

Naval Medical Center Portsmouth Pediatric Anesthesia Practice Guidelines



Revised Jun 2022

**Naval Medical Center
Portsmouth, Virginia
Pediatric Anesthesia Practice Guidelines**

The purpose of the manual, is to provide guidance and a systematic approach to pediatric anesthesia. While there are many variants of the practice of pediatric anesthesia, learning how to set up in a systematic way, will help to organize your thoughts and give you a safe, dependable way to safely anesthetize children.

Table of Contents

Preoperative

- 1) URI
- 2) Ambulatory Surgery
- 3) NPO Guidelines
- 4) Pre-operative Sedation/Parental Induction

Intraoperative

- 1) Room-set up
 - Room temperature
 - Warming Measures
 - MSMAIDS
 - Machine
 - Suction
 - Monitors
 - IV
 - Drugs
 - Special
- 2) BLITS scan
- 3) Intraoperative Analgesia
 - Medication Charts
 - Methadone Tutorial
 - Regional Anesthesia/LAST
- 4) Blood Products and Transfusion
- 5) Neuromonitoring

Postoperative

- 1) Transport and Disposition
- 2) Emergence Delirium
- 3) Post-Operative Nausea and Vomiting
- 4) PACU Sign Out and OSA Guidelines

Remote Anesthesia

Emergencies

- 1) Anaphylaxis
- 2) Bronchospasm
- 3) Laryngospasm
- 4) Fire
- 5) Hyperkalemia
- 6) Intracranial Hypertension
- 7) Malignant Hyperthermia
- 8) Masseter Muscle Spasm
- 9) Unexpected Cardiac Arrest

Pediatric Vital Signs

Phone Numbers

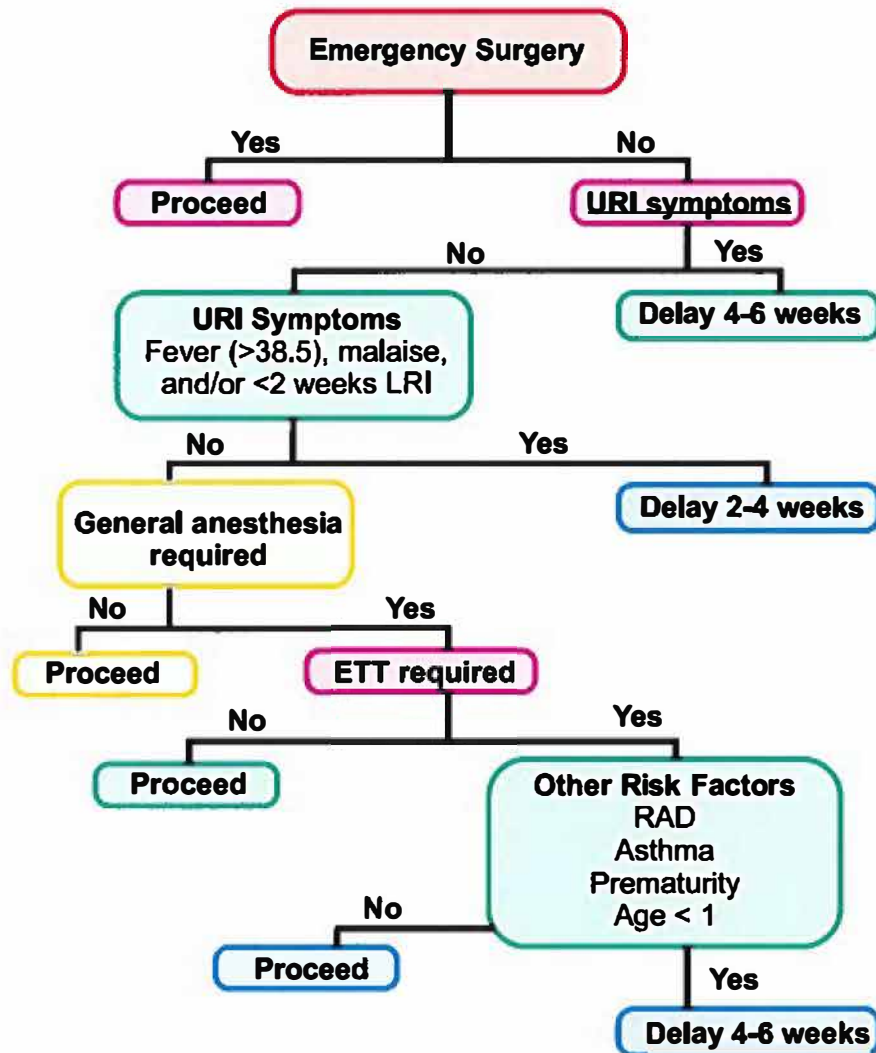
SBE Prophylaxis Guidelines

References

Pre-operative

1) The Child with a URI

The typical child has, on average, 6 URI's per year with each infection lasting 1-2 weeks and residual airway reactivity for an additional 2-4 weeks. Lower respiratory tract infections (LRI's) may last 2-4 weeks and leave the airway reactive for an additional 4-6 weeks. Therefore, a child has at least a 50% chance of having a reactive airway at any given time. The following flow chart may be used to determine the suitability of a child with recent URI for surgery.



Pre-operative

2) Ambulatory Surgery and the Ex-Premature Infant

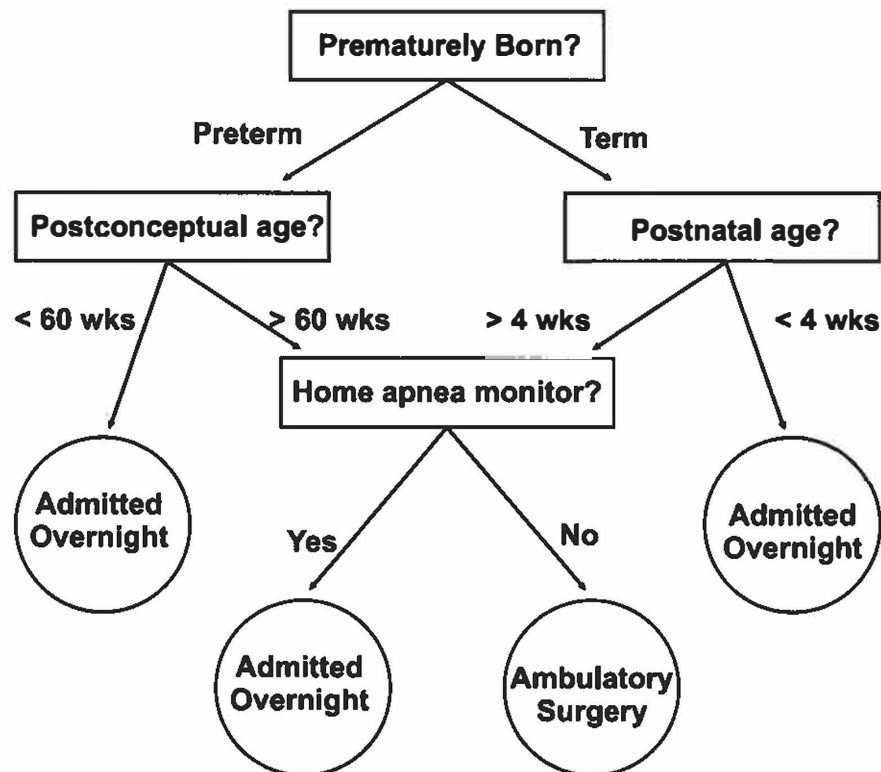
Postoperative apnea and bradycardia commonly occur in premature* and former premature infants who have received general anesthesia. Additionally, full term infants less than 44 weeks post-conceptual age are considered to be at risk for apnea and bradycardia. Anemia (hematocrit <30%) is also an independent risk factor for postoperative apnea.

Apnea is defined as the absence of breathing for a period of greater than 15 seconds, which is frequently accompanied by bradycardia.

As a result of increased risk for postoperative apnea and bradycardia, elective surgeries are postponed in infants until they are deemed no longer at risk. If an infant at risk must undergo a procedure, it is imperative that these patients have appropriate monitoring for the first 24 hours postoperatively.

The following are the guidelines we will use at NMCP:

**Premature is < 37 weeks post-conceptual age*



Pre-operative

3) NPO guidelines

2 hours	Clear Liquids
4 hours	Breast Milk
6 hours	Formula/ non-human milk
8 hours	Solid Food

4) Preoperative Sedation/Parental Presence During Induction

A smooth transition from the awake state to the anesthetized state is desirable for all patients, regardless of age. Pediatric patients are uniquely challenging because of their inherent distrust of people who are unfamiliar to them ("stranger anxiety"), which generally occurs in children older than 8-9 months. To overcome the obstacle of stranger anxiety one can: 1) keep a familiar person with the child at all times while the patient is awake or 2) pharmacologically alter the child's mood. The latter option is especially attractive because it is very frequently successful, it decreases the incidence of recalling a trip to the operating room, and it facilitates not having the parent attend induction of anesthesia in the operating room. Parental presence in the operating room, while certainly not forbidden, is not without risk to the parent or operating team. Although it may not be desirable for us to have parents in the operating room, they should never be told that they absolutely cannot be present in the operating room for an otherwise routine induction—even if the child has been sedated preoperatively.

PO medications:

- 1) Routine anxiolysis: Midazolam 0.5-0.7 mg/kg PO to a max dose of 20mg.
- 0.7 mg/kg for younger children
- 2) Ketamine 4-5 mg/kg may be mixed with 0.5-0.7mg/kg cherry flavored midazolam
- 3) Clonidine 2mcg/kg PO mixed with 10 mL juice

Intranasal medications:

- 1) Dexmedetomidine 2-3 mcg/kg
- 2) Midazolam 0.2mg/kg (stings, use concentrated 5mg/mL)

Intramuscular medications:

- 1) Ketamine 3-8 mg/kg
 - 2) Glycopyrrolate 0.005 mg/kg
 - 3) Midazolam 0.05 mg/kg (use concentrated 5mg/mL)
- Mix all three together, to give anesthesia, amnesia, anti-hallucinogen (midazolam), anti-sialagogue (glycopyrrolate)

Intraoperative

1) Room Setup

Request Pediatric Cart on Wishlist

Room Temperature:

Warm the room for all neonates, infants, and small children. Heat loss occurs most with extremes of age. Convection and radiation account for 85% heat loss, while conduction and evaporation account for the other 15%. Pre-operative warming is the most effective way to prevent heat loss during anesthesia.

- Heat room to >26C or 79F.
- Call Facilities Management at 757-953-0050, 3-0050, or ask the room nurse for assistance

Radiant Warmer ("French Fry") Lights:

- Place in OR for all children under one year of age, less than 10 kg, syndromic, CP, or for very long procedures.
- Maximum effectiveness on an uncovered patient
- Flexible ruler that unrolls from lamp and shows the correct distance from lamp to patient (if the light has the ruler...some do not)

Pediatric Warming Blankets:

- Bair hugger underbody or warm water mattress for every case
- Have Bair hugger set to 43C or warm water mattress at 38-40C

MSMAIDS:

Machine:

- Start Anesthesia machine, monitors, and computer.
- Log into Essentris and Innovian
- Routine ventilator machine check should be performed at the beginning of the day, to include routine automated machine check, volatile agent levels, manual check of ability of machine to hold positive pressure, and patient's information (peds vs infant vs neonate, and wt). Ensure a pediatric circuit is on the ventilator. The large blue filter may be removed, or placed on the expiratory limb on the machine side. Ensure a Jackson-Rees in room for hand ventilation in emergencies with an oxygen tank. For patients >50 kg, an adult circuit should be placed. Keep the machine plugged into a red outlet (generator power), in the event of power loss. Remember the battery life on the machine will give you the ability to run volatile agent and oxygenate/ventilate your patient for up to 30 minutes.
- Between cases, pressure test must be conducted after every circuit change

Intraoperative

Suction:

- Suction canister and tubing should be hooked up to the ventilator. Turn On.
- Small, straight suction catheter or 10-14 Fr suction catheters for neonates and infants
- Yankaur or straight suction for older children
- ETT suction catheters available (6 Fr for 2.5-3.5 ETT, 8 Fr for 4.0 – 4.5 ETT, 10-14 Fr for ETT larger than 5 ETT)

Monitors:

- Pulse Oximeter, blood pressure cuff, EKG leads. Have temperature cable ready to insert into the patient after induction.
- Lay cables at the top of the bed, ready for immediate placement on the patient
- For more complex cases, check the technician has set up the transducers for central and/or arterial lines
- Set up for any extra monitoring required for the case (BIS, TEE, etc)

Airway:

- Facemask sized for age and weight
- Oral airways sized for age and weight (measure tragus of ear to edge of mouth)
- Nasal trumpets are on the cart...normally do not use these in the small children
- LMA sized for age and weight (see top of LMA package)
- Laryngoscope and blade sized for age and weight
 - Premature neonates: Miller 00 or 0
 - Term neonates: Miller 0 and Miller 1
 - Infants and toddlers to 18 months: Miller 1
 - Toddlers 18 months to 4 years: Wis 1.5 and Macintosh 2
 - Children age 4 to 10 years: Macintosh 2 (or Miller 2) and Macintosh 3
- ETT sizes one above and one below
 - **Use cuffed ETT's**, unless a neonate requires a 2.0-2.5 ETT. If using a 3.0, have cuffed and un-cuffed available.
 - Stylet the ETT with the end of the stylet right above the Murphy eye
 - **Do not inflate cuff right after intubation**, listen over the trachea for a leak at 20 cm H₂O.
 - If large leak at 20 cm H₂O, add air until leak either just goes away, or a very small leak still appreciated
 - If no leak at 20 cm H₂O, go to 25 cm H₂O. If still no leak, exchange out the tube.
 - If a longer case, make sure there is a leak at least at 20

Intraoperative

Pediatric Endotracheal Tube Sizing

ETT size	AGE
2.0-2.5 uncuffed	extreme premie/tracheal stenosis
3.0cuffed/uncuffed	premature infant up to term neonate
3.5 cuffed	young infant to 12 months of age
4.0 cuffed	12-24 months of age
4.5 cuffed	24 to 36 months
(Age/4 + 4) = ETT size uncuffed tubes (Age/4 + 3.5) = ETT size cuffed tubes	
Depth of placement: 3 X ETT diameter = distance at the lips. *For Neonates: 1/2/3/4 kg = 7/8/9/10 cm @ gum lin	

IV:

- <15 kg use 500 ml bag of LR with Buretrol filled to 20 mL/kg
- >15 kg 500 mL bag of LR with microdripper
- Maintenance fluids: 4mL/kg/hr 1st 1-10 kg + 2 mL/kg/hr next 10-20 kg + 1 mL/kg/hr for > 20 kg
 - **Rule of Thumb:** For patients over 20 kg, add 40 to weight in kg, and that is your hourly maintenance rate
 - Glucose addition to fluids:
 - Newborns and Premature Infants
 - D10W or TPN at maintenance rate (4ml/kg/hr).
 - Lipid infusions may be discontinued during operative procedures after discussion with the surgeon and neonatologist.
 - Neonates (Not Requiring IV Dextrose) and Infants up to 3 Months
 - D5LR at maintenance rate (4ml/kg/hr).
 - To prepare D5LR, dilute 10 ml of D50 in a 100 ml aliquot of LR in the buretrol or 5 mL D50 into 50 CC LR.
 - Children Greater than 6 Months
 - No additional dextrose is necessary unless there is a history of hypoglycemia or the existence of a risk factor for hypoglycemia.

Intraoperative

- IV start kit in bottom drawer pediatric cart = IV leash (flush with NS syringe), tourniquet, chlorhexidine swab, 2x2's, small tegiderm, and tape. Add small veniguard and two each of the 24 and 22 gauge IV catheters. -Have IV kit ready on ventilator table next to airway equipment. D/W staff if larger PIVs/#PIVs to be used for larger patients or big cases.
 - Rule of Thumb: if the fluid hung is > 20-30 cc/kg, then can be dangerous for volume overload. Always watch the flow of your IV, and the amount of fluid that is hung.
- Place ultrasound in room if anticipated difficult IV start
- IV setups should be requested on the "wish list" in the anesthesia workroom on the day prior to surgery. The anesthesia corpsmen will place them on the IV pole in your OR. **It is the responsibility of the anesthetizing team to ensure all air bubbles are removed from the tubing.** Flush the medications ports prior to use, as air is trapped here and ends up in the line.
- Central line or arterial line placement, D/W staff their preference for size of the cannulating catheter or line used/set up
- Fluid warmers for larger cases with anticipated blood loss or hypothermia, ask the techs to help with warmer and tubing setup
- Request Belmont or rapid infusion if concern about massive transfusion protocol

Line sizing:

Arterial Line

Radial (24g for <5kg, 24-22g for 5-10kg, 22g for 10-20 kg, 20g for >20kg);

Femoral (22g for <20kg, 20g for >20kg; consider using single lumen CVL)

Central Line

Internal/External Jugular Vein: 4fr, 5cm for <5kg; 5fr, 5cm for 5-15kg; 5fr, 8cm for 15-30 kg; adult CVL for > 30kg

Femoral vein: 3fr, 5cm for 5kg-20kg, 5fr, 8 cm for 20-30 kg; Adult 2 lumen for >30 kg

Guidewires

24g catheter: 0.015 inch wire (Cook)

22g catheter: 0.018 inch wire (Arrow)

20g catheter: 0.025 inch wire (Arrow)

General Procedure set up

POSITION: Optimize your patient for the procedure. Positioning is half the battle in many procedures.

PREP: Have your prep ready and on the field

POKE: Have all kits, needles, medications, ultrasounds, etc set up and ready for quick access while you are scrubbed into your procedure.

You will learn to optimize your equipment, and your hand positioning as you get better and quicker at lines, neuraxial blocks, peripheral nerve blocks, etc.

Intraoperative

Medications:

- D/W staff medications needed for the day's cases.
- Full medications chart provided later in the book
- Emergency drugs as per below:

Drugs	IM	IV
Succinylcholine:	4 mg/kg	2 mg/kg
Atropine:	20 mcg/kg	20 mcg/kg
Epinephrine:		10 mcg/kg

20 mg/mL
100 mcg/mL

Succinylcholine and Atropine:

- Calculate out the dose for all patients in mg (SUX), mcg (Atropine), and mL. Write next to your patient's name on your daily work sheet.
- Draw up one syringe of Succinylcholine and Atropine based on the largest patient of the day.
- Place a 23 g needle on each syringe for quick access for IM injection
- Remember, for patients with burns, severe CP, immobile you can use IM rocuronium 2 mg/kg instead of SUX, to prevent hyperkalemia

Epinephrine:

- For patients < 10 kg, dilute epinephrine down to 10 mcg/mL, some staff may request down to 1mL/kg
- Easy way to do dilution: use epinephrine from grey code burstajet which is 100 mcg/mL. Add 1 CC (100mcg/mL) to 9 cc normal saline = 10 mcg/mL
- ANAPHYLAXIS DOSING IM = 0.15-0.3 mg IM

2) BLITS scan intraoperatively to keep you on track:

Breathing

- SpO2---look at number, FiO2
- EtCO2---look at the number, waveform
- PIP, PEEP, TV, I:E ratio

Level of Anesthesia

- Volatile agent level (MAC)
- IV anesthetics
- Hemodynamics (HR, BP)
- Regional blocks

Intake and Output

- Everything going in and out of the patient (IVF, foley, etc.)

Temperature and Twitches

- Temperature probe, Bair hugger, warmed fluids, etc.
- Neuromuscular blockade, twitches, etc.

Special

- Literally all other monitors...a line, central line, TEE, BIS, etc.

Remember a good scan from right to left or left to right or your monitors, equipment, fluids, etc., as you are doing your BLITS.

Intraoperative

3. Intraoperative Analgesia

Pain control for the pediatric population is comprised of a multi-modal approach to support the enhanced recovery of patients after surgery. In addition to opioid medications, non-opioids adjuncts and regional techniques enhance the pediatric pain experience, and are important in prevention of chronic pain syndromes.

Below is a list of suggested adjuncts. A table is provided with the medication dosing for both opioid and non-opioid medications.

Mild pain

- Acetaminophen, NSAIDS, Dexamethasone, Dexmedetomidine, Esmolol

Moderate pain

- Ketamine, Lidocaine, Magnesium

Severe pain

- Gabapentin, Methadone

Acetaminophen dosing chart:

Age	IV Dose/hour	Max dose	PO Dose/hr	Max dose
28-32 weeks	7.5 mg/kg Q 8hrs	22.5 mg/kg/day	10-12 mg/kg Q 6 hrs	40 mg/kg/day
33-36 weeks	7.5 mg/kg Q 6hrs or 10 mg/kg Q 8 hrs	40 mg/kg/day		
37-44 weeks	10 mg/kg Q 6 hrs	40 mg/kg/day		
>44 weeks	15 mg/kg Q 6 hrs	60 mg/kg/day		

Medication Chart

Assume IV dosing for all drugs on the chart unless specified as other next to the drug listed.

Drug	Dosage
Acetaminophen	See chart above
Adenosine	0.1 mg/kg rapid push (max 6 mg), second dose 0.2mg/kg (max 12 mg)
Albuterol	4-8 puffs or 2.5 mg neb
Amiodarone	5 mg/kg load (300 mg max),
Ampicillin	25-50 mg/kg
Atropine	IV: 20 mcg/kg ETT code: 40-60 mcg/kg
Calcium chloride (watch PIV infiltration)	10-20 mg/kg
Calcium gluconate	30-50 mg/kg
Cefazolin	30-50 mg/kg
Cefoxitin	25 - 40 mg/kg
Celebrex	PO: 1-2 mg/kg BID
Cisatracurium	0.15-0.2 mg/kg

Intraoperative

Drug	Dosage
Clevidipine	<u>Bolus</u> : 10-15 mcg/kg (max 250 mcg) <u>Infusion</u> : 1-2 mg/hr = 2-4 mL/hr or 1mcg/kg/min up to 10 mcg/kg/min
Clindamycin	10 mg/kg
Clonidine (Epidural)	1-2 mcg/kg
Dexamethasone	<u>Antiemetic dose</u> 0.1 <u>Airway dose</u> 0.5 mg/kg (max 16 mg)
Dextrose	0.5-1 g/kg (D 50) 2-4mL/kg (D 25) 5-10 mL/kg (D10)
Dexmedetomidine	<u>Bolus</u> 0.5 - 1mcg/kg/min load—10 min <u>Infuse</u> 0.1-1 mcg/kg/hr <u>Intranasal</u> 2-3 mcg/kg <u>Sleep Endoscopy</u> : run at 2 mcg/kg over 10 minutes during procedure
Diazepam	0.1-0.2 mg/kg
Diphenhydramine	0.5 – 2 mg/kg (max 50 mg)
Dobutamine	<u>Infusion</u> : 2-20 mcg/kg/min
Dopamine	<u>Infusion</u> : 2-20 mcg/kg/min
Ephedrine	0.2-0.3 mg/kg
Epinephrine	<u>Code</u> : 10 mcg/kg <u>Infusion</u> : 0.1 – 1 mcg/kg/min <u>Crup</u> : 3 mL of 1mg/mL epi into 3 mL NS = 0.25 mL racemic epi for inhalation <u>Anaphylaxis</u> : 0.15 – 0.3 mg IM
Etomidate	0.2-0.3 mg/kg
Esmolol	<u>Bolus</u> : 0.1-0.5 mg/kg <u>Infusion</u> : 25-350 mcg/kg/min (titrate to effect)
Fentanyl	<u>Bolus</u> 0.5-1mcg/kg <u>Infusion</u> 1-2 mcg/kg/hr
Flumazenil	10 mcg/kg (max 0.2 mg)
Gabapentin	5-40 mg/kg/day divided into 3 doses for children $\geq$ 3 YO
Glycopyrrolate	5-10 mcg/kg
Hydrocortisone	Adrenal insufficiency: <u>Minor procedure</u> 3-5x maint. Dose <u>Major procedure</u> 5-10 x maint. Dose with 1-2 day taper <u>Acute adrenal insuff</u> : bolus 2mg/kg (max 100 mg)
Hydromorphone	<u>Bolus</u> 5-10 mcg/kg <u>PCA</u> : infusion 1 mcg/kg/hr demand 10-30 mcg/kg, 10 min LO
Ibuprofen	5-10 mg/kg
Insulin	0.1 U/kg
Ketamine	<u>IV</u> : 0.5-2 mg/kg <u>IM</u> : 3-4 mg/kg <u>PQ</u> : 4-5 mg/kg <u>Infusion</u> : 0.1-0.25 mg/kg/hr

Intraoperative

Drug	Dosage
Ketorolac (IV/IM)	0.5 mg/kg (max 30 mg), watch in infants less than 6 mo old
Labetalol	0.1 mg/kg
Lidocaine	<u>Bolus</u> : 1-1.5 mg/kg <u>Infusion</u> : 30mcg/kg/min = 1.5mg/kg/hr 33 mcg/kg/min = 2mg/kg/hr
Lorazepam	0.25-0.5 mg Q 6 hrs
Magnesium	25-50 mg/kg (max 2 g)
Midazolam	<u>IV</u> : 0.05 mg/kg <u>PO</u> : 0.5-0.7 mg/kg <u>Nasal</u> (stings): 0.2 mg/kg
Morphine	<u>IV</u> 25-50 mcg/kg q4h <u>intrathecal</u> 2-5 mcg/kg <u>epidural</u> 20-50 mcg/kg <u>PCA</u> : <u>infusion</u> 5 mcg/kg/hr <u>demand</u> 2-6 mcg/kg, 10 min LO <u>cont. infusion</u> 5-10 mcg/kg/hr
Methadone	0.1-0.2 mg/kg (lean body weight)
Nalbuphine	50 mcg/kg q4h
Naloxone	<u>IV</u> : < 20 kg = 100 mcg/kg (max 200 mcg) >20 kg = 2 mg <u>Infusion</u> : 0.002 – 0.16mg/kg/hr
Neostigmine	50-70 mcg/kg
Nicardipine	<u>Infusion</u> : 0.5-5 mcg/kg/min
Nitroglycerine	<u>Infusion</u> : 0.25-0.5mcg/kg and titrate up to 1-5 mcg/kg/min
Nitroprusside	<u>Infusion</u> : 0.3-1 mcg/kg/min, titrate up to 8
Norepinephrine	<u>Infusion</u> : 0.1-2 mcg/kg/min
Ondanestron	0.1 mg/kg
Procainamide	15mg/kg over 30 min., do not mix with amiodarone
Propofol	<u>Bolus</u> : 2-5 mg/kg <u>Infusion</u> : 20-300 mcg/kg/min
Phenylephrine	<u>Bolus</u> : 1-10 mcg/kg <u>Infusion</u> : 0.5 – 5 mcg/kg/min
Physostigmine (IV/IM)	0.02 mg/kg (max 0.5mg/dose, 2 mg total) repeat initial dose Q 5-10 min. as needed
Remifentanyl	<u>Bolus</u> : 1-1.5 mcg/kg <u>Infusion</u> : 0.05-2 mcg/kg/min
Rocuronium	<u>Intubating</u> : 0.6 mg/kg <u>RSI</u> : 1.2 mg/kg <u>IM</u> : 2 mg/kg
Sodium Bicarbonate	1meq/kg SLOW bolus or $BE \times WT (kg) \times 0.3$ <u>TCA overdose</u> : 1-2 meq/kg until serum pH >7.45
Succinylcholine	<u>IV</u> : 2 mg/kg <u>IM</u> : 4 mg/kg
Suggamadex	2 mg/kg for 2 twitches 4mg/kg for 2 post-tetanic twitches 16 mg/kg no twitches

Intraoperative

Drug	Dosage
Vasopressin	<u>bolus</u> 0.4U/kg (max 40) <u>infusion</u> 0.0002 – 0.002U/kg/min or 0.2 – 2mU/kg/min
Vecuronium	0.1 mg/kg

*Assume IV dosing for all drugs on the chart unless specified as other next to the drug listed.

Reversal agents (dosing above)

Flumazenil is for benzodiazepines.

Naloxone is for opioids.

Physostigmine is for scopolamine.

Methadone Tutorial:

- Generally used for larger cases that will have monitoring overnight, not same day surgeries
- Doses of 0.15-0.2 mg/kg can be bolused at the start of a procedure, with minimal side effects
- For longer cases, and patients being monitored in PICU, a repeat dose of 0.1mg/kg may be given at the end
- Time from injection to analgesic effect < 10 min, half-life is 36 hours
- Single intraoperative bolus improve pain for up to 72 hours
- Peak respiratory depression seen within 60 minutes of a single IV bolus
- At small doses, clinical effects terminated by redistribution and elimination half-life irrelevant
- Side effects of prolonged QT and respiratory depression seen doses larger than a single IV intraoperative dose
- Caution if the patients is on any SSRI/SNRI, has severe OSA, or prolonged QT at baseline

Regional Anesthesia:

In the younger pediatric population, neuraxial techniques are generally done after the patient has been anesthetized, given the danger of trying to place a block on a moving target.

In the adolescent population, a choice may be given to the patient as to whether they would like the block placed with some sedation or asleep. For communication purposes (parasthesias, test dosing of epidurals, etc), if the older pediatric patients (> 12 YO) can tolerate a sedated block placement, that is preferred.

Caudal Block

Indications: May produce analgesia up to the T-6 level. Commonly used for genitourinary procedures and hernias. May be used for thoracic procedures, when a catheter is threaded.

Contraindications: any major deformities over the site of the block, sepsis, coagulopathy, parent or patient refusal

Equipment: 22 g angiocatheter or b-bevel needle (better pop with b-bevel needle), sterile gloves, chloroprep, 10 mL syringe with leash

Medications: Ropivacaine 0.2% 1:200K (5 mcg/mL) Epinephrine. Mix 100 mcg epi into 20 cc vial of 0.2% ropivacaine = 5mcg/mL epi.

Dosing: 0.75 mL/kg sacral roots (circumcision), 1 mL/kg lumbar roots (inguinal hernia), 1.25 mL/kg lower thoracic roots (orchiopexy)

***May be re-dosed after a longer case of ~3 hours

Adjuncts: Clonidine (preservative free) 1-2 mcg/kg, Morphine (preservative free) 30-50 mcg/kg

Rule of thumb: when you are in the caudal space, the 10 cc syringe should push like a good IV. Use the same size syringe with each caudal block to ensure you know the feel.

*Ropivacaine has been chosen as the local anesthetic of choice, given better cardiac safety profile compared with bupivacaine.

*Clonidine can cause apnea, and should be used in the appropriate patient population

*Morphine may be given, but should be done in patients who will be in a monitored bed post-operatively, given the bi-phasic risk (2hrs, 12 hrs) for respiratory depression

*Test dose 0.5 mcg/kg epinephrine to max of 15 mcg after caudal inserted

Positive test dose:

- HR >10 bpm, SBP > 15 mm Hg, T-wave > 25% increase (with properly placed ECG leads)

Caudal Catheter

Generally for children <2 YO. An 18-gauge angiocatheter is inserted through the sacrococcygeal membrane using the same technique as a caudal block. The needle is removed and through the angiocatheter, a 21 gauge epidural catheter is inserted. Stylet catheters will increase the chance for successful localization of the catheter due to their increased rigidity compared to an unstylet catheter. Confirming the level of the caudally-placed catheter can be achieved by examining under fluoroscopy the location of the stylet tip or the spread of injected radiographic contrast (Omnipaque), which is available in the Pain Clinic.

*See epidural dosing (next page) for catheters

Caudal Catheter

Ultrasound guided caudal:

- Beneficial for tough to feel anatomy, or when placing the 18 g catheter for caudal catheters.
- Look up "frog" and "pulsating sign" caudal block on You Tube. Great tutorial.

Epidural Catheter

Indications: Need for prolonged analgesia after a thoracic, intraperitoneal, lumbar, or extensive LE procedure

Contraindications: any major deformities over the site of the block, sepsis, coagulopathy, parent or patient refusal

Equipment: pediatric epidural kit

Placement: Skin to epidural space depth (SED) gold standard 1mm/kg to the epidural space

MRI imaging study changed formula to $SED = 9 + (0.62 \times \text{wt in kg})$, more precise than the 1mm/kg (Vanderbilt study)

Use saline for loss of resistance technique and NOT air, given risk for air embolism especially in the smaller patients

Medications: test dose 0.5 mcg/kg epinephrine (EG: 10 kg child. 10kgX 0.5mcg/kg = 5 mcg = 1mL of 1:200K epi in local anesthetic), Ropivacaine 0.1%

Dosing:

	Max bolus dose(mg/kg)	Max infusion rate (ml/kg/hr)
Ropivacaine 0.1%	<2 mo 2	0.1-0.25
	>2 mo 3	0.2-0.4
Bupivacaine 0.125	<2 mo 2	0.1-0.25
	>2 mo 3	0.2-0.4

*Ropivacaine is preferred, as less cardiotoxicity and motor block. Bupivacaine dosing provided for those using this book at other institutions who do not have ropivacaine available.

Adjuncts to local anesthetic in epidural solutions (run at local anesthetic rate with the following concentrations):

Clonidine	0.2-0.5 mcg/mL
Hydromorphone	2-5 mcg/mL
Fentanyl	1-2 mcg/mL

*If any narcotic or clonidine is added to an epidural solution, the patient should be monitored in the PICU, given the lack of end tidal CO2 monitoring on the ward (at Portsmouth)

Periperal Nerve Block

Regional Technique	Bolus Dose	Continuous Infusion
Upper extremity blocks	0.2-0.4 mL/kg	0.1-0.2mL/kg/hr
Lower extremity blocks	0.3-0.5 mL/kg	0.15-0.3mL/kg/hr
TAP blocks	0.3-0.5 mL/kg	0.25mL/kg/hr

*Ropivacaine **bolus** dosing 0.2%-0.25% younger children, 0.375% – 0.5% older children (>10 YO)

*Ropivacaine **infusion** dosing 0.1%, usually effective

*May also use Bupivacaine in similar doses, but Ropivacaine preferred at Portsmouth

LAST (local anesthetic toxicity syndrome

SIGNS:

- **Neurologic:** Circumoral or tongue numbness, metallic taste, light headed, visual and auditory disturbances, seizures
- **Cardiac:** block fast sodium channels Purkinje fibers and ventricles = decrease rate depolarization = prolonged PR, widened QRS, sinus bradycardia/arrest

TREAT:

- Stop local anesthetic infusion, request intralipid, secure airway, give 100% O₂
- Treat seizures with benzodiazepines and be prepared to assist ventilation
- Treat hypotension with REDUCED doses epinephrine 1mcg/kg
- PALS, if indicated by heart rhythm, level of clinical stability
- Start Intralipid 20% 1.5 mL/kg over 1 minute, if patient not improving
- Start infusion 0.25 mL/kg/min
- Repeat bolus every 3-5 minutes up to 3mL/kg total dose until circulation restored
- Increase rate to 0.5mL/kg/min if BP remains low or declines
- Continue infusion for 10 minutes after hemodynamically stable
- MAX intralipid 20% dose = 10mL/kg over the first 30 minutes (total bolus and infusion)

***Remember:

- AVOID vasopressin, calcium channel blockers, and beta blockers
- Monitor and correct acidosis, hypercarbia, and hyperkalemia
- Consider alerting nearest cardiopulmonary bypass/ECMO center and ICU if no ROSC after 6 minutes

Blood Products and Transfusion

Component	Dose	Effect
Packed red blood cells	10-15 mL/kg	Increase hemoglobin by 2-3 g/dL
Platelets*	5-10 mL/kg	Increase platelet count by 50,000-100,000/mm ³
Fresh frozen plasma	10-15 mL/kg	Factor levels increase by 15%-20%
Cryoprecipitate	1-2 units/kg	Increase fibrinogen by 60-100 mg/dL

Hg	age	g/dL (normal values)	Hg	age	g/dL (normal values)
	neonate	17		6-24 mo	11-14
	1 mo	10-17		2-5 YO	11-15
	2-3 mo	9-14		5-11 YO	12-15
	4-6 mo	11-12		11-18 YO	12.5-17.5

UNIVERSAL DONORS:

PRBC = O NEGATIVE

FFP = AB POSITIVE

PRBC:

Each 6 mL **WHOLE blood**/kg raises Hg 1 gm

Platelets: NL = 150-200 x 10⁹/L²

Apheresis platelets collected from single donor equivalent to ~4-6 pooled units of random donor platelets.

Apheresis unit contains 200-400 mL plasma

***Neonates and infants <4 months old per NMCP transfusion guidelines PRBC and Platelets:

- Irradiated
- Leukocyte-reduced
- CMV-seronegative preferred (RBCs)
- Sickle test negative If large volume or rapid transfusion: Washed RBC's or RBC units < 5 days old
- Dedicated units

Transfusion Ratio for Blood Components

- PRBC:FFP:PLT:CRYO = 2:1:1:1 (units)

Blood Products and Transfusion cont'

******Watch for hypocalcemia with PRBC transfusion, especially in neonates**

Signs: jittery, hypotension, coagulopathy

NL level: iCal 1-1.25 mmol/L or 4-5 mg/dL

Treat: Calcium Gluconate 30 – 50 mg/kg over 5 minutes
Calcium Chloride 10 – 15 mg/kg over 5 minutes

- 3x more elemental calcium than gluconate
- Watch out for extravasation in small, peripheral IV's, need LG IV or central access

Factor VII

90 mcg/kg

DDAVP

0.3 mcg/kg over 20 min.

Tranexamic Acid

Spines: Load 30 mg/kg, infusion 10 mg/kg/hr

Craniosynostosis: Load 30 mg/kg/hr, infusion 5 mg/kg/hr

Bicarbonate Replacement (mEq)

- (Base Deficit) X 0.3(pt. wt. in kg)

Neuromonitoring

Most spinal fusions with instrumentation and neurosurgical procedures around the foramen magnum, brainstem sensory or motor cortex are performed with neurophysiologic monitoring. Neurophysiologic recordings monitor the function of the cerebral cortex (the EEG, somatosensory evoked potentials, and visual evoked potentials), brainstem (brainstem somatosensory evoked potentials, auditory evoked potentials), and spinal cord (somatosensory evoked potentials and motor evoked potentials). Because of the very low amplitude of the SSEPs (0.1-20mcV), computer signal averaging is used to extract the signal from the background EEG activity. MEPs amplitudes are much greater than those of SSEPs, in the millivolt range as compared to the microvolt range.

SSEPs demonstrate the integrity of the ascending/dorsal columns, whereas MEPs monitor the descending /anterior columns of the spinal cord. It is possible to have focal damage to the motor areas in the spinal cord in which the SEPs remain normal. Because the cortico-spinal tracts travel through the ischemia-sensitive ventral gray matter, MEPs are more easily affected by a decrease in the spinal cord perfusion and oxygenation. MEPs have the additional advantage of providing instant feedback, as no averaging is required. Transient changes of MEPs with normal SSEPs are usually not clinically significant. By contrast, persistent changes are followed by post-operative motor deficits.

Inhalational anesthetics produce a dose-dependent increase in latency and decrease in amplitude. Up to 0.5-1 MAC of an inhalational anesthetic in the presence of nitrous oxide is compatible with adequate monitoring of SSEPs. However there is a high degree of interindividual variability of response. All intravenous agents have minimal effects on cortical SSEPs, except for etomidate and ketamine which actually increase the amplitude. Continuous infusions of propofol 100-200 mcg/kg/min are well tolerated. Muscle relaxants improve SSEPs recording because they suppress EMG activity and provide a cleaner background. High doses of continuously infused opioids are compatible with SSEP monitoring, but bolus doses of opioids as well as other sedatives should be avoided during critical stages of surgery.

MEPs are extremely sensitive to the inhibitory effects of volatile anesthetics. Doses as low as 0.25-0.5 MAC can suppress synaptic transmission. Nitrous oxide, although less suppressive than other inhaled agents, demonstrates a synergistic effect on amplitude depression when combined with other anesthetics. Low dose propofol infusions (50 – 125 mcg/Kg/min) do not substantially depress MEPs responses. If muscle relaxants are used while MEPs are recorded, at least two twitches in a train of four are required for adequate monitoring, and a continuous infusion of a short acting muscle relaxant is preferable. Bite blocks should be used in unrelaxed patients, as masseter contraction will occur with transcranial stimulation which can result in injury to the tongue. Many institutions perform a TIVA with propofol and remifentanyl (or another opioid) for cases involving monitoring of spinal cord integrity.

Infants, young children, and patients with preoperative neurologic deficits have very small cortical signals, which can be lost with even minimal doses of inhaled anesthetics. TIVA has been shown to provide better preservation of SSEPs and deeper level of hypnosis than inhalational anesthetics. In addition to propofol, remifentanyl is infused at 0.1-0.5 mcg/kg/min and titrated according to hemodynamic response. Longer acting opioids should also be titrated at the end of surgery for post-operative pain control.

Alterations in physiologic parameters which alter the sensory and motor EPs	
Temperature	<27°C >42°C
Anemia	Hct<15
Hypotension	MAP<40mmHg
Hypoxia	
Hypocarbica	PaCO ₂ <25mmHg

Neuromonitoring cont'

Agents	Amplitude	Latency
Halothane	↓	↑
Desflurane	↓	↑
Isoflurane	↓	↑
Sevoflurane	↓	↑
Nitrous oxide	↓	↔
Barbituates	↓	↑
Etomidate	↑	↔
Ketamine	↑	↔
Midazolam	↓	↔
Opioids	↔	↔
Propofol	↔	↔

Blood transfusions, crystalloid, dopamine, or phenylephrine as clinically indicated can be used to improve spinal cord perfusion. Midazolam (0.05mg/kg) can be used as an amnestic. Labetalol and occasionally clevidipine are used to control blood pressure. Generally, volatile agent up to 0.7 MAC in combination with IV infusions can be tolerated for neuromonitoring procedures, but one must always check with each neurophysiologist.

Post-Operative Considerations

Patient Transport and Disposition

*****If your patient is a known difficult airway, severe OSA, long case, unexpected complication, will remain intubated, or you need any type of higher level post-operative monitoring...IE 1:1 nursing ratio...call for a NICU or PICU bed (depending on patient age). NMCP does not have end tidal CO2 monitoring on ward beds available or a step down unit.

*****Always have some propofol and a flush with you when transporting pediatric patients. If going to an ICU setting with an intubated or trach patient, bring all airway adjuncts/extras with you.

PACU: Supplemental oxygen should be used for transportation of all infants and for children s/p airway surgery (e.g., T&A).

PICU: Transport with supplemental oxygen (cylinder with at least 1000 psi), Jackson-Reese circuit, monitor (pulse oximetry at a minimum), and consider bringing emergency drugs and airway adjuncts. Have the OR nurse notify the PICU well in advance if patient will remain intubated.

NICU: Have the OR nurse call the NICU well in advance so that NICU nurse and RT can come to the OR for patient transport. Patient is transported in isolette with full monitoring. Intubated patients may be transported with either manual or mechanical ventilation (the RT will set the ventilator to your specifications).

Maintenance Fluids

IV should be saline locked and disconnected or a maintenance fluid written for LR using the 4/2/1 rule (4 ml/kg/hr for the 1st 10 kg, 2 ml/kg/hr for the 2nd 10 kg, and 1 ml/kg/hr for each subsequent kg).

Rule of Thumb: for shorter cases where the patient has already received 20-30 mL/kg fluid, helpful to saline lock the PIV for PACU, so when the child awakens, they are not thrashing around in tangled IV tubing.

Pain Management

Because of the risk of respiratory depression in children, narcotic orders should be written with great care. As a rule, only one class of narcotic should be ordered on the PACU order sheet and the maximum recommended weight-based dose should never be exceeded. Consider using incremental dosing up to the maximum dose (e.g., morphine 0.025 mg/kg IV every 10 minutes to a maximum of 0.1 mg/kg). Keep in mind that the peak onset of respiratory depression for fentanyl is 3-5 minutes and for hydromorphone and morphine is 15-20 minutes.

Special Situations: Children with a clinical or empiric diagnosis of OSA undergoing airway surgery are extremely sensitive to the respiratory depressant effects of narcotics (right shift of the CO₂ curve..). Dosing for these children should, in general, be reduced by half. Children who have received a caudal block should not have narcotics ordered on the PACU order sheet. If a child who has received a caudal appears to be in pain, then the anesthesiologist should personally evaluate the child.

*****Remember that it is better to be called to evaluate a child in the PACU for post-operative pain, then for hypoxemia secondary to respiratory depression from narcotic overdosing.

Rule of Thumb for OSA:

- Children under the age of 3 years with a documented history of OSA undergoing T&A should be admitted overnight minimum to the ward for observation
- Children without a documented history of OSA but demonstrating serious upper airway obstruction should, at the very least, be observed for a prolonged period in the PACU prior to discharge, and discuss with ENT team the possibility of needing a ward bed.
- Severe OSA patients need to be admitted to PICU overnight.
- Pediatric OSA score: mild = <5, moderate = 5-10, Severe = >10

Emergence Delirium (ED)

ED incidence in children ages two to five undergoing general anesthesia is 12-13%, with some reports as high as 30%. The child will have disorientation, non-purposeful movements, detached behavior, inconsolable, thrashing, and avoiding eye contact. The symptoms are self-limiting and resolve in 5 to 20 minutes. Midazolam as a pre-medication does not necessarily decrease ED. Intraoperative TIVA, dexmedetomidine, and propofol 1mg/kg upon emergence (if VA is used) from anesthesia may decrease the incidence. During transport of the child with emergence delirium, it is important to prevent the child from injuring himself by using sufficient restraint. Because of its high incidence in the one to five year-old age group, emergence delirium should be discussed with parents pre-operatively to prepare them should it occur. In PACU, the child may be given dexmedetomidine or 0.5-1mg/kg propofol to help break the ED. Care should be taken with both agents, as dexmedetomidine requires a longer observation period, and propofol can render the child apneic as doses greater than 1mg/kg.

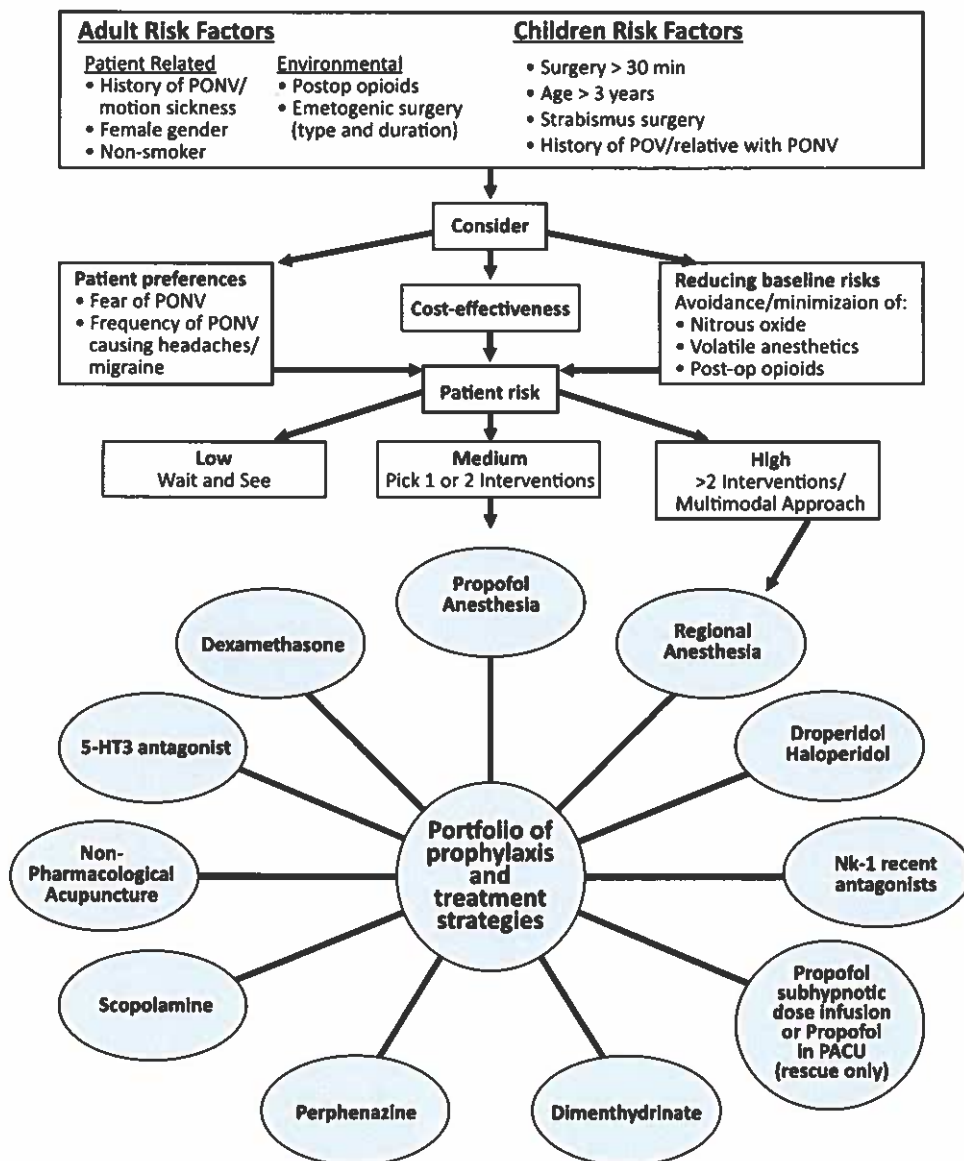
Post Operative Nausea and Vomiting

PONV is more common in children than adults (>20-30%).

Incidence is lower in younger children, but increases in adolescence.

Higher for certain procedures such as T and A, strabismus surgery, and middle ear procedures.

PONV increase child and parental dissatisfaction, delays in discharge from PACU and/or unplanned hospital admissions.



Physician Sign Out

- Every patient should receive a post-operative note for sign out from the PACU staff.
- If your patient is admitted to one of the ICU's, then you need to do a post-operative note yourself.

Remote Anesthesia (Non-OR Anesthesia)

Often in pediatric anesthesiology, we are tasked with providing sedation or general anesthesia for procedures far removed from the OR. Because young children cannot sit perfectly still for these procedures, general anesthesia is most often employed. Typical sites for remote anesthesia include MRI, CT, PET, PICU, Angiography Suite, Fluoroscopy, and Dermatology.

An MRI compatible anesthesia machine is permanently installed in the MRI scanner. An MRI-compatible pediatric cart is also available and is kept in the anesthesia work room. In most other instances, it is possible to have an anesthesia machine and pediatric cart set up in the remote location by our anesthesia corpsmen.

For those providing remote anesthesia in MRI for the first time, it is imperative that you check in with the MRI tech on duty BEFORE entering the MRI scanner. An MRI screening form must be completed, and all metallic objects must be removed from your person prior to entering the scanner. The MRI scanner is a powerful magnet, and there are case reports of serious patient injury and death resulting from metallic objects flying with high velocity into the magnet.

For all remote cases, the minimum set-up should include: pediatric IV; pediatric cart with emergency drugs, IV starting kit, oral airways, laryngoscope, and ETT tubes set out; a Jackson-Reese circuit with pediatric mask; transport oxygen; portable monitor with pulse oximeter; and a transport gurney. A programmable pump with large syringe and PCA tubing may also be helpful for propofol infusions.

When entering the remote site for the first time, make sure to note the availability and location of wall suction and oxygen. These are frequently located far from your area of operation, necessitating extension lines. The techs working in these areas can often locate these extensions for you.

Emergencies---Initiate PALS first for any of these scenarios if patient unstable

Anaphylaxis

Causes = neuromuscular blockers, latex, antibiotics, suggamadex, chlorhexidine (among the top culprits)

- Remove the offending agent
- O₂ to 100%, albuterol, LR or NS 20-30 mL/kg, Epi 1-10 mcg/kg, Vasopressin 10mU/kg, Methylprednisolone 2mg/kg (max 100 mg), diphenhydramine 1mg/kg (max 50 mg), ranitidine 1mg/kg
- Send mast cell tryptase within 2 hours of the event

Rule of thumb: If you obtain a quick CBC and there is hemoconcentration, may be an indicator truly was anaphylaxis, given vasodilation and "leakiness" of the vessels will cause the H/H to go up as the plasma extravasates out of the blood vessels.

Bronchospasm

Causes = multiple!!, light anesthesia, asthma, kinked ETT, mucus plug, recent URI, mainstem or "tickling" carina with ETT, etc.

- 100% O₂, hand bag, auscultate, check ETT depth/secretions/mucus plug, deepen anesthetic, albuterol, epi 1mcg and titrate up as needed. If refractory consider ketamine 1-2 mg/kg, IV steroids
- Consider CXR and possible pneumothorax if above interventions do not work

Laryngospasm

Causes = multiple!! Closure of vocal cords especially during induction and emergence during stage 2/light anesthesia, especially when coupled with a recent uri.

- 100% O₂, hold positive pressure 10-30 cm H₂O. If IV in place: propofol 1-2 mg/kg then step up to SUX 2 mg/kg, If no IV: SUX 4 mg/kg. Atropine 20 mcg/kg can be helpful for the possible bradycardia seen by SUX.

Rule of Thumb: Treat every extubation like the patient is going to laryngospasm. ETT out...facemask on...hold positive pressure at least 10-15 cm H₂O until patient is initiating good breaths

Fire

Causes = O₂ > 30% during airway surgery...yes this includes tonsillectomies

- Decrease your FiO₂ to <30% for all airway surgeries
- If fire occurs = Simultaneous action = Stop fresh gas flow, remove ETT and circuit from patient, remove all other flammable materials, pour saline into airway
 - = Re-intubate and re-establish ventilation, if difficult airway, go for surgical airway
 - = Bronchoscopy to look for tracheal tube fragments or residual material in airway
 - = Keep all items removed from patient for later inspection

Hyperkalemia

Causes = anything that causes a rise in the K= trauma, burns, MH, SUX, renal failure, massive transfusion, old blood, etc.

- Top 4 steps: stop all K containing solutions, hyperventilate 100% O₂ to ETCO₂ 28-30, albuterol 10 puffs, calcium gluconate 60 mg/kg or chloride 20 mg/kg
- Next steps: insulin 0.1U/kg, glucose 0.5g/kg, sodium bicarbonate 1-2 mEq/kg, furosemide 0.5-1mg/kg
- If cardiac arrest > 6 minutes, call for ECMO or bypass
- Dialysis

Intracranial hypertension

Causes = mass effect, trauma, bleeding, increased ETCO₂, etc

- GCS <8 intubate, keep PaCO₂ 30-35, paO₂ >60 mm Hg, CPP > 50 mm Hg, HOB > 30 deg, TIVA and VA off
- Vasopressors to maintain BP and CPP
- Hypertonic saline 1-3 mL/kg over 20 min then 0.1-1mL/kg/hr to keep serum <360 mOsm/L
- Mannitol 0.25-1g/kg
- Seizure prophylaxis levetiracetam (Keppra) 10 mg/kg
- DC glucose containing solutions, watch compression neck vessels, watch hyperthermia
- Refractory ICP elevation = consider barbiturate coma and paralysis with hypothermia (34C)

Malignant Hyperthermia

Causes = defect in ryanodine receptor causing uncontrolled release of calcium from the sarcoplasmic reticulum with sustained muscle contraction

- Signs: tachycardia, HTN, increased ETCO₂ and temperature, muscle rigidity, acidosis, hyperkalemia
- Call for help and the MH cart. MH hotline 1-800-644-9737
- Stop surgical procedure, VA, and SUX. Intubate..if no secure airway...
- Attach charcoal filter, 100% FIO₂ and flows to 10 L/min, hyperventilate to reduce ETCO₂ no lower than 28 mm Hg
- Dantrolene = dose 2.5 mg/kg Q 5 minutes until STX resolve. May need up to 30mg/kg. Infusion rate 0.25mg/kg/hr
 - Dantrium/Revonto = 20mg vial mixed with 60 mL sterile water
 - Ryanodex = 250 mg vial mixed with 5 cc sterile water
- Sodium bicarbonate 1-2 mEq/kg
- Cool patient if temp > 39C = ice to axilla, groin, head, infuse cold saline, NGT and foley lavage cold water or saline
 - STOP cooling when patient <38C\
- Treat hyperkalemia = SEE algorithm above under hyperkalemia
- VT or afib = do not use calcium channel blockers, give amiodarone 5mg/kg
- Start Aline and large bore IV's, central line if able...
- Labs: ABG or VBG, electrolytes, serum CK, serum/urine myoglobin, coagulation panel
- Place foley catheter, maintain UOP > 2mL/kg/hr
- PALS at any time if pt goes into cardiac arrest/consider ECMO or bypass
- If not response after 10mg/kg dantrolene, consider other causes such as sepsis, NMS, serotonin syndrome, myopathy, pheo
- ICU post operatively and full deposition guidelines available at <http://www.mhaus.org>

Malignant Hyperthermia - Room Preparation

For patients susceptible or possibly susceptible for malignant hyperthermia, the anesthesia core technicians and nurses should be alerted. This should be the first patient of the day, if possible. Standard preparation of the room includes taping over the vaporizers on the anesthesia machine and placing one carbon filter on each limb of the anesthesia circuit. A pure 100% O₂ for 90 seconds (or per manufacturer specifications) is needed after the carbon filters are in place. Additionally, the sodalyme cannisters should be changed before the machine has been flushed and a new circuit and reservoir bag should be installed.

NOTE: if patient carries the DX of MH, plan to watch in PACU for 6 hours post-operatively, even when all the above precautions have been taken

Masseter Muscle Spasm

Causes = MMR is a sustained contracture of the jaw muscles following the use of succinylcholine that may be a forewarning of MH. A mild increase in masseter muscle tone following succinylcholine with limb flaccidity may be a normal response. It is not possible to determine, clinically, whether that increase in tone represents an MH reaction or not. However, if generalized rigidity also occurs, then MH is highly likely. Immediately check potassium and blood gas.

- Immediately stop VA, change to TIVA, and stop any elective cases
- Secure the airway, 100% O₂, consider charcoal filters, close eye on temperature and ETCO₂
- Check CK, electrolytes, ABG or VBG, place foley to check myoglobinuria. Continue lab checks Q 6hrs for 24 hrs, with concern for rhabdo or myopathy
- Clinical signs of MH occur in about 20% of cases of MMR. These signs may follow immediately or be delayed..
- Unless clinical signs of MH appear, dantrolene sodium for injection is not recommended following the occurrence of MMR only.
- Myoglobinuria may occur within a few hours after MMR and should be sought and treated to prevent acute tubular necrosis.
- Pt should be admitted for 24 hour watch in PICU
- Discuss muscle biopsy with an MH expert.

Sudden Unexpected Cardiac Arrest in Children:

Children less than about 10 years of age who experience sudden cardiac arrest after succinylcholine in the absence of hypoxemia and anesthetic overdose should be treated for acute hyperkalemia first. In this situation calcium chloride should be administered along with other means to reduce serum potassium. They should be presumed to have subclinical muscular dystrophy and a neurologist should be consulted. Measure CK, myoglobin, ABG's until normalized.

3 Main Things That Will Harm Your Patient:

Ventilator - high PIP, PEEP, Volumes...

Volatile Agent - 8% Sevo not turned down...gets hyperventilated into patient...brady...asystole

Volume - Overloading (especially < 10 kg kiddos...) volume causing pulmonary edema or worse...

Pediatric Vital Signs

(values are listed in an easily memorized format and may lie at the high or low limit of normal values for that age group)

SBP: (Age *2) + 70 quick formula

AGE	HR (bpm)	SBP (mm Hg)	RR (bpm)	BS (gm/dl)	BV (ml/kg)
Premie (<37wPCA)	160	50	50	30	100
Neonate (<30d)	140	60	40	40	90
Infant (1m-12m)	120	70	30	50	80
Child (1y-12y)	100	80	20	60	70

PCA = Post-Conceptual Age. HR = Heart Rate. SBP = Systolic Blood Pressure.
R = Respiratory Rate. BS = Blood Sugar. BV = Blood Volume.

Contact Numbers

Anesthesia Workroom	953-3249
Blood Bank	953-1625
CT	953-1230
IMD	953-7200
NICU	953- 4490/1/2
MRI	953-1239
PACU	953-3336/7
Pediatric Surgery	953-2433
Pediatric Ward 4A and B	953- 4494/5/8
PICU	953-3521
Systems Control	953-0050

2007 AHA SBE Prophylaxis Recommendations **(Most recent update)**

Table 1. Cardiac Conditions Associated With the Highest Risk of Adverse Outcome From Endocarditis for Which Prophylaxis With Dental Procedures Is Reasonable

Prosthetic cardiac valve or prosthetic material used for cardiac valve repair
Previous Infectious Endocarditis (IE)
Congenital heart disease (CHD)*
Unrepaired cyanotic CHD, including palliative shunts and conduits
Completely repaired congenital heart defect with prosthetic material or device, whether placed by surgery or by catheter intervention, during the first 6 months after the procedure†
Repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device (which inhibit endothelialization)
Cardiac transplantation recipients who develop cardiac valvulopathy
*Except for the conditions listed above, antibiotic prophylaxis is no longer recommended for any other form of CHD.
†Prophylaxis is reasonable because endothelialization of prosthetic material occurs within 6 months after the procedure.

Table 2. Dental Procedures for Which Endocarditis Prophylaxis Is Reasonable for Patients in Table 1

<i>All dental procedures</i> that involve manipulation of gingival tissue or the periapical region of teeth or perforation of the oral mucosa*
*The following procedures and events do not need prophylaxis: routine anesthetic injections through noninfected tissue, taking dental radiographs, placement of removable prosthodontic or orthodontic appliances, adjustment of orthodontic appliances, placement of orthodontic brackets, shedding of deciduous teeth, and bleeding from trauma to the lips or oral mucosa.

Table 3. Regimens for a Dental Procedure

Situation	Agent	Regimen: Single Dose 30 to 60 min Before Procedure	
		Adults	Children
Oral	Amoxicillin	2 g	50 mg/kg
Unable to take oral medication	Ampicillin OR Cefazolin or ceftriaxone	2 g IM or IV	50 mg/kg IM or IV
		1 g IM or IV	50 mg/kg IM or IV
Allergic to penicillins or ampicillin—oral	Cephalexin [†] OR Clindamycin OR Azithromycin or clarithromycin	2 g	50 mg/kg
		600 mg	20 mg/kg
		500 mg	15 mg/kg
Allergic to penicillins or ampicillin and unable to take oral medication	Cefazolin or ceftriaxone [†] OR Clindamycin	1 g IM or IV	50 mg/kg IM or IV
		600 mg IM or IV	20 mg/kg IM or IV
IM indicates intramuscular; IV, intravenous.			
*Or other first- or second-generation oral cephalosporin in equivalent adult or pediatric dosage.			
†Cephalosporins should not be used in an individual with a history of anaphylaxis, angioedema, or urticaria with penicillins or ampicillin.			

Summary of Major Changes in 2007 Recommendations

Bacteremia resulting from daily activities is much more likely to cause IE than bacteremia associated with a dental procedure.
Only an extremely small number of cases of IE might be prevented by antibiotic prophylaxis even if prophylaxis is 100% effective.
Antibiotic prophylaxis is not recommended based solely on an increased lifetime risk of acquisition of IE.
Limit recommendations for IE prophylaxis only to those conditions listed in Table 1.
Antibiotic prophylaxis is no longer recommended for any other form of CHD, except for the conditions listed in Table 1.
Antibiotic prophylaxis is reasonable for all dental procedures that involve manipulation of gingival tissues or periapical region of teeth or perforation of oral mucosa only for patients with underlying cardiac conditions associated with the highest risk of adverse outcome from IE (Table 1).
Antibiotic prophylaxis is reasonable for procedures on respiratory tract or infected skin, skin structures, or musculoskeletal tissue only for patients with underlying cardiac conditions associated with the highest risk of adverse outcome from IE (Table 1).
Antibiotic prophylaxis solely to prevent IE is not recommended for GU or GI tract procedures.

Suggested References

- A. *A Practice of Anesthesia for Infants and Children** (*PRACTICE OF ANESTHESIA FOR INFANTS & CHILDREN*) by Charles J. Cote, I. David Todres, Jerrold Lerman (4th Edition 2009)
- B. *A Practical Approach to Pediatric Anesthesia* by Robert Holzman, Thomas Mancuso, David Polaner (2nd edition 2016)
- C. MHAUS website <https://www.mhaus.org/>
- D. *Online Intensive Review of Pediatric Anesthesia*. (Society for Pediatric Anesthesia) (Softcover book of lectures 2015).
- E. *Pediatric Pain Pocket Reference* compiled by Aarti Mehla, MD Lucile Packard Children's Hospital, Stanford, CA. 2017
- F. *Pedi Crisis Critical Events Cards* presented by Society of Pediatric Anesthesia at <http://www.pedsanesthesia.org/> 2018

Notes:

Updated January 2019