Pediatric Anesthesia – Overview

Anthony Renkas, DO

Presenter

- UW-Oshkosh
  - 1993-2003; B.S.
- The Blood Center of Wisconsin – Milwaukee, WI
  - 2003-2004; Platelet & Immunology Research
- Michigan State University – College of Osteopathic Medicine
  - 2004-2008; Doctor of Osteopathic Medicine (D.O.)
- Anesthesia Residency – Michigan State University
  - 2008-2012
- Pediatric Anesthesia Fellowship – Children's Hospital of Wiscosin; Milwaukee, WI
  - 2012-2013
- Marshfield Clinic – Staff Anesthesiologist
  - 2013-Present

General Outline

- Pre-op
  - Interview with child and guardian
  - Pre-op fasting
  - Pre-op sedation
- Intra-op
  - Induction – “Mask Induction”
  - Fluids
  - Medications
- Post-op
  - Pain Management
    - Neuraxial Anesthesia (i.e, Caudals, Epidurals)
  - Airway
  - Emergence Delirium

Pre-Op

- Interview
  - Problems with anesthesia in the past? Family History of anesthetic complications?
    - Common: Slow to wake up, “wakes up crazy”, emergence delirium, post operative nausea & vomiting (PONV)
      - Minor additions or subtractions to the anesthetic plan
    - Rare: difficult intubation, malignant hyperthermia (discussed in a later lecture)
      - Likely need to change the anesthetic plan to a “non-triggering” anesthetic
        - Triggers:
          - Volatile Anesthetics: Sevoflurane, Desflurane, Isoflurane
          - Depolarizing paralytics: Succinylcholine

Pre-Op

- Interview
  - Any recent upper respiratory infection (URI) symptoms?
    - Fever, sore throat, productive cough, runny nose, earache, etc.
  - The pediatric population already has a more sensitive and irritable airway compared to the adult population. A recent URI increases a child's risk of airway complications during and after an anesthetic and/or airway manipulation.
    - Coughing, laryngospasm, bronchospasm, oxygen desaturation during anesthesia, post-intubation subglottic stenosis, post-operative desaturation

Pre-Op

- Interview
  - Recent URI
    - How long ago did symptoms resolve?
    - It has been shown that it takes 4-6 weeks for a child to return to baseline after a URI. Ideally, we would wait this long for elective procedures, but that's usually not practical.
    - Have a discussion with parents/guardians and surgeon to determine the best course.

Pre-Op

- Interview
  - Other questions
    - Any loose or cracked teeth?
      - Usually 5-10yo range
      - Sometimes we'll pull them out under controlled circumstances.
    - Do you have any questions?

Pre-Op

- Interview
  - Last time the patient ate or drank?

Pre-op

- Fasting/NPO Guidelines for elective cases
  - Why do we have NPO Guidelines? Who do we make surgical patients fast?

Pre-Op

- Aspiration! Hooray!
  - Aspiration is very bad.
  - Cause pneumonitits.
    - Main risks for pneumonits are volume and pH
      - Gastric fluid volume greater than 0.4mL/kg (10kg 1 year old would need 4mL of gastric fluid)
      - pH < 2.5
  - Worst case scenario:
    - Aspiration → Pneumonitis → ARDS → Difficulty Oxygenating

Pre-Op

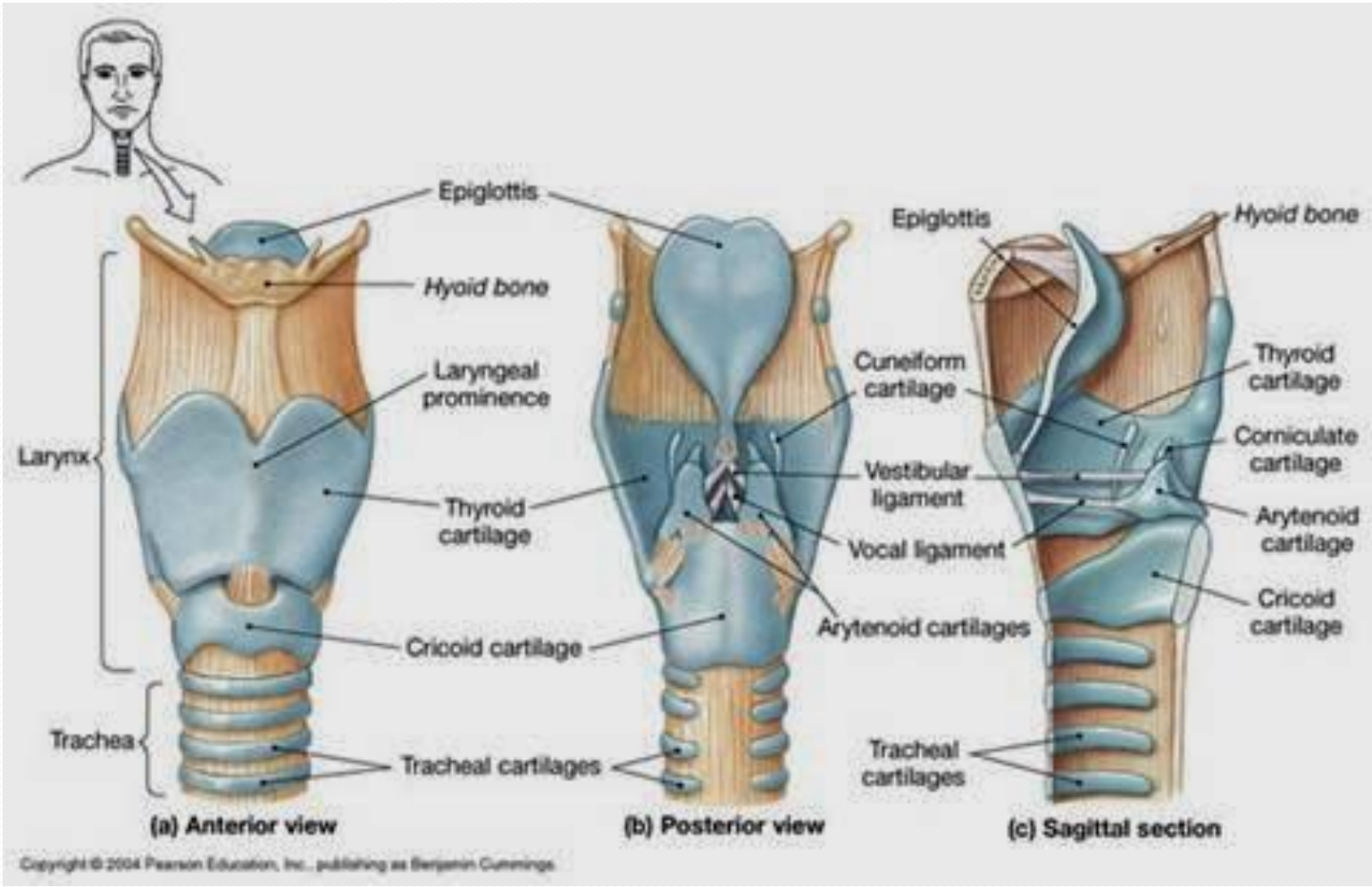
- Fasting/NPO Guidelines
  - NPO Guidelines have evolved over the years, but here are the current ones:
    - 2-hours for “Clear Fluids”
      - Examples: water, fruit juices without pulp, carbonated beverages, pedialyte, tea/coffee without dairy
    - 4-hours for Breast Milk
    - 6-hours for Formula
    - 8-hours for solids/full meals.

Pre-Op

- Gum
  - Ultimately up to the anesthesiologist.
  - Chewing gum increases gastric fluid volume, but also appears to increase pH
    - 0.4mL/kg and pH<2.5
    - As long as the gum is spit out, there probably is not an increased risk.
  - If gum was swallowed an elective case should be cancelled. (Gum in the lungs would be bad)

Pre-Op

- Rapid Sequence induction (Need an IV!)
  - Try to secure the airway as quick as possible to minimize the time of an unprotected airway.
  - Propofol quickly followed by muscle relaxant (succinylcholine, high dose rocuromium).
  - Cricoid cartilage pressure
    - To close off esophagus and obstruct anything that may be coming up the esophagus.
      - Probably doesn't work.
  - Intubate

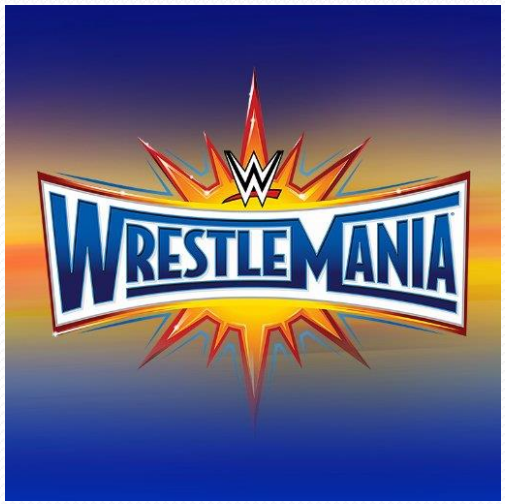

Epiglottis
Hyoid bone
Laryngeal prominence
Larynx
Thyroid cartilage
Cricoid cartilage
Trachea
Tracheal cartilages
(a) Anterior view
Epiglottis
Cuneiform cartilage
Vestibular ligament
Vocal ligament
Arytenoid cartilages
Tracheal cartilages
(b) Posterior view
Epiglottis
Hyoid bone
Thyroid cartilage
Corniculate cartilage
Arytenoid cartilage
Cricoid cartilage
Tracheal cartilages
(c) Sagittal section
Copyright © 2004 Pearson Education, Inc., publishing as Benjamin Cummings

Pre-Op

- Fasting/NPO Guidelines
  - Pizza Party!
    - 12yo swallowed a quarter
    - Father said child had not eaten in close to 8-hours
    - Child said he had recently eaten pizza.

Pre-Op

- Sedation
  - Every anesthetic is better with pre-op sedation.
    - Everyone is happier.
      - Nurses, patient, parents/guardians, anesthesiologist.
      - Most of the time. Sometimes the dosage doesn't have the intended affect



Pre-Op

- Sedation
  - Common medications, routes and dosages:
    - Midazolam (Versed)
      - Usually PO or IM. Can be given IN
        - PO = 0.25-0.75mg/kg
        - IM = 0.1-0.15mg/kg
        - IN = 0.2mg/kg
    - Ketamine
      - Usually IM.
        - IM = 2-10mg/kg

Pre-Op

- Sedation
  - “Ketamine Dart”
    - Midazolam (0.1mg/kg), Ketamine (5mg/kg), Glycopyrrolate (10mcg/kg)
      - Ketamine can cause sialorrhea (increased secretions) so Glycopyrrolate is given as an antisialagogue (decrease secretions).
    - “The Kid Behind the Chair”

Intra-Op

- Mask induction
  - Typical volatile anesthetic ("gas") used:
    - Sevoflurane
    - Halothane (out of production)
    - and if the pre-operative sedation didn't do the trick…

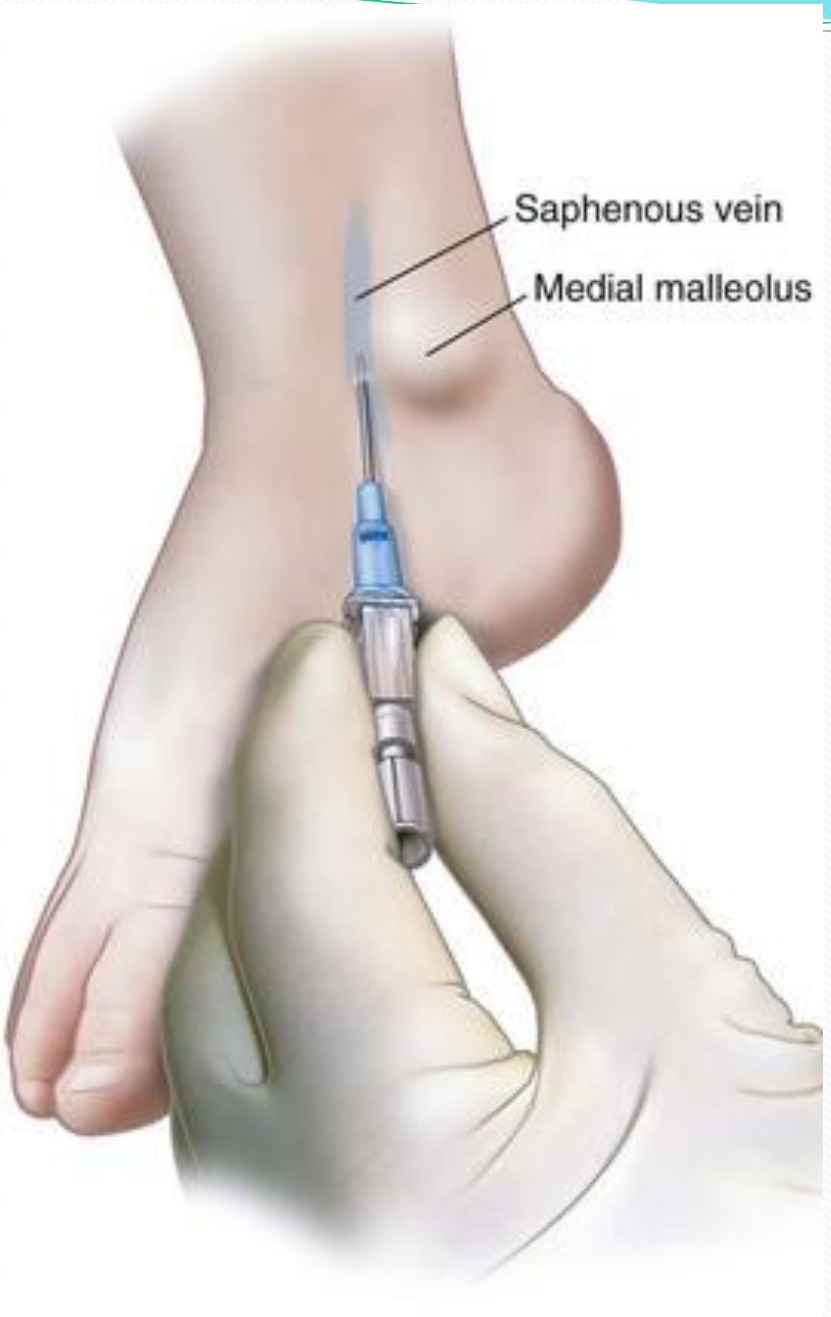
BRUTANE!

Intra-Op

- Mask Induction
  - “The Kid That Didn’t Want to Go to Sleep”

Intra-Op

- IV-access
  - Commonly obtained after mask-induction (as long as patient was NPO).
  - Common sites for IV-access in pediatric population:
    - Hand
    - Antecubital Fossa
    - Saphenous
      - Nice location in 2-6 year old range, because it's "out of sight, out of mind".
    - Need to wrap IVs.


Saphenous vein
Medial malleolus

Intra-Op

- Fluid Management
  - Crystalloid vs. Colloid
    - Crystalloid
      - 0.9% NS
      - Lactated Ringer
      - All other solutions with different mixtures of electrolytes and dextrose.
    - Colloid
      - Human Albumin (5%, 25%)
      - Starch solutions (Hextend, Hespen, Voluven)
        - Recently fallen out of favor
          - No benefits
          - Expensive

Intra-Op

- Fluid Management
  - "4-2-1 Rule" – Pertains to crystalloid fluids. Maintenance

MAINTENANCE FLUID REQUIREMENTS IN CHILDREN THE "4-2-1 RULE"	
BODYWEIGHT (kg)	MAINTENANCE RATE
0–10	4 mL/kg/h
11–20	40 mL+2 mL/kg/h for each kg over 10 kg
21–70	60 mL+1 mL/kg/h for each kg over 20 kg

Intra-Op

- Fluid Management
  - “4-2-1 Rule”
    - Calculates hourly rate:
      - Ex: 10kg child
        - 40mL/hr
      - Ex: 31 kg child
        - 71mL/hr

Intra-Op

- Fluid Management
  - NPO Deficit
    - Recommend replacement of 50% of the deficit in the first hour, 25% in the 2nd hour and 25% in the 3rd hour.
      - Ex: 31kg child is NPO for 8 hours
      - Deficit = 71mL x 8 hours = 568mL
      - First Hour of Surgery = 71mL + 284mL = 355mL
      - Second Hour = 71mL + 142mL = 213mL
      - Third Hour = 71mL + 142mL = 213mL
      - Then deficit theoretically corrected

Intra-Op/Post-Op

- Medications
  - Common medications and their peri-operative dosages.
    - Opiods (q5-10 minutes; titrated to effect)
      - Morphine: 0.1mg/kg
      - Fentanyl: 3-5mcg/kg
    - Acetaminophen (q4-6 hours)
      - IV: 15mg/kg over 15 minutes (Ofirmev)
      - PO: 15mg/kg
      - PR: 30mg/kg
    - Ketorolac: 0.5mg/kg (q6 hours)

Intra-Op/Post-Op

- Medications
  - Postoperative Nausea and Vomiting (PONV) Prophylaxis
    - Dexamethasone (shown to have analgesic properties as well)
      - Tonsillectomy/Adenoidectomy dose: 0.5mg/kg
      - PONV prophylaxis dose: 0.1mg/kg
    - Ondansetron (Zofran) = 0.1mg/kg
  - Can also give 10mL/kg fluid boluses for PONV.
  - Nothing is 100% for getting rid of PONV except for time.

Intra-Op/Post-Op

- Medications
  - Story: “Morphine Overdose”

Post-Op

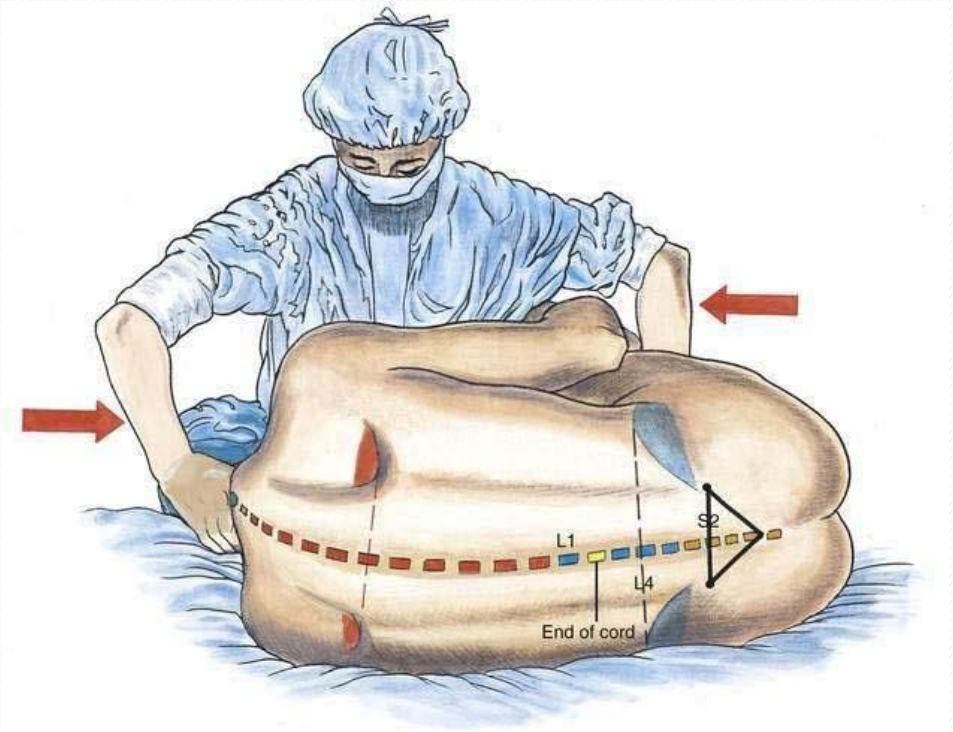
- Pain Management
  - Neuraxial Anesthesia
    - Epidurals
    - Caudals
    - Spinals

Post-Op

- Pain Management
  - Epidural
    - Usually placed in the pediatric population after induction of anesthesia
    - Pt positioned in a lateral decubitus position.

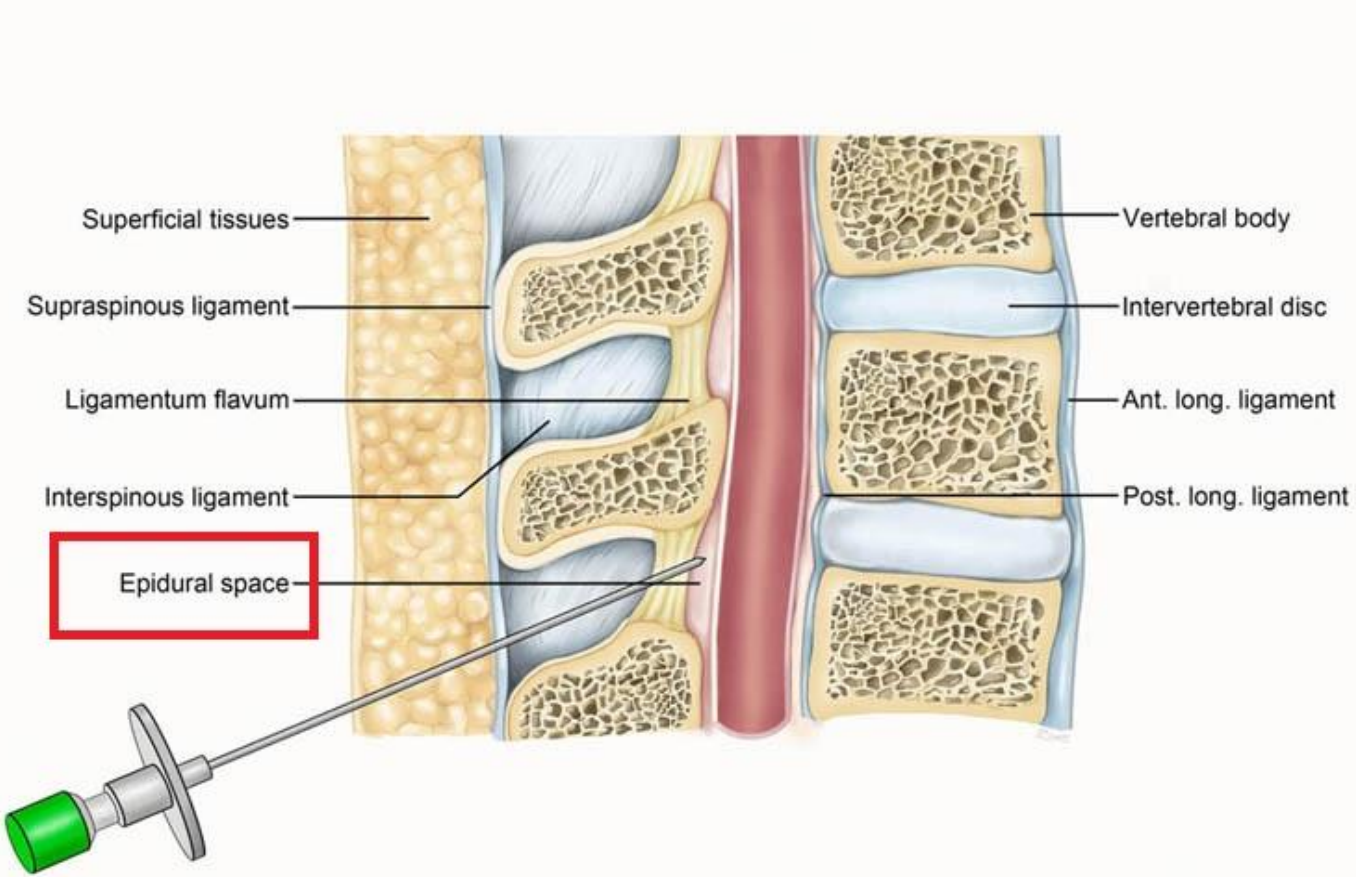
Post-Op

- Pain Management
  - Epidural
    - Lateral Decubitus Position:



Post-Op

- Pain Management
  - Epidural



Post-Op

- Pain Management
  - Epidural
    - Infusion local anesthetics and dosages:
      - Bupivacaine: 0.2-0.4mg/kg/hr
      - Ropivacaine: 0.2-0.5mg/kg/hr
    - Opiods (commonly added to infusion)
      - Fentanyl: 0.3-1mcg/kg/hr
      - Hydromorphone (Dilaudid): 1-2.5mcg/kg/hr

Post-Op

- Pain Management
  - Epidural - Dosing
    - Local Anesthetics – Examples:
      - Bupivacaine 0.25% = 2.5mg of Bupivacaine per mL
      - Lidocaine 1% = 10mg of Lidocaine per mL
      - Ropivacaine 0.5% = 5mg of Ropivacaine per mL
    - So…10kg child has a Bupivacaine 0.1% infusion running
      - 1mg of Bupivacaine per mL
      - 0.2-0.4mg/kg/hr = 2-4mg/hr
      - Infusion should be in the range of 2-4mL/hr
      - Break it up into infusion and demand dose
        - 2mL every hour with 0.5mL bolus q30minutes (3mL/hr)

Post-Op

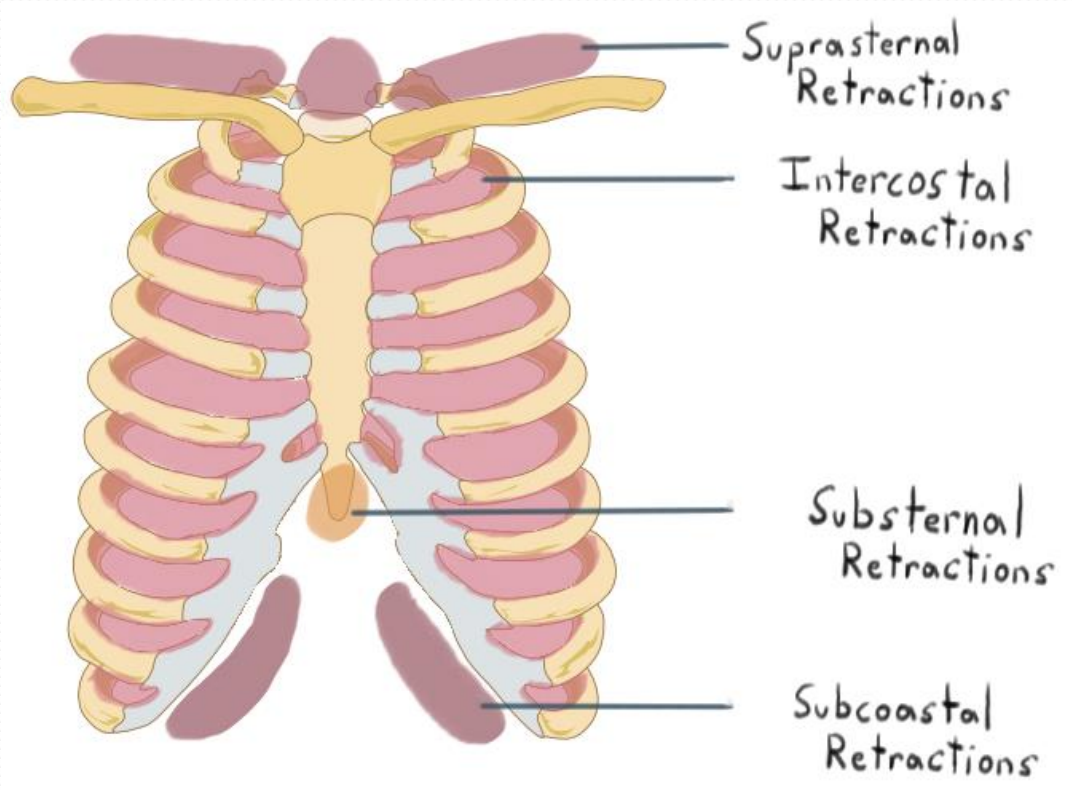
- Arrival to PACU
  - Airway patency (hear breaths?, retractions present?)
  - Color of lips (blue?)
  - Vitals obtained
    - Heart rate, blood pressure, O2 saturation, respiratory rate, temperature
  - Administer supplemental O2
  - Report:
    - IV access (size and location), premedication, type of anesthetic, fluids given, medications given (opiods, bronchodilators, PONV prohylaxis, NSAIDs, etc.), use of regional anesthesia (nerve block, epidural, caudal or just local), difficulties with surgery/anesthetic

Post-Op

- Airway – Patency
  - Retractions: The sucking in of the skin in between or around the bones of the chest when inhaling. This suggests an obstructed airway.

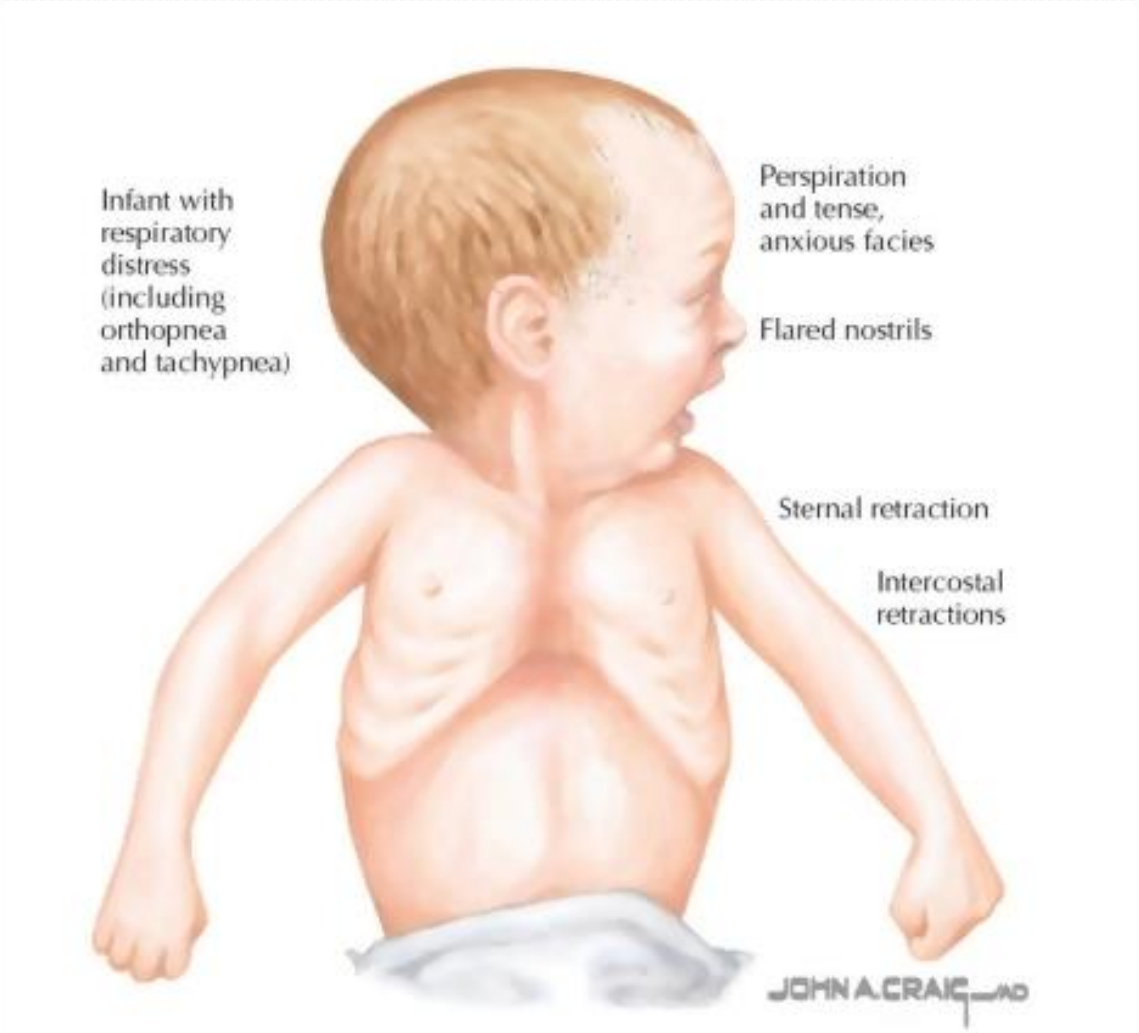
Post-Op

- Airway – Patency
  - Retractions



Post-Op

- Airway – Patency
  - Retractions



Post-Op

- Airway – Patency
  - Opening airway with Jaw-thrust/Chin-lift maneuver

Post- Op

- Airway – Patency
  - Jaw-thrust/Chin-lift maneuver
    - Important to stay on the mandible in the pediatric population.
      - Can cause compression of soft tissues and close off airway further if not on mandible.

Post-Op

- Airway
  - Post-intubation Croup/Stridor
    - Occurs in 0.1%-1% of children
    - Causes:
      - Endotracheal tube too large
      - No leak at >25cm H_2O
      - Multiple intubation attempts
      - Position other than supine for surgery
      - Age 1 to 4 years
      - Surgery greater than 1 hour
      - Coughing on the endotracheal tube
      - History of Croup

Post-Op

- Airway
  - Post-intubation Croup/Stridor
    - Treatment:
      - Humidified Mist
      - Nebulized epinephrine
      - Dexamethasone

Post-Op

- Emergence Delirium

Post-Op

- Emergence Delirium
  - Definition: A dissociated state of consciousness in which children are inconsolable, irritable, uncompromising, and/or uncooperative.
  - Thrashing, disoriented, crying, screaming, unable to recognize parents or surroundings, inconsolable and talking irrationally.
  - Occurs more often in children (10-20%) than adults.
  - Particularly common in children younger than 6 years old.
  - Most episodes last 10-20 minutes and resolve spontaneously without sequelae.

Post-Op

- Emergence Delirium – Causes
  - Pain?
    - More common with a procedure that results in pain, but…
    - Occurs in procedures without pain (MRI sedation)
  - Volatile anesthetics?
    - Occurs more frequently with less-soluble gases (Desflurane and Sevoflurane) than with more-soluble gases (Isoflurane and Halothane)
  - The mechanism by which ED occurs remains unknown.

Post-Op

- Emergence Delirium – Treatment
  - No magic bullet
  - Fentanyl
    - Intranasally: 2mcg/kg
    - IV: 1-2mcg/kg
  - Midazolam
    - IV: 0.1mg/kg
  - Propofol Infusion
  - Dexmedetomidine (Precedex) Infusion

Post-Op

- Emergence Delirium – Treatment
  - Need to weigh treating the delirium with side effects of treatment, cost and labor/time.
    - Yes, I can give Fentanyl to decrease the intensity of the ED, but then I have to expose the child to opioids, wait for the Fentanyl to wear off before discharge, possibly support airway. Or I can wait 10-20 painful minutes.
    - Further "muddy the waters" with more medications. More meds to emerge from.
    - Takes time to set-up a propofol and dexmedetomidine drip
    - Dexmedetomidine is expensive.

Pediatric Anesthesia - Overview

- Questions?

Reference

- **A Practice of Anesthesia for Infants and Children**. Cote, Lerman, Todres. Saunders Elsevier. ©2009


Robert K. Stoelting
Ronald D. Miller
Basics of ANESTHESIA
Stoelting
Miller
Basics of ANESTHESIA
FIFTH EDITION