethasone**	**IV:** 0.25 - 0.5 mg/kg (max 10mg)
Fentanyl	**IV:** 0.25 - 2 mcg/kg **Intranasal**: 1 – 2 mcg/kg	**Ondansetron**	**IV:** 0.1 - 0.15 mg/kg
Remifentanil	**Infusion:** 0.1 – 0.5 mcg/kg/min	**Acetaminophen**	**IV:** 10-15 mg/kg
Glycopyrrolate	**IV**: 4 - 10 mcg/kg	**Ketorolac**	**IV:** 0.5 mg/kg

Peds Pearls

- Individualized Care
  - Developmental stages & age specific anxieties
  - **Infant:** bring their binky or blanket
  - **Toddler:** fear of separation from parents, get on their level, show that mom/dad/stuffed animal uses the mask
  - **School age:** explain the process to them, bring comfort items, let them hold the mask, decorate it with stickers, verbalize what they are fearful/anxious about
  - **Adolescents:** include them in the discussion/plan, give them choices, keep them covered
  - Nitrous PIV? Hurricane cold spray? EMLA cream? PO premed?
  - Non-pharmacologic methods to reduce anxiety & improve cooperation – play therapy, presence of parents during induction/IV placement
- Family-centered Care
  - Set appropriate expectations
  - Explain the process of inhalation induction – fighting/crying, eye rolling, dystonic movements – all normal! Acknowledge that it is scary for them to see their child this way
  - Children feed off of their parents reactions…
- Developmental Delays
  - Therapeutic toys, counting, do one thing at time, low stimulation (noise), ask the parents!
- Distractions: music, TV shows, games
- Child life specialists

Thank you!

References

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