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OF Anesthesiology



New Jersey Dental Society of Anesthesiology
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Management of Pediatric Emergencies in the Office

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What does “Pediatric Patient” mean

- Neonate First 4 weeks (or up to 44 weeks post conception)
- Newborn Birth to 2 months
- Baby Birth to 2 years
- Infant One month to one year
- Toddler Ages 1-3 years
- Preschool Ages 4-5 years
- Child Ages 5-12 years
- Child Ages 1-12
- Adolescence Ages 12-18 years

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Pediatric Patient



They are just small adults right?

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What Makes The Pediatric Patient Different Than The Adult Patient?

- Behavioral
- Anatomic
- Physiologic



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Behavior



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Behavior

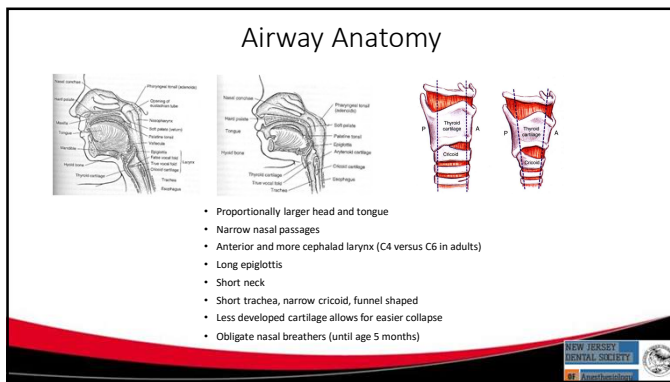
- Calming techniques
 - Reassuring calm voice
 - Nitrous oxide
 - Pre Medication
 - Inhalational Anesthetic



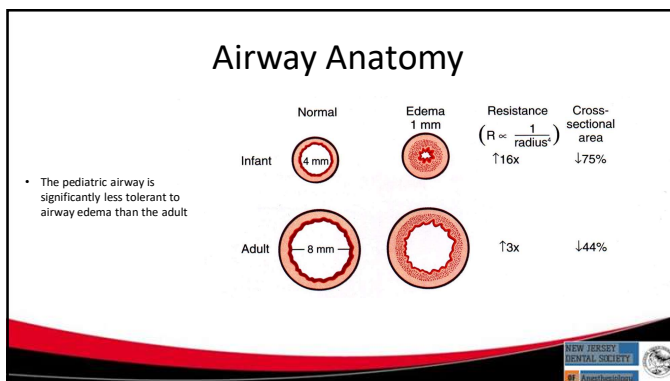
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Airway Physiology

- Oxygen Consumption in adults 3-4mL/kg/min
- Oxygen Consumption in infants 6-8mL/kg/min
- Increased CONSUMPTION
- Increased AIRWAY RESISTANCE
- Decreased RESERVE (desaturate quickly)



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Brodsky Grading System

- **Grade 0:** Tonsils are removed or within the tonsillar fossa
- **Grade 1:** Tonsils are just outside the tonsillar fossa and take up to 25% of the oropharynx
- **Grade 2:** Tonsils take up 26-50% of the oropharynx
- **Grade 3:** Tonsils take up 51-75% of the oropharynx
- **Grade 4:** Tonsils take up more than 75% of the oropharynx



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How do kids compensate?

- Pediatric pulmonary
 - increased CONSUMPTION
 - increased AIRWAY RESISTANCE and
 - decreased RESERVE
- How did we survive against these odds?
 - If I can't increase volume (depth), rate and effort is increased

Variable	infant	adult
Respiratory frequency	30-60	12-16
Tidal Volume (mL/kg)	6-8	7
Dead space (mL/kg)	2-2.5	2.2
Alveolar ventilation (mL/kg/min)	100-150	60
FRC (mL/kg)	25	40
Oxygen consumption (mL/kg/min)	6-8	3-4

Minute Ventilation = Tidal volume * Respiratory rate



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Cardiovascular

- Cardiac output (CO) = Stroke Volume (SV) x Heart Rate (HR)
- Stiff less compliant myocardium leads to relatively fixed stroke volume
- Fixed SV results in **CO dependent on HR**
- Less Cardiac Reserves
- Parasympathetic nervous system continues to dominate until adolescence
- Predominant parasympathetic control of the heart can lead to bradycardia
- Higher metabolic demand



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AVOID BRADYCARDIA!

Airway more susceptible to obstruction



Obstruction causes hypoxia quicker



Hypoxia leads to Bradycardia



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AVOID BRADYCARDIA!

Increased Parasympathetic stimulation

Directly by drugs and indirectly by respiratory obstruction



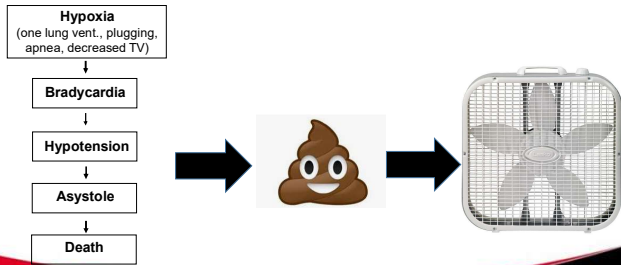
Parasympathetic stimulation leads to Bradycardia

Decreased cardiovascular stability
Leads to bradycardia quickly



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Manage Respirations and Avoid Bradycardia!!!!!!



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Preoperative Evaluation

- Obtaining age, weight, height
 - Calculate BMI
 - Determine drug dosing (local, sedation and emergency drugs)
- Obtaining health history
 - Allergies or adverse reactions
 - Medication history
 - Relevant diseases

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Preoperative Evaluation

- Obtaining health history Continued:
 - Physical abnormalities and neurological impairment that may increase the potential for airway obstruction (history of snoring or obstructive sleep apnea)
 - The summary of previous relevant hospitalizations, including history of sedation or general anesthesia and any complications
 - Relevant family history, particularly that related to anesthesia, should also be included

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Preoperative Evaluation

- Review of systems with a special focus on abnormalities of cardiac, pulmonary, renal and hepatic function
- Vital signs, **remember age appropriate ranges**
- Airway focused physical examination
 - tonsillar hypertrophy,
 - abnormal anatomy, e.g., mandibular hypoplasia

PEARS
Pediatric Emergency Assessment Review System

Normal Adult Respiratory Functioning

Age	Respiratory Rate	Respiratory Effort	Respiratory Sound	Respiratory Color
Adult	12-20	Normal	Clear	Normal

Normal Adult Vital Signs

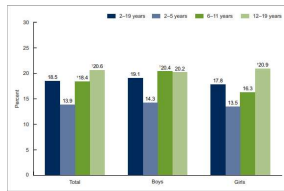
Age	Heart Rate	Blood Pressure	Temperature	SpO2
Adult	60-100	90/60-120/80	36.0-37.8	94-100



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Preoperative Evaluation

- Childhood obesity



- Higher incidences of :
 - Desaturation
 - Obstruction
 - Difficult mask ventilation
 - Bronchospasm



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Preoperative Evaluation

Kids develop 6-8 URIs/Year

And even more frequently in younger kids attending preschool and daycare

Approximately 30% of children present for surgery with signs & symptoms of a URI

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To sedate or
not to sedate?

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Preoperative Evaluation

- Upper Respiratory Infections
 - Increased airway reactivity 2-8 weeks after infection
 - Children at 11-fold risk for respiratory complications if recent URI and endotracheal anesthesia is performed
 - Laryngospasm and bronchospasm significantly increased 2 weeks after URI
 - Recommend waiting 6 weeks AFTER resolution of URI

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Upper Respiratory Infections

Should we anesthetize the child with a recent mild-moderate URI?

- "Children with a mild URI may be safely anesthetized, since the problems encountered are generally easily treated and without long-term sequelae" *J Clin Anesth 1992;4:2000*
- "Nearly 2000 procedures would have to be canceled to prevent 15 cases of laryngospasm" *Anesth 2001;95:300*
- "Mild, uncomplicated URIs undergoing procedures that do not involve instrumentation of the airway can be safely anesthetized without any increase in risk". *Anesth Analgesic 2005;100:59-65.*

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Upper Respiratory Infections

- Problems Interpreting Data When Looking at Surgery and URIs
 - How to classify URIs
 - Type/Duration of surgery
 - Airway Instrumentation
 - Anesthetic Agent/Technique



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URI: Postponement of elective procedures

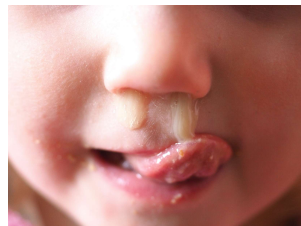
- Mucopurulent secretions
- Productive cough
- Fever >38 C
- Lethargy
- Signs of pulmonary involvement
- Bacterial sinusitis
- Co-morbid conditions, e.g., asthma
- **When in doubt, postpone case**



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COLDS Score

- C-urrent Signs & Symptoms
- O-nset
- L-ung disease
 - Asthma, etc.
- D-evice
 - ETT>LMA>Mask
- S-urgery
 - Airway vs nonairway



Lee, LK et al. Perioperative respiratory adverse event in children with URI, Validation of the COLDS score, Pediatric. Anes. 2018; 28:1007-1014



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Points:	1	2	5
Current Signs & Symptoms	None	Mild: Parent confirms URTI and/or congestion, rhinorrhea, sneezing, low grade fever or dry cough	Moderate/severe: Purulence, wet cough, abnormal lung sounds, lethargy, toxic appearance, or high-grade fever
Onset	>4 weeks ago	2-4 weeks ago	< 2 weeks
Lungs	None	Mild: e.g., RSV, mild intermittent asthma, CLD if > 1yo, loud snoring, passive smoking	Moderate/severe: e.g., moderate persistent asthma, infant with CLD, OSA, pulmonary HTN
Airway Device	None or facemask	LMA or supraglottic device	Endotracheal device, ETT
Surgery	Other, e.g., ear tubes	Minor surgery: Adenotonsillectomy, flexible bronchoscopy, dental extractions	Major surgery: Cleft surgery, rigid bronchoscopy, maxillofacial surgery

3-25 points total, the higher the score, the greater the risk. Judgement is always involved. Any individual 5 score should be considered a red flag for proceeding. Never "Zero" risk for reactive airway.

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Second Hand Smoke Exposure

Relative risk 10x higher for developing laryngospasm vs no domestic environmental tobacco smoke exposure



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Preoperative Evaluation

Parental Presence

- Is it beneficial for the child
- Effect on child behavior
- Parental preparation (is it about to become 2 patients?)

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Avoiding/Managing the Adverse Event Requires Vigilance at Every Step

Starts with:

- Appropriate patient selection
- Appropriate preparedness



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Pre-Procedural Vigilance

- A documented pre-sedation medical evaluation, including a focused airway exam
- An appropriate interval of fasting before sedation
- No sedative or anxiolytic medications without supervision from skilled medical personnel (i.e., not at home or by a technician)
- Sedative and anxiolytic medications should only be administered by, or in the presence of individuals skilled in airway management and cardiopulmonary resuscitation



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Procedural Vigilance

- Age- and size-appropriate equipment and appropriate medications
- Continuous and appropriate monitoring
- Designated anesthesia personnel to monitor the patient's cardiorespiratory status during and after the procedure



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Vascular Access

- IV available if needed
- IO availability when IV difficult
- EMS Team will have IO system



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Emergency Medications

- Need to know where the medications are
- How are they drawn up
- Do they have to be mixed?
- How are you going to give them?



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Medication Errors

- Third leading cause of morbidity and mortality in kids
 - Wrong dose
 - Infusion errors > bolus errors
 - Wrong syringe, i.e., wrong medication



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Emergency Medications

- Calculate medications PRIOR to sedation
 - Broselow Pediatric Emergency Tape
 - Ten Minutes Saves A Life! App
 - PediStat
 - Stanford manual
- IM syringes and needles in the room
- Have IV/IM meds in room
 - Atropine
 - Succinylcholine



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Post - Procedural Vigilance

- Specific discharge criteria
- Children sedated using medication with a long half-life (e.g., chloral hydrate, pentobarbital and chlorpromazine) may require extended observation.
- Don't hurry the D/C
- 2 responsible escorts

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Management of Emergencies



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Respiratory Emergencies

With the pediatric patient, it is respiratory until proven otherwise!



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Plan for failure

- Airway assessment pre-op and understand ability of patient to tolerate apnea
- Identify cricothyroid membrane pre-op (over age of 10)
- Anticipate that if you cannot perform BVM have supra-glottic airway and LMA ready (correct size)
- If need to intubate, consider video laryngoscope



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Airway Challenges

- Ability to mask ventilate
- BMI > 26
- History of snoring
- Obese
- Facial hair (peds not so much)
- Tonsillar hypertrophy
- Ability to intubate
- Mallampati score
- Thyromental distance
- MIO
- ROM of neck
- Distortion of airway



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Respiratory Emergencies

First steps

- Relieve airway obstructions
- Open the airway
- Head Tilt Chin Lift
- Protrude the tongue
- Assess if they are moving air or not
- Check/turn up oxygen



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Unable to ventilate/intubate

- Stop procedure, deep suction, pack off wound
- Open airway, confirm sniffing position, grab tongue and pull forward
- BVM with or without nasal or oral airways
- Place supraglottic airway
- Call 911?
- Intubate patient
- Cricothyroidotomy (not recommended under the age of 10)
- Percutaneous needle cric (Jet Ventilation)
- Tracheostomy



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Apnea vs. Obstruction

- Opioids
- Benzodiazepines
- Inhalational agents

- Mechanical obstruction
 - Tongue/soft tissue
 - Tongue retractor
 - Foreign object



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Pharmacologic Treatment

- Lower/Stop inhalational agent
- Opioid overdose
 - Narcan First dose
 - < 40kg 0.01mg/kg IV/IM q2m
 - >40kg 0.4mg IV/IM q2m
 - Narcan second dose
 - <20 kg 0.1mg/kg IV/IM q2m
 - >20kg 2 mg/kg IV/IM q2m
- Benzodiazepine overdose
 - Flumazenil 0.01 mg/kg up to maximum of 0.2mg IV q1m
 - Max total dose .05mg/kg or 1mg



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Laryngospasm

- Spasm of the vocal cords – partial or complete
- Protective reflex to prevent foreign material into the tracheobronchial tree
- Usually direct airway stimulation (blood, secretions in airway)
- GERD, irritable airways
- Light planes of anesthesia



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Laryngospasm

- Compared to adults:
- -3 X more likely in neonates and infants
- -2 X more likely in children ages 1-8
- -Second hand smoke increases the risk from 0.9% to 9.4%
- URTI increases by 2.4-5 times
- Asthma increase risk 10 times



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Laryngospasm - Recognition

- Partial laryngospasm
 - Stridor
 - Minimal air movement
 - Visible use of accessory respiratory muscles
 - De-saturate
- Complete laryngospasm
 - No air movement = no breath sounds
 - Visible use of accessory respiratory muscles
 - De-saturate



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Laryngospasm - Treatment

- Usually self-limiting
- Support ventilation, BVM w/ 100% oxygen
- Deepen anesthesia
- First dose 0.1-2mg/kg (0.5mg/kg) of succinylcholine
- If persists, intubating dose of 1-2mg/kg succinylcholine and intubation (Make sure pt. is adequately anesthetized!)
 - DO YOU HAVE AN IV ? IF NOT 2-4mg/kg dosage IM (max 150mg)
- Succinylcholine can cause bradycardia, have atropine ready
 - Atropine: 0.01-0.02mg/kg IV, 0.03-0.06mg/kg IM



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Negative Pressure Pulmonary Edema

Sucking against a closed glottis – Laryngospasm accounts for >50% of POPE

- Normal intrapleural pressure is -5 to -10 mmHg, may rise to -50 to -100mmHG
 - Increases transcapillary hydrostatic pressure causing pulmonary edema
- Results in right ventricular distension, leftward shift of intraventricular septum, decreased left ventricular compliance



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Negative Pressure Pulmonary Edema

- Fluid leaking from capillaries to alveolar space and interstitium
- Hypoxia
- Pink, frothy sputum
- Stridor
- Accessory respiratory muscle use
- Wheezing as progresses



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Negative Pressure Pulmonary Edema Treatment

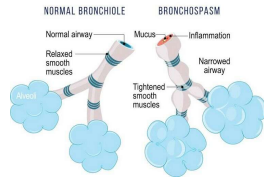
- **100% O2**
- Removal of obstruction
 - Intubation
 - Succinylcholine
- Correct hypoxemia
 - May require PEEP
- Diuretics unless volume depleted
- If you suspect pulmonary edema call 911 and send them to the hospital for management.



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Bronchospasm

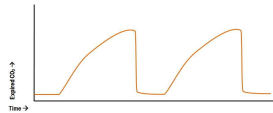
- Narrowing of the bronchi due to contraction of the bronchial muscles



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Bronchospasm - Recognition

- Restricted airflow
- Unable to ventilate patient
- High peak inspiratory pressure (if tubed)
- Decreasing O₂ sat
- Wheezing on lung exam
- "shark fin" capnography



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Management

- May need to deepen anesthetic
- B₂ agonists
 - Albuterol (know how administer via YOUR BVM)
 - 4 puffs of Albuterol inhaler q2m x2 doses
 - Epinephrine (Racemic - inhaled)
 - Ipratropium bromide
 - Magnesium Sulfate
- If unable to move air, may need IM or IV Epinephrine
 - 10-20mcg IV q1m
 - Epi pen (>30kg) or Epi Pen Jr. (<30kg)

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Bronchospasm

- Best bet is prevention
- E.g. consider cancelling surgery if asthmatic patient has concomitant factors (bronchitis, URI)
- Consider steroids pre-operatively for decreased mucus production, potentiate B2 agonist
- Consider giving anticholinergics for decrease secretions
 - Glycopyrrate, Atrovent

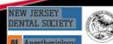


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Allergy/Anaphylaxis

Why in Kids?

- The younger the child the higher the chance of a new exposure
- May not be the first exposure which leads to anaphylaxis
- Some kids will grow out of an allergy by adulthood



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Allergy/Anaphylaxis

- Mild/Moderate - Pruritis, flushing, urticaria, edema – peri-oral, conjunctivitis
- Severe - hypotension, wheezing, dyspnea, n/v, diarrhea, CV collapse, death



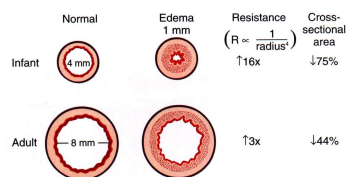
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Allergy/Anaphylaxis

- Remove offending drug/material if known
- 100% O2 Support the airway as needed
- No Airway Involvement
 - Diphenhydramine 25-50mg IV/IM
 - Steroids: Dexamethasone 0.3mg/kg
- Airway Involvement: straight to epi
 - Epinephrine: 0.01mg/kg IM of 1:1000 epi (typically 0.15mg dose)
 - Inhaled Beta 2 agonist: Albuterol 2-4 puffs



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Aspiration

- Obesity
- GERD
- Hiatal hernia
- Pregnancy
- Trauma patients
- No throat screen used
- **Inadequate Adherence to NPO Guidelines**



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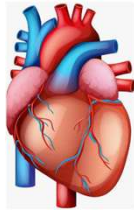
Aspiration - Sequelea

- Aspiration pneumonitis vs. pneumonia
- Physical obstruction
- Laryngospasm
- Bronchospasm



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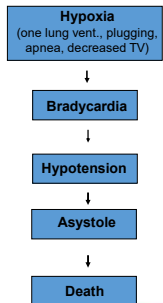
Cardiac Emergencies



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Cardiac Arrest

- Most often PULMONARY driven in child



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Bradycardia

- Remember CO is dependent on HR in pediatric patient, must avoid bradycardia!
- Atropine: 0.01-0.02mg/kg/dose (max 0.5mg/dose child, 1mg adolescent), may repeat again at 5 minutes
- Epinephrine: 10-20mcg IV q1m



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Cardiac Arrest

- ABCs- Airway, breathing Circulation
- Secure/manage the airway
- **If unresponsive child and no pulse or pulse less than 60 bpm start CPR**
- AHA Algorithm similar to adults. If shockable, 2 shocks prior to epinephrine. If not shockable, straight to epi
 - Epinephrine 0.01mg/kg (max dose 1mg) q3-5min
 - Amiodarone 5mg/kg bolus q3-5min (max 1st dose 300mg, 2nd dose 150mg)



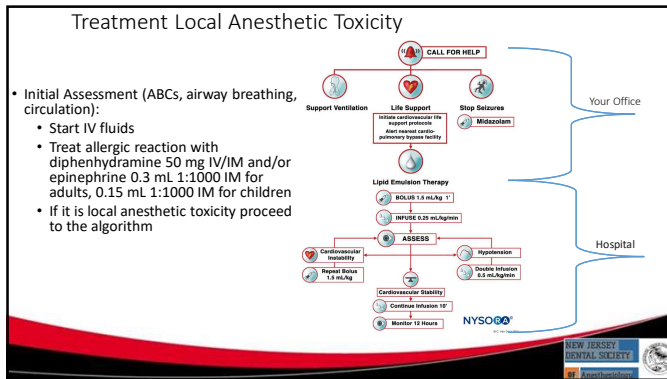
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Local Anesthetic Systemic Toxicity

- | | | |
|---|--|--|
| <ul style="list-style-type: none"> • Initial signs/symptoms <ul style="list-style-type: none"> • Anxiety • Dizziness • Slurred speech • Confusion • Tremors • Hypotension | | <ul style="list-style-type: none"> • Late signs/symptoms <ul style="list-style-type: none"> -Seizures -Bradycardia -Ventricular Arrhythmias -Unconsciousness -Cardiovascular collapse |
|---|--|--|



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Malignant Hyperthermia

- Autosomal Dominant Inheritance
- Hypermetabolism of skeletal muscle following exposure to certain triggering agents
 - Safe agents
 - Local
 - Propofol
 - Benzodiazepines
 - Non-depolarizing muscle relaxants
 - Anesthetic-related disease
 - Succinylcholine
 - Inhalation agents

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Epidemiology

- 1:15,000 Pediatric patients
- 50% of MH cases occur in patients with 2 or more uneventful anesthetics
- Mortality Rate
 - 70 % when untreated
 - <5% when recognized and treated
- Upper Midwest appears to have greatest incidence in USA

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Prevention

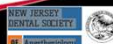
- Obtaining Family History
- Clean/flush Line
 - Consider which patients to use Inhalation agents on



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Recognition

- First sign is sudden increase end-tidal CO₂
- Decrease O₂ saturation
- *Tachycardia*
- Dysrhythmia
- Hyperthermia
- Muscle rigidity
 - Masseter muscle



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Treatment

- Prevention is the best treatment!!!
- Call 911
- Stop all triggering agents (change circuit)
- Hyperventilate with 100% oxygen
- Dantrolene
- Cool patient
- Treat acidosis
- Maintain UOP (>2 ml/kg/hr)
- Treat hyperkalemia
- Call MH hotline: 1-800-644-9737



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Dantrolene

- Mixture
 - 20 mg dantrolene, 3 g mannitol, 60 mL H₂O
- Decreases Ca release from the sarcoplasmic reticulum
- Side effects
 - Muscle weakness, hyperkalemia, GI upset, thrombophlebitis



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Ryanodex

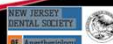
- Dosage
 - Good option – same as dantrolene 2.5mg/kg
- Max
 - 10mg/kg (if additional dosage necessary)



FOR BEST AND MOST EFFICIENT ADMINISTRATION, CHOOSE RYANODEX®
RYANODEX® BECOMES SIGNIFICANTLY LESS EFFECTIVE IN OTHER DANTROLENE FORMULATIONS AND IS
ADMINISTERED IN LESS THAN 1 MINUTE!™

	Dantrolene Solution (Ryanodex®)	Other Dantrolene Solutions
Concentration per mL	20 mg	20 mg
Volume of solution needed to administer 2.5 mg/kg	0.125 mL	60 mL
Preparation and administration of 2.5 mg/kg of dantrolene (20 mg/kg)		
Time to mix dantrolene	1 min	30 min
Time to inject and flush catheter	1-2 minutes	10-15 minutes
Volume needed for catheter flush	0.125 mL	10-15 mL
Total volume	1 mL	30 mL
Time to inject 2.5 mg/kg	10 minutes	30 minutes

Source: Ryanodex (Dantrolene) 20 mg/60 mL vial



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Outpatient Testing

- Muscle contracture test or biopsy
 - Exaggerated response to electrical stimulation when exposed to halothane and caffeine
 - Biopsy is not completely diagnostic - histologically
 - Variable muscle fiber size, increased # internalized nuclei, "moth-eaten" fibers
- May also have increased baseline CK level



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Recovery and Discharge

- Complete recovery in recovery area
- Post-anesthetic laryngospasm in peds
- Recovery in lateral position to avoid secretions irritating chords
- State of consciousness, vitals, age appropriate ambulation, pain control, absence of post-op N/V
- Must have car seat if age appropriate, no unattended recovery!

TWO ADULT ESCORTS MANDATORY



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Complications at home

- Narcosis
- Aspiration
- Inadequate pain control
- PONV
- Thermoregulation events



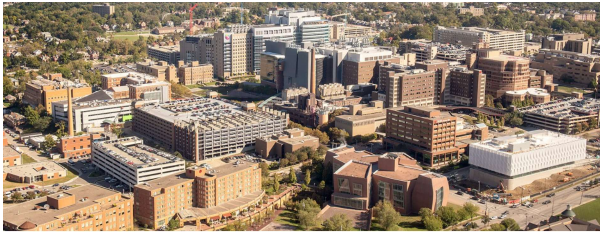
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Summary

- Majority of adverse events are related to airway or respiratory events -managed with simple maneuvers
- Pre-procedural health evaluation and case selection
- Appropriate and continuous monitoring
- Adequate preparation - equipment, medication and monitors
- Appropriate recovery prior to discharge
- Simulator training enhances skills, low risk, high stakes training



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Thank You
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