Pediatric Anesthesia
an introduction

Sidney K. Merritt MD
Associate Clinical Professor of Anesthesiology

UCSD
Children are not short adults
Babies are not short children
Overview

- Peds vs. adult anesthesia
- Patient categories
- Anesthetizing a child
Overview

★ Peds vs. adult anesthesia

★ Patient categories

★ Anesthetizing a child
What makes pediatric anesthesia different than adult?

- Neonatal physiology
- Drug dosing
- Airway
- Premeds/psychology
- Consent
- Types/lengths of surgeries
- IV/fluids
- Concern about apoptosis
Neonatal Physiology

**Cardiovascular**
PDA
PFO
CO 2-3X adult (per kg)
Total body water 75-80% (adult 50-60%)

**Pulmonary**
O$_2$ consumption 2X adult
Alveolar ventilation 2X adult
Oxyhemoglobin curve shifted left by fetal hemoglobin
FRC 25%
TV 6 mL/kg (same as adult)

**Neurological**
Apnea/bradycardia
CNS fragile, at risk (but BBB not really “leaky”)
ANS imbalance
Neonatal Physiology

**Renal**
GFR 25% of adult level
Cannot concentrate urine as well as adults, but can secrete more dilute urine

**Liver**
Hyperbilirubinemia
Glucuronidation immature

**Temperature regulation**
High body surface ratio
Brown fat metabolism

**Hypoglycemia**
Diabetic mother
Premature, SGA, IUGR, illness or other stress
Hepatic glycogen mechanisms immature
Prolonged hypoglycemia = neurological damage
**Medication Dosing**

* Always dose mg/kg or mcg/kg
* Doses may differ based on age
* MAC higher than adult
* Volume of distribution greater in infants/young kids
Airway

- Size/depth calculations
- Cuffed vs. uncuffed ETT
- Post-extubation croup
- Poisseuille’s law
- Position of larynx
- Congenital malformations
Behavioral/Psych

- Patient may not cooperate
- Rational explanations don’t work
- Bad experience in OR may have long sequela for patient and family
- Reassurance increases anxiety
- Distract the patient
- Parent inductions
Consent

* Consent should be obtained from both the patient (under age 18) and the parent

* When a case may be done despite patient refusing consent is sometimes unclear

* Full informed consent must be obtained without terrifying the patient/parent
Types of surgeries

- Hernias, appys, circs
- T and As, BMTs, DL/bronch
- Orthopedic
- Urologic
- Cancer-related procedures
- Congenital problems
- Ophtho, derm, GI, dental
- Imaging (CT, MRI)
IV and fluids

* 22-gauge common size IV, 24 for infants
* PL, LR or NS; **NEVER** hypotonic
* PRBC, albumin, FFP
* Bolus 10 mL/kg, repeat if needed
* Run dextrose at *maintenance* rate in infants during long cases

**Maintenance (mL/hr:)**
- First 10 kg = 4X weight (6 kg kid = 24 mL/hr)
- Second 10 kg = 2X weight (12 kg kid = 44 mL/hr)
- Over 20 kg = weight + 40 mL (24 kg kid = 64 mL/Hr)
Apoptosis

* 1999, rat studies, anesthesia = brain damage
* Ketamine, isoflurane, N₂O, midaz
* Doses extremely large, lengthy
* Rat brains develop much more quickly than human babies
* More data needed, no change in practice is recommended now
Overview

★ Peds vs. adult anesthesia
★ Patient categories
★ Anesthetizing a child
Patient categories

Premature (<37 weeks)
Neonates (0 - 1 month)
Infants (1 - 12 months)
Toddlers (13 - 36 months)
Little kids (3 - 6 years)
Big kids (7 - 12 years)
Adolescents (13 - 18 years)
**Premature infants**

- Neonatal physiology
- Pulmonary, RDS/CLD/RAD
- Apnea/bradycardia
- Fragile CNS/IVH/ROP
- GI, NEC, poor nutrition
- IV access may be difficult
- Blood volume 90 mL/kg, anemia
Premature infants

* Keep Fi O2 low (0.21%)
* Run dextrose
* ETT size/depth:
  2.5, 3.0, 3.5 size ETT
  1 2 3 4 kg baby
  7 8 9 10 cm deep ETT
* No outpatient surgery until >60 wks post-conceptional age
Neonates (0 to 1 month)

- Infant physiology
- Bradycardia/apnea
- Cardiac arrest rate 10X > infants
- Hypoglycemia with long fasting
- ETT size/depth (3.0-3.5 at 9-10 cm)
- No elective surgeries or scans
- No outpatient anesthetics
Infants (1 to 12 months)

* Bradycardia on induction
* Airway/ETT size/depth
  3.0, 3.5, 4.0 at about 10 cm
* IV access can be challenging
* MAC highest at about 6 months
* Blood vol 80 mL/kg, hgb 11-12
* Anemia risk at 2 - 3 months
**Infants**

* Timing of outpatient surgery
  
  <1 mo = no elective surgery
  
  1 - 3 mo = watch in PACU 6 hours post-op
  
  >3 mo = outpatient surgery OK

* Post-operative pain control
  
  Regional (usually caudal block) or local infiltration
  
  Avoid narcotics if < 6 mo for outpatient surgery
  
  Use low-dose fentanyl or ketorolac/acetaminophen
**Toddlers (12-36 months)**

- Can be uncooperative/frightened
- Premed/iPad distraction/parent induction
- Let them sit up for induction
- Post-operative delirium more common
- Don’t forget the binky/blankie!
- ETT 4.0 - 4.5, 12 - 14 cm deep
Little kids (3-6 years)

- Usually cooperative, may be frightened
- iPad/premed/PI
- Respond well to stories/games
- Bring their toys/blankets
- Avoid “brutane” induction
- ETT 4.5 - 5.0, 14 - 16 cm deep
**Big kids (7-12 years)**

- Talk to them with respect
- Never hold them down
- iPad/premed/PI if anxious
- Place IV or premedicate if patient won’t cooperate with mask induction
- Bribe them
- ETT 5.0 - 6.0, 16 - 18 cm deep
Adolescents (12-18 years)

* Pregnancy test all girls
* Consent from parents and patient
* Pre-op IV if too large for safe mask induction
* PONV prophylaxis (puberty = puke)
* ETT 6.0 - 6.5, 18-20 cm deep
Overview

- Peds vs. adult anesthesia
- Patient categories
- Anesthetizing a child
Anesthetizing a child

ASA NPO Guidelines
Preops/consent
Premedications
Parent Inductions
Inductions (mask or IV)
Muscle relaxants/succinylcholine
Airway
Maintenance
Emergence/PACU
American Society of Anesthesiologists

NPO Guidelines for *all* ages

Clear liquids: 2 hours
Breast milk: 4 hours
Formula: 6 hours
Light meal/milk: 6 hours
Longer fast: “prudent” in select cases
Pre-op evaluation/consent

- CV: congenital heart condition?
- Pulmonary: RAD? URI?
- Other health issues?
- Dental: loose teeth?
- PSH/anesthetic history
- Premed or PI needed?
- NPO status
- Consent
The kid has a cold

Higher risk of minor respiratory complications, not death

Consider rescheduling if patient has:

* fever, lethargy, dehydration
* wheezing, abnormal lung exam, productive cough
* asthma, airway issues
* trisomy 21, other serious chronic illness
* age less than six months of age
* the surgery is airway, facial or major procedure

Higher risk of minor respiratory complications, not death

Consider rescheduling if patient has:

* fever, lethargy, dehydration
* wheezing, abnormal lung exam, productive cough
* asthma, airway issues
* trisomy 21, other serious chronic illness
* age less than six months of age
* the surgery is airway, facial or major procedure
Premedication

* Peds patients usually don’t have an IV
* Oral vs intramuscular, intranasal
* Midazolam
  - 0.25-1 mg/kg PO (10-20 min)
  - 0.025 mg/kg IV (instant)
  - 0.2-0.4 mg/kg IN (5-10 min)
* Ketamine
  - 3-10 mg/kg PO (10-20 min)
  - 3-10 mg/kg IM (5-10 min)
* Narcotics
  - IV fentanyl (1 mcg/kg) or morphine (0.05 mg/kg)
  - IN fentanyl (1-2 mcg/kg) or PO hydrocodone
* Upsides
  - Anxiety or pain reduction, improvement of cooperation
* Downsides
  - Cost and time increases, extra medication
**Parent Induction (PI)**

- Bringing parent into the OR (or induction room) with their child
- Dress/prepare parent
- *Do not* let parent “help” restrain child
- Evidence of usefulness sparse
- Downsides minimal
- Parents *love* it; psychological benefit?
Induction

- Mask induction methods
- IV inductions
- Choice of airway
- Muscle relaxant
- Loose teeth
Slow mask induction

- Put on all monitors before starting
- Open the pop off valve
- Use the iPad, tell a story or do relaxation
- 3L O₂, 6L N₂O for 15-30 seconds
- Slowly dial in the sevo to 2% over 1 min, then crank it to 8% (go faster if the pt becomes uncooperative)
Fast mask induction

- Put on all monitors when possible
- Let patient sit up if small/uncooperative
- Offer $5 if kid can open eyes after 20 breaths (discuss this in preop)
- $3L O_2, 6L N_2O, 8% sevo$
- Open pop-off valve, don’t allow any room air to enter mask
Mask induction gone wrong

* No IV and bradycardia
  Turn down sevo, consider atropine IM

* No IV and laryngospasm
  2-hand jaw thrust, oral aw, 100% O₂, gentle CPAP
  Place IV stat, IM succinylcholine/atropine, intubate

* Can’t get IV
  Ask for help, do without, CVL, IO line

* Patient moving all around (sevo dance)
  Wait for sevo to work, give IN fent, hold arm for IV
Mask induction...continued

* After pt loses lid reflex, turn off nitrous and place IV

* Avoid ventilating the pt until the IV is in place

* After IV, over-breathe with 8% sevo for a minute and give med bolus (lido, fent, and/or propofol) for airway management
IV induction

* Premed midazolam 0.025-0.05 mg/kg, and/or fentanyl 1 mcg/kg
* Full monitors, preoxygenate
* Propofol dose 3-5 mg/kg if stable
* +/- muscle relaxant
Succinylcholine

- Black box warning
- Hyperkalemic arrest in patients with DMD
- Up to 1 in 2000 young boys
- Use it only when indicated
- Difficult AW, high-risk full stomach, severe laryngospasm
RSI

Most peds providers modify:

- Midazolam IV pre-RSI
- Less optimal preoxygenation
- Roc instead of sux
- Low-dose roc + masking
- Masking with cricoid
Choice of airway

- Mask for short cases with no IV
- LMA
- ETT if MR required, surgery above neck, full stomach, prone position, infant or small toddler
- FOI for difficult airway usually done asleep (as long as mask airway is OK)
- Native airway w/NC O₂ for MRIs
Loose teeth
part of the peds airway exam

* Kids 5 to 10 years of age
* If quite loose, make sure family OK with pulling tooth after induction
* If family refuses, be sure to discuss risk of aspirated tooth and document
* Give the kid a dollar
Maintenance

- Sevo vs. iso, nitrous vs. air
- Propofol, dex, remi
- Muscle relaxants
- Narcotics
- PONV prophylaxis
Pain Control

* Narcotics
* Regional anesthesia
* Local by surgeon
* Clonidine
* Ketorolac/Acetaminophen
Wake ups

- You can turn the vapor off a little later than in adults
- Reversal
- Deep vs. awake extubation
- Bronchospasm/laryngospasm
- Delirium
- Post-op orders
PACU

- Extubation by RNs at RCH
- Laryngospasm
- Delirium
- PONV
- Parents
Overview

* Peds vs. adult anesthesia
* Patient categories
* Anesthetizing a child
Summary

Babies and children have special challenges and rewards and are quite different to anesthetize than adults.