

Pediatric Respiratory Emergencies



Children's Hospital Colorado

Affiliated with



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Financial Disclosures

- No relevant financial relationships with any commercial interests.

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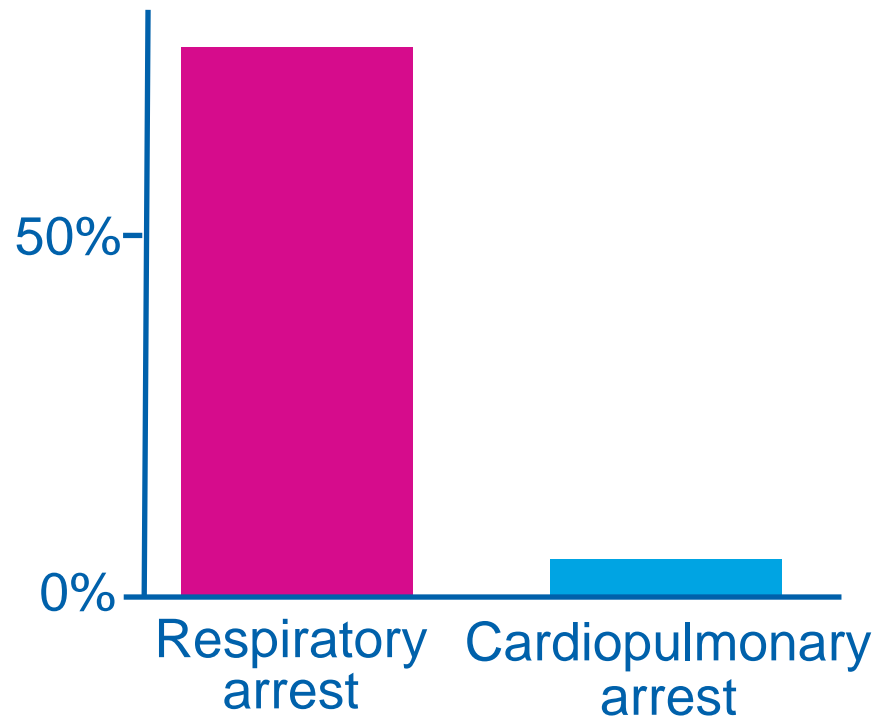
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Objectives

- Review the pediatric airway and signs/symptoms of respiratory distress in pediatric patients.
- Discuss the causes and treatment of common pediatric respiratory issues.
- Review selected upper vs lower respiratory emergencies
- Discuss approach to different pediatric respiratory cases

Survival Following Respiratory Arrest vs. Cardiopulmonary Arrest in Children

Survival
Rate





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Pediatric Respiratory Emergencies

- What scares you about pediatric patients?
- How does pediatric airway differ from adult airway?

Pediatric Airway

- **Large head for size of body**
 - Prone to flexion/obstruction when supine
 - May need to place towels/padding beneath torso to account for big head & maintain c-spine
 - **Large tongue for size of mouth**
 - Obstruction
 - Difficult to get out of the way when intubating
 - **Everything is smaller**
 - Smaller nasal passages makes them more susceptible to marked increase resistance to airflow
- **POSITIONING**

Signs of Respiratory Distress

Early Signs



RR

- Nasal flaring
- Intercostal, supraclavicular, and subcostal retractions
- Neck muscle use
- Audible noises: stridor, wheezing
- "see-saw" respirations

Late Signs

- RR >60
- Cyanosis
- Decreased muscle tone
- Severe accessory muscle use (sternal retractions)
- Poor peripheral perfusion
- Altered mental status
- Grunting
- Head bobbing





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Late Signs of Respiratory Distress

Respiratory Distress & Failure

- **Distress:**
- State of increased
- **respiratory rate** and increased **respiratory**
- **effort:**
 - Tachypnea
 - Nasal flaring
 - Retractions



Respiratory Distress & Failure

- **Failure:**
- Inadequate gas
- exchange by the
- respiratory system

- *Usually follows period of distress
- Most common pathway to cardiopulmonary arrest!!!





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“My baby is having trouble breathing”

- What are you thinking of in route to scene?
- What are primary causes of respiratory distress in pediatric patients?
- What equipment/medications are you getting ready?

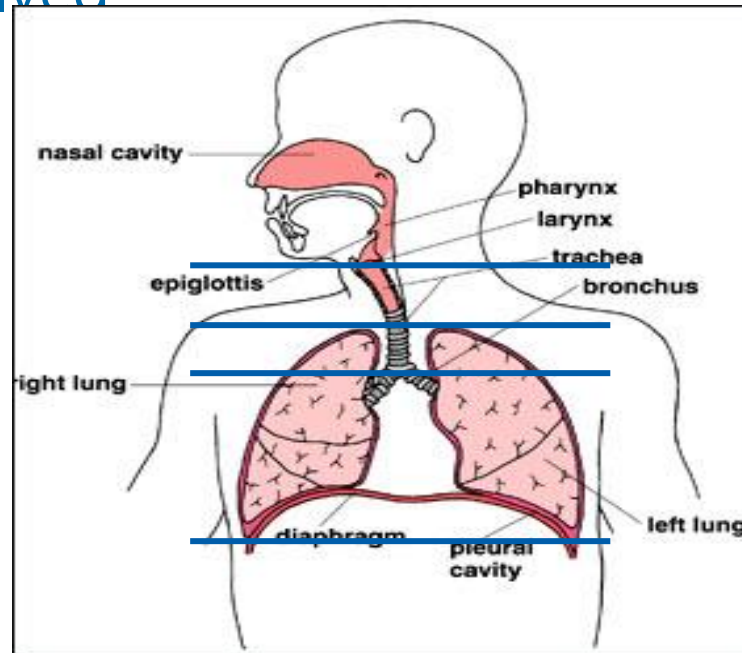
A-B-C

- **Airway**
 - Is there anything preventing getting air in?
 - What can we do to improve/fix issues with getting air into/out of lungs
- **Breathing**
 - Is patient breathing? Is there respiratory effort?
 - Is oxygen getting into body? Is CO₂ getting out?
 - How can we support breathing?
- **Circulation**
 - Is heart pumping? Is body being perfused?
 - How can we help/support circulation?



Define the Problem

- Is this a primary respiratory problem?
- Which part of the respiratory tree is involved?



“My baby is having trouble breathing”

- 4 yo with 1 day history of cough, congestion, and fever of 101.
- Woke up from sleep with difficulty breathing.
- FOC and 15 yo brother Covid + 2 days ago



4 yo Respiratory Distress

- 02:22 Arrive at scene
- Pt in arms of mother; loud breathing; fussy/crying
- HR: 185 RR: 60 Pox: 92% Temp: 102.8
- What else do you want to ask?
- What physical exam findings are you looking for?
- What do you want to do?

4 yo Respiratory Distress

Physical Exam:

- Vitals: HR: 185 RR: 40 Pox: 92% Temp: 102.8
- General: Anxious/scared
- Mucous membranes dry, no lesions; + nasal discharge.
- Chest: intercostal and suprasternal retractions; + raspy distress and stridor when crying
- Circulation: skin pale, mottled extremities, tachycardic

Now what?

What do you think is going on?



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ABC of Pediatric Breathing Issues

- Majority of respiratory issues caused by the BIG THREE of pediatric respiratory diseases

A

B

C



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ABC of Pediatric Breathing Issues

- Majority of respiratory issues caused by the BIG THREE of pediatric respiratory diseases

Asthma

Bronchiolitis

Croup

Asthma vs Bronchiolitis vs Croup

Asthma

- Lower airway
- Viral/allergy irritant/???
- Can't getting air out
- Tight cough
- Wheezing
- All day/night

Bronchiolitis

- Upper and lower
- Viral etiology
- Hypoxia/WOB/Apnea
- Wet cough
- Crackles
- Seasonal
- Snot

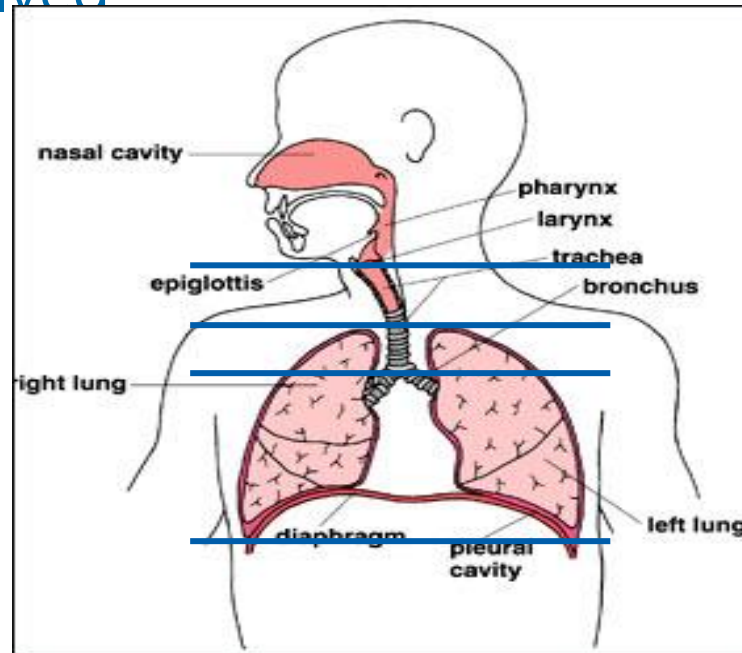
Croup

- Upper airway
- Viral etiology
- Can't getting air in
- Barky cough
- Stridor
- Middle of the night or after sleep



Define the Problem

- Is this a primary respiratory problem?
- Which part of the respiratory tree is involved?



Asthma

- Lower respiratory tract issue
 - Combination:
 1. Airway constriction—smooth muscle
 2. Airway inflammation
- Physical Exam
 - Tachypnea and respiratory distress, retractions
 - Prolonged expiratory phase (look at the belly)
 - Wheezing and difference in aeration
- Treatment
 - Albuterol-relaxes smooth muscles, thus opens airways
 - Atrovent-(only beneficial in start of treatment)
 - Steroids-decreases airway inflammation
 - 2mg/kg load then 1mg/kg BID for 4-5 days
 - Magnesium-smooth muscle relaxation

Bronchiolitis

- Lower respiratory tract issue
 - Airway constriction/swelling at bronchioles:
 - Mucous collects in airways
 - Poor oxygen and CO₂ exchange (low oxygen saturation)
- Physical Exam
 - Tachypneic with normal insp/exp phase (look at belly)
 - Tons o'snot
 - Wheezing, rhonchi with symmetric aeration throughout
 - Retractions
- Treatment (supportive)
 - Suction
 - Oxygen
 - Fluids – encourage or IV

Croup

- Upper respiratory tract issue
 - Airway constriction/swelling at area of vocal cord
- Physical Exam
 - Tachypnea
 - Stridor
 - Retractions
 - Lungs Clear
 - Raspy voice or not speaking
- Treatment
 - Steroids
 - Epinephrine nebulizers
 - heliox

4 yo Respiratory Distress

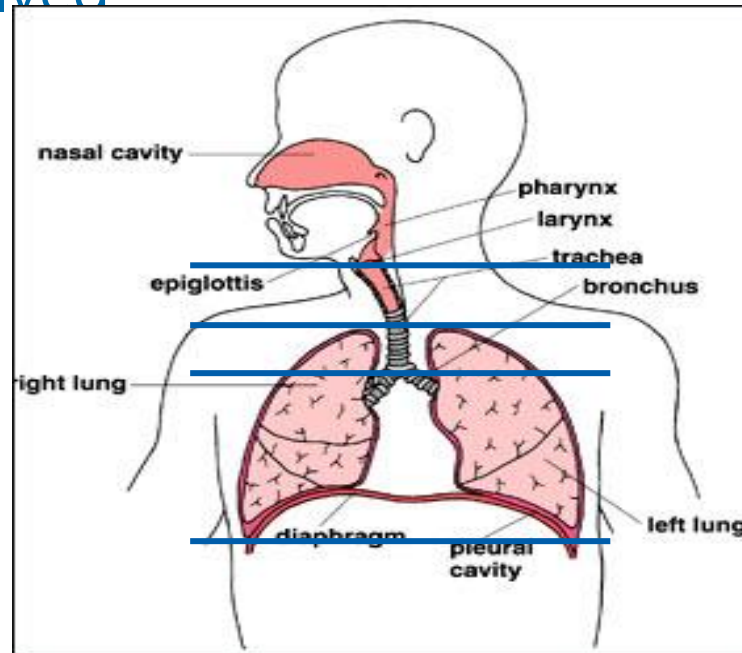
Physical Exam:

- Vitals: HR: 185 RR: 40 Pox: 92% Temp: 102.8
- General: Anxious/scared, + raspy voice
- Mucous membranes dry, no lesions; + nasal discharge.
- Chest: intercostal and suprasternal retractions; stridor when crying; lungs good aeration, transmitted UAW sounds during inspiration
- Circulation: skin pale, mottled extremities, tachycardic



Define the Problem

- Is this a primary respiratory problem?
- Which part of the respiratory tree is involved?





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Differential of Stridor/Upper AW

- Infection
 - Croup
 - Bacterial tracheitis
 - Retropharyngeal abscess
- Foreign Body-(especially starting w/o period of sleep)
- Laryngomalacia/Tracheomalacia
- Less common causes:
 - vocal cord paresis,
 - subglottic hemangioma,
 - causes rapidly progressing stridor, sometimes associated with a facial hemangioma
 - vascular ring, vascular sling, fixed mediastinal mass

Croup

- Typical story:
 - 3 y.o. (6 months -6 years) wakes up in middle of the night or after a nap and “can’t breath”.
 - Parents report pt was “coughing and wheezing”.
 - Has slight runny nose last evening before bed.
 - Has never had anything like this before.
 - Got better on ride in to ED.
 - When you go to examine patient gets upset and gives horse cry

Airway Resistance

	<u>Normal</u>	<u>Edema</u>	<u>Δ diameter</u>	<u>Δ resistance</u>
Infant	 4 mm	 2 mm	↓ 50 %	↑ 16 ×
Adult	 8 mm	 6 mm	↓ 25 %	↑ 3 ×

Croup

- Accounts for over 90% of stridor with fever
- Subglottic stenosis secondary to edematous, inflamed mucosa
 - NOT SMOOTH MUSCLE ISSUE
- Most commonly caused by parainfluenza >>> RSV, adenovirus, and influenza
- With different waves of Covid, we saw large number of Covid+ croup with more recent variants
 - Older kiddos

Croup

- Treatment:
 - **Position**
 - Mild-Barky cough, no stridor at rest
 - Decadron: standard dose 0.6mg/kg (max 8mg)
 - Studies have shown as doses as low as 0.2 mg/kg are just as affective
 - No studies have shown benefit from 2nd dose
 - Cool mist-no study to show this is beneficial
 - Severe-Stridor at rest and/or severe distress
 - Racemic epinephrine(0.5 ml of 0.25% solution dissolved in 2.5ml of NS)
 - Watch for 2-3 hours after treatment
 - Heliox-Use limited by hypoxia
 - Pt with significant hypoxia with croup are worrisome for severe disease/critical airways
- Albuterol does not help as not a smooth muscle issue



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15 month with difficulty breathing

- CC: My child is having a hard time breathing and has a fever?
- 2 days of cough, congestion and tactile fever.
- Decreased drinking and post-tussive emesis
- 8 yo sibling with cold;

- Triage vital signs:
 - HR 173 RR: 54 Pulse Ox: 91% Temp: 38.8



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15 month with difficulty breathing

- PMHx: None.
- Allergies: Amoxicillin
- Family Hx: MOC: thyroid issues FOC: ulcerative colitis
- Immunizations: UTD

- What else do you need to ask?



15 month with difficulty breathing

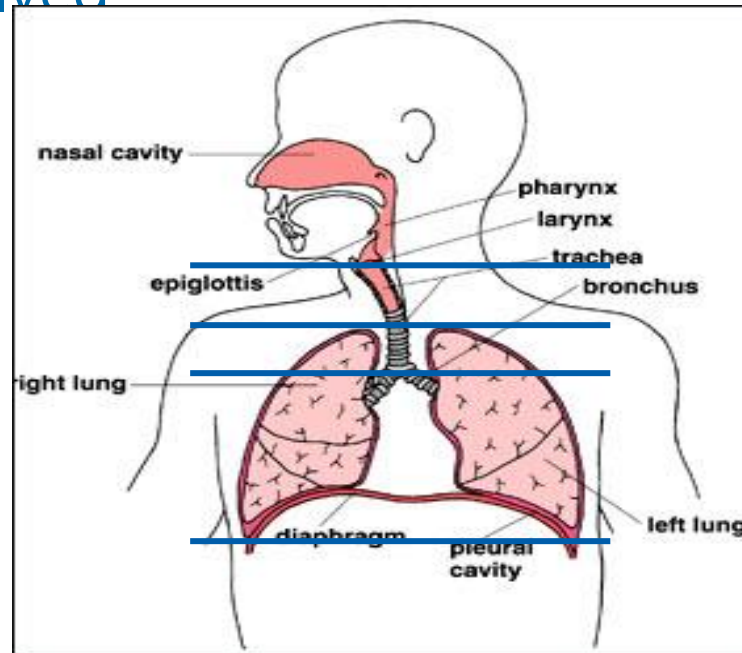
- PE: HR 173 RR: 54 Pulse Ox: 91% RA; Temp: 38.8 BP 80/55
- Gen: Tired appearing in MOC's arms. + cough
- HEENT: + nasal discharge; TM: erythematous bilat
- Lungs: + retractions; coarse BS with intermittent crackles and wheezing. Symmetric aeration, normal I:E.
- Heart: S1S2 no m/r/g. Tachycardiac
- Abd: soft, NT/ND. No HSM
- Ex: Cap refill 2-3 sec.

What is going on and what do you want to do?



Define the Problem

- Is this a primary respiratory problem?
- Which part of the respiratory tree is involved?



Bronchiolitis

- Acute viral infection- most commonly RSV
- Age \leq 2 years of age
- Infant's sx are worsen for the first 3-5 days
- Infectious process \rightarrow **destruction in lining of bronchioles**
 - Bronchoconstriction
 - Mucous plugging
- Most common in winter and early spring
- Apnea= most concerning complication in infants

Bronchiolitis

- **Signs/Symptoms**
- runny nose, coughing, sneezing, tachypnea, retractions, wheezing/crackles, volume depletion due to decreased oral intake, apnea, fever





Bronchiolitis-Interventions

- Contact isolation-mask up
- Supportive care!!
 - SUCTION, SUCTION, SUCTION
 - Position
 - Oxygen-heated high flow
 - Treat fever
 - ORT with Pedialyte
 - Positive pressure
 - SUCTION again



**Nasal suction=
LIFESAVER**



Supplemental Oxygen

Nasal Cannula



- Simple mask



- Non-rebreather

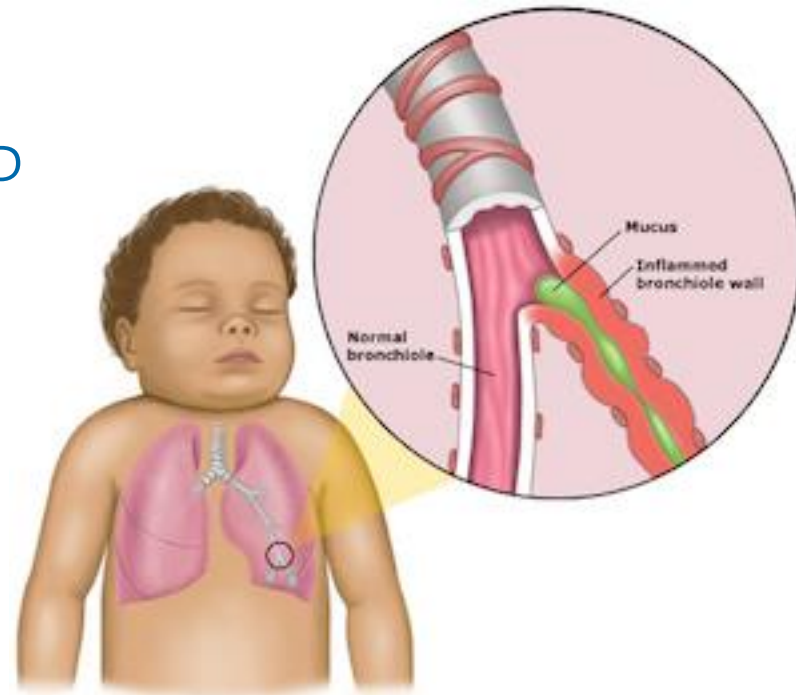


Bronchiolitis

- Viral infection
 - RSV; human metapneumo virus, parainflu, flu
- Clinical picture varies with age
 - Neonates/newborns
 - Apnea BEFORE onset of symptoms
 - Toddlers:
 - Nasal secretions/congestion
 - Wet cough
 - Poor PO intake
 - Coarse breath sounds/wheezing/crackles—washing machine
 - Tachypnea
 - +/- Fever
 - School aged
 - Cough-post nasal drip
 - Viral pneumonitis

Bronchiolitis

- What is the problem?
 - Viral infection makes the bronchioles swell and become inflamed. Mucus collects in these airways, which can make it difficult for air to flow freely into and out from the lungs.
- How do we make diagnosis?
 - Clinical diagnosis—NO TEST NEEDED
 - CXR-
 - Unlikely to be helpful
 - Increase Abx→Increased “allergies”
 - Viral DFA
 - Who cares which virus?
 - We never use to care



Bronchiolitis

- What do we do?
 - **Suctioning**—helps clear secretions in upper airway but not lower airway, but has proven beneficial
 - Supplemental O₂ when hypoxic
 - **Position**
 - Things thought to possibly help, but evidence lacking:
 - Steroids—Decrease airway swelling??—no proven benefit
 - Hypertonic saline nebs: thin secretions/mucus plugging—Studies yet to show significant benefit
 - Albuterol—rarely helps more likely hurts



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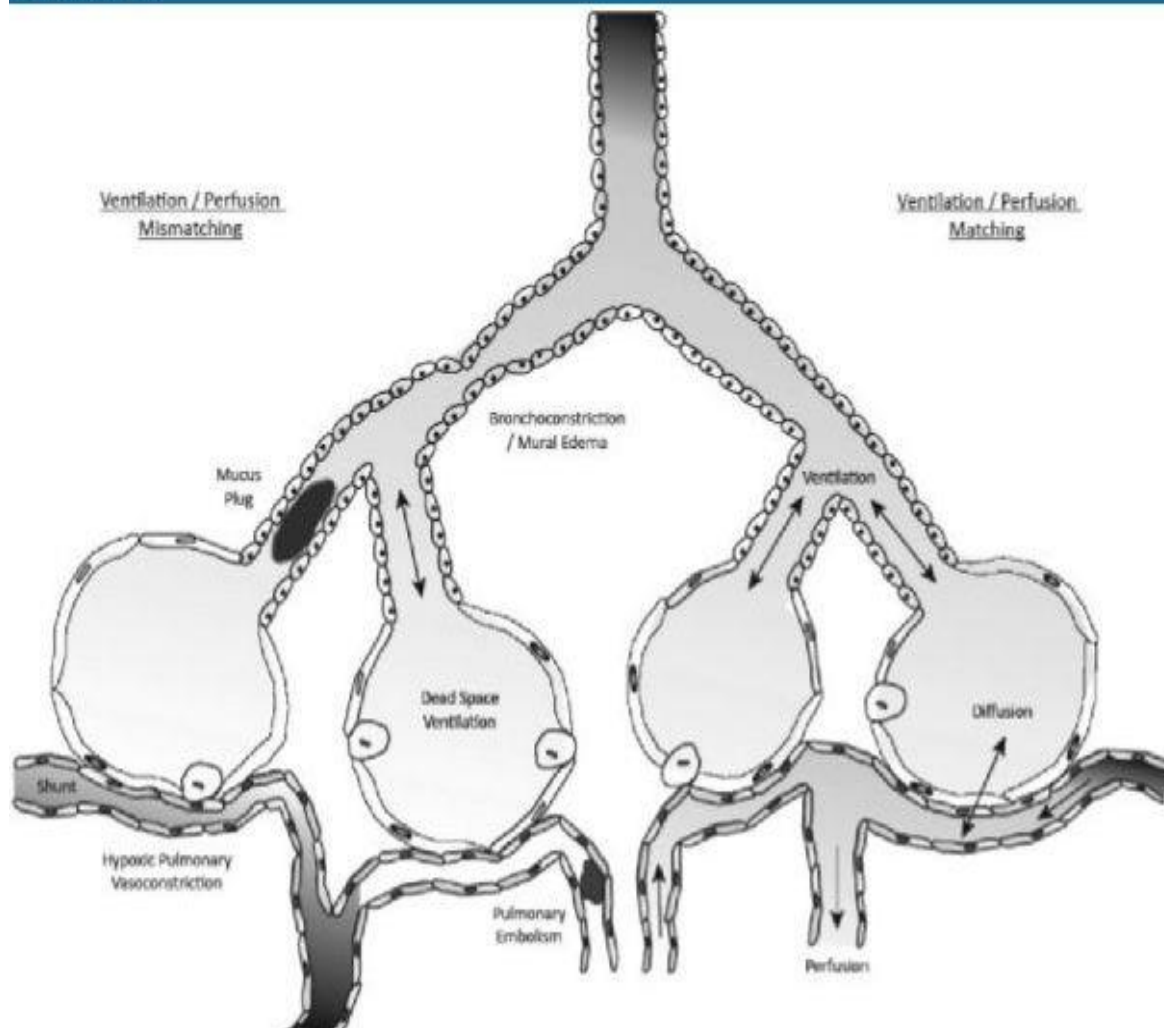
Albuterol in bronchiolitis??

- How does albuterol work?
- Where does it have its effect?
- Why might this make bronchiolitis worse?



V/Q Mismatch

Medscape



Remember the Basics!!

Albuterol ≠ "All-better-ol"





15 month with difficulty breathing

- Pt suctioned with nasal saline flush for large amount of thick secretions.
- Pt able to drink 8 ounces.
- Motrin given

- 30 min later:
- HR: 145 RR: 55 Pulse Ox: 84% Temp: 37.5

- Now what?



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15 month with difficulty breathing

- Pt placed on O₂ via low flow nasal cannula, but pulls it out immediately
- How do we delivery needed O₂?
 - Blow by?
 - Facemask?
 - Keep trying nasal cannula?





Why Not Blow-by?

- A manikin of a child with a facemask of appropriate size was transported along a 60 m corridor from OR to the PACU. O₂ delivery to the face of the manikin was measured during transport.
- Six blow-by methods were tested with oxygen flows of 3, 6, and 10 L/min and with the facemask at 0 cm from the face and at 5 cm from the face.
- The outcome parameter was: blow-by method reaching and maintaining an FiO₂ >50% during transport from OR to the PACU.



Why Not Blow-by?

- At 0 cm from the face, blow-by methods maintained a $FiO_2 > 50\%$
- At 5 cm only at 10 L/min flow blow-by methods were able to maintain an $FiO_2 \sim 50\%$
- At distance greater than 5cm from face or at flow rates less than 10 L/min, FiO_2 decreased to $\sim 21\%$.
- The decrease in FiO_2 typically started within 6-12 meters from the start of the transport



Barends CRM, Yavuz P, Molenbuur B, Absalom AR. Performance of blow-by methods in delivering oxygen to pediatric patients during transport: A laboratory study. *Pediatr Anesth*. 2018; 28: 1142–1147. <https://doi.org/10.1111/pan.13515>



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15 month with difficulty breathing

- Nasal cannula put back on with Tender Grips
- Have parent hold child wrapped in blanket.
- Distraction:
 - Provide toys/movie
- 30 minutes later:
 - HR: 145 RR: 52 (with retractions and head bobbing)
 - Pox: 92% on 2Liters
- Now what?





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15 month with difficulty breathing

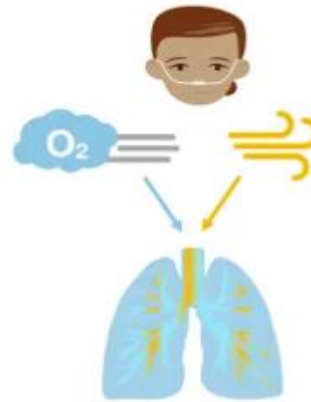
- Pt suctioned and O2 turned up to 4 liters w/out improvement.
- Decision made to increase respiratory support by starting patient on heated high flow (e.g., Vapotherm (i.e., HHF).
- How does HHF work?



How does HHF work?

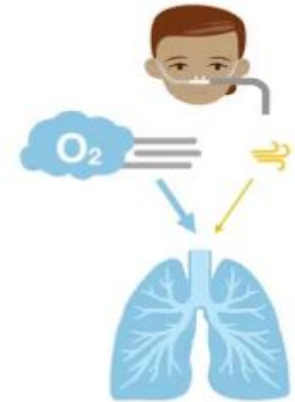
- There are three main proposed benefits of HFNC:
 1. Precise oxygen delivery
 2. Functional residual capacity enhancement
 3. Dead space washout

Nasal cannula



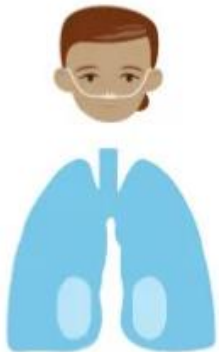
Room air entrainment
Oxygen dilution

HFNC



Minimal room air entrainment
Greater oxygen delivery

Nasal cannula



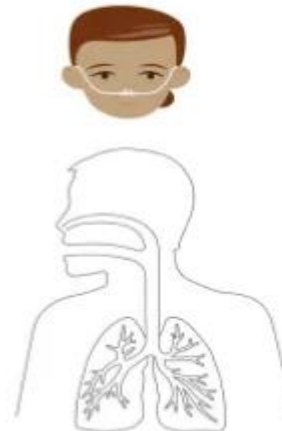
HFNC



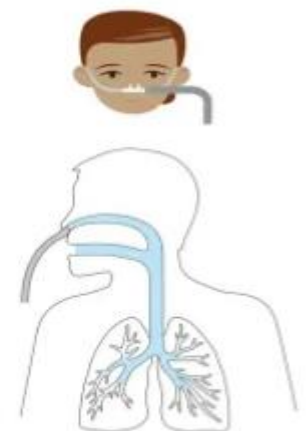
↑ 25%

Functional residual
capacity (FRC)

Nasal cannula



HFNC



Dead space washout



How does HHF work?

Summary of Actions:

Dead space washout	Reduce dead space making minute ventilation more efficient
Reduce inspiratory work of breathing	Exceed inspiratory flow thus eliminating nasal resistance
Improved lung Mechanics	Warmed, humidified gas has been shown to improve conductance, lung compliance and lung elasticity
Eliminates metabolic work associated with gas conditioning	Attenuates the energy and water loss associated with conditioning inspiratory gas
Provision of mild distending pressure	Provides positive distending pressure for lung recruitment. It prevents alveolar collapse
Improve secretion mobilisation	Ideal humidification of the inspired gas has been shown to restore muco-cilliary function and reduce symptoms of airway exacerbations

Table adapted from: High Flow Nasal Cannula Therapy in Neonatology (TL Miller 2013).



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15 month with difficulty breathing

- Pt improves initially on HHF, but later in the night had increased RR (58) and difficulty maintaining pulse ox (86%)
- Now what?

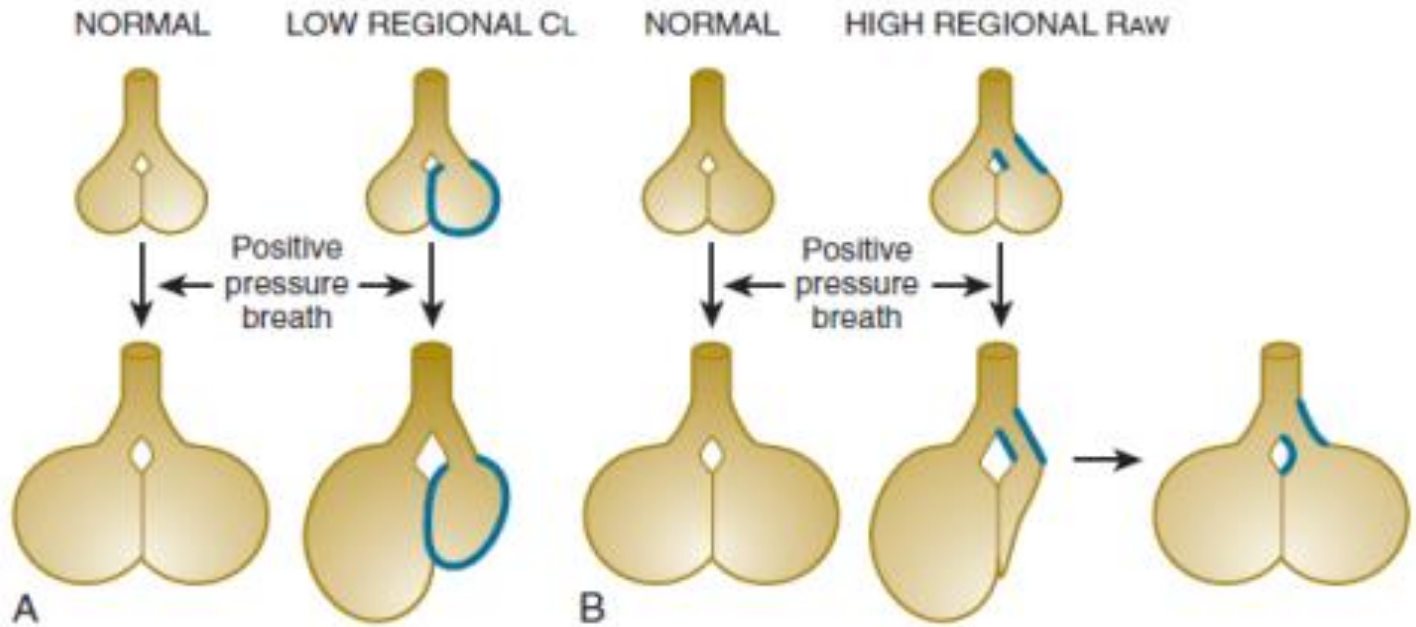


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15 month with difficulty breathing

- Decision made to increase respiratory support and place patient on CPAP/BiPAP to transfer
- Scuba mask





Overdistension of normal alveoli due to non-uniform pathology

A: Uneven compliance distribution

B: Uneven resistance distribution



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15 month with difficulty breathing

- Decision made to increase respiratory support and place patient on CPAP/BiPAP to transfer
- Scuba mask
- IVF (Pt needs to be NPO)
- Sedation:
 - Dexmedetomidine (Precedex)





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13 yo vomiting and difficulty breathing

- 16:10 911 call– Something is wrong with my son, he is vomiting and having trouble breathing.
- What are you thinking as you are driving to home?



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13 yo vomiting and difficulty breathing

- 16:38 Arrive at house
 - MOC says "He is on the couch and has been throwing up for a couple hours. He is really sleepy and now having hard time breathing"
 - What else do you want to know from parent?
 - When enter house what are you first looking for with patient?



13 yo vomiting and difficulty breathing

- 13:42: HR: 138 BP: 92/42 RR: 30 Pox: 95%
 - GEN: Sleepy but moans when you stimulate him.
Opens eyes when you ask him to and tells you his name
 - HEENT: Mucous membranes-very dry
 - Lungs: normal aeration. No wheezing/stridor. Breathing hard and fast
 - Heart: Tachycardic. Cap refill 3 seconds.
 - Abd: diffusely tender

- What else do you want to know?



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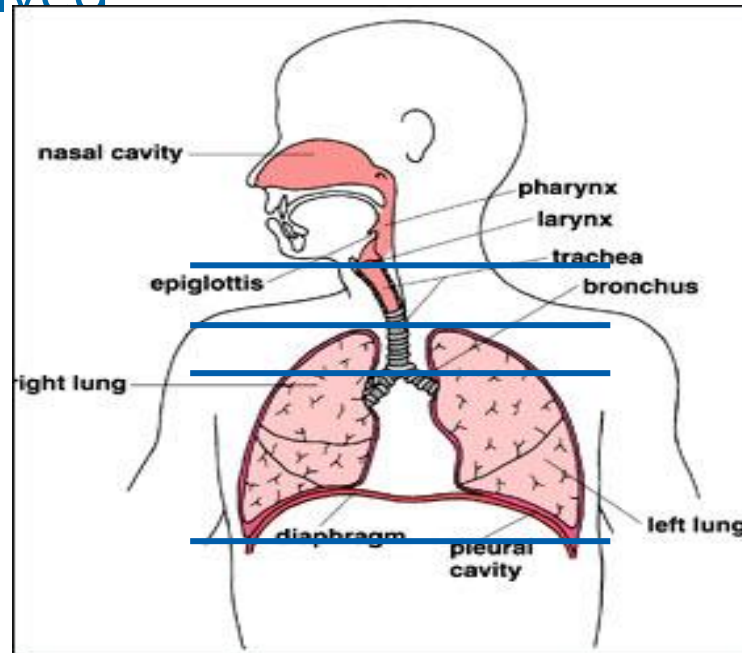
13 yo vomiting and difficulty breathing

- What is on your differential diagnosis?
- What's next?



Define the Problem

- Is this a primary respiratory problem?
- Which part of the respiratory tree is involved?





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13 yo vomiting and difficulty breathing

- Glucometer reads: HIGH
- What's going on?
- What's next?



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- Just a reminder to that other systemic illnesses can cause tachypnea and signs of respiratory distress

2 yo “Not breathing”

- Call to EMS:
 - “Help my child is not breathing. Please hurry”
- What are you thinking about when on way to home?
- What do you want to have ready to go?



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2 yo "Not breathing"

- Floppy and dusky child
- Now what?

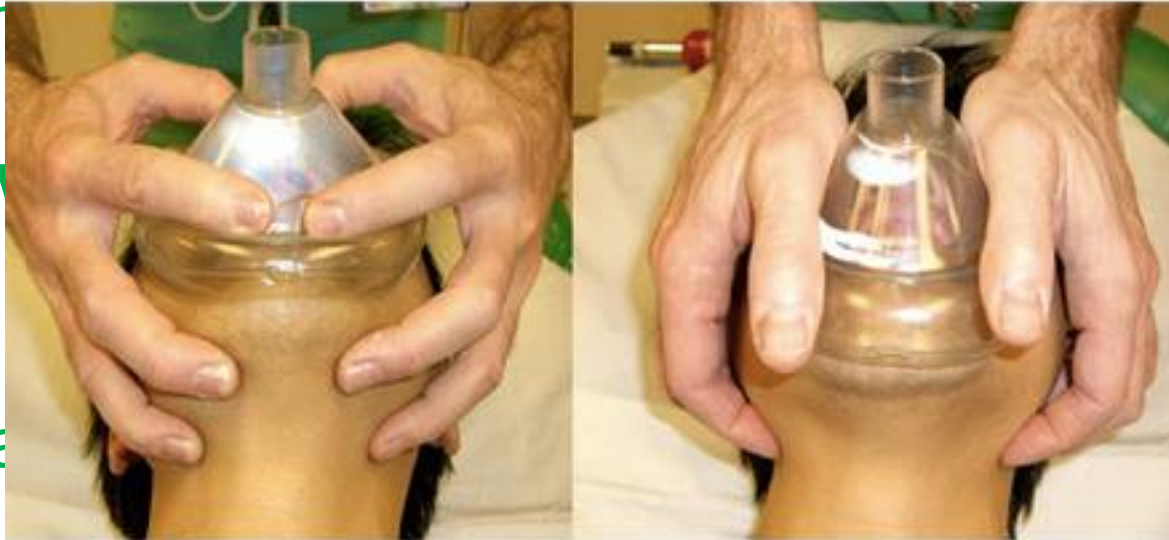
2 yo "Not breathing"

- Position child to open airway
 - Any foreign body in mouth?  No
 - Any improvement with opening airway?  No
- Any chest rise?  No

Bag-Mask Ventilation

- **THE single most important life-saving skill**
- C-E technique/2 hand Thelar technique/v-clam

- **Jaw**
- Not
- Alwa





- Right Size
- Right Positioning
- Right Rate



Correct
Covers mouth, nose, and
chin but not eyes



Incorrect
Too large: covers eyes
and extends over chin



Incorrect
Too small: does not cover
nose and mouth well

2 yo “Not breathing”

- 60 seconds after starting BVM
 - Improved color;
 - Stronger brachial pulses
 - Vital signs: Pulse Ox 90% HR: 100
- Now what?
- What is on your differential diagnosis?
- Anything you want to ask family?
- Any physical exam findings you looking for?



2 yo “Not breathing”

- Pt continues to require BVM.
- Not fighting BVM
- No movement of limbs.
- Call to ED:
 - This is **** coming lights and sirens with 2 y.o. female with unresponsiveness and requiring bagging. HR 90 Pulse ox 94% being bagged and delayed cap refill. We are 3-5 min out.



2 yo “Not breathing”

- Arrives to ED with BMV in progress.
 - Floppy child when moved to bed.
 - HR: 100 Pox: 94% BP: 78/44 T: 37.5
 - A: No structural abnormalities; no FB seen.
 - B: No respiratory effort. Symmetric aeration and chest rise with bagging
 - C: 2+ brachial pulses.
 - D: No obvious major injuries; Dextrose: 94
 - E: Warm blankets asked for
-
- What else do you want to know?
 - What do you want to do?

2 yo “Not breathing”

- Decision made to give Narcan
- How much?
- Pt screams and starts to breath on own.
- Urine Fentanyl POSITIVE





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Trafficker-Quantities of “Rainbow Fentanyl” Arrive in New York

Approximately 15,000 candy-colored fentanyl pills seized in Manhattan

DEA Warns of Bright Fentanyl Used to Treat Americans





When to take control of airway?

- Insufficient respiratory effort
 - Poor oxygenation and ventilation
 - Depressed mental status (seizing, overdose, infection)
 - "GCS < 8 → Intubate" (Well not always true...check that gag)
- Impending loss of airway
- Planned/anticipated next step
- Ongoing or potential risk for aspiration
 - Subglottic
 - Endotracheal
 - Cricothyrotomy



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5 yo vomiting and difficulty breathing

- 15:10 911 call– Something is wrong with my son, he is vomiting and having trouble breathing.
- What are you thinking as you are driving to home?



5 yo vomiting and difficulty breathing

- 15:18 Arrive at home
 - MOC w/ patient meet you at the door.
 - Pt coughing and then has his 4th episode of emesis
 - HR: 140 RR: 36 Pox: 92% on RA
 - Pale appearing and coughing
 - Heart: S1 S2 tachycardic
 - Lungs: coughing with every deep breath; poor aeration
 - Derm: diffuse erythematous rash on trunk and lower extremities
- What else do you want to know?
- What is going on?



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Anaphylaxis

- Severe life-threatening allergic rx
- Symptoms can develop rapidly-seconds/minutes
- Can lead to anaphylactic shock (distributive shock)-massive vasodilation






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Anaphylaxis-Symptoms

- Flushed/red skin
- Hives
- Intense itching
- Angioedema
- Noisy breathing (stridor, wheezing)
- Tachycardia
- Hypotension
- Anxiety
- N/V



Anaphylaxis- Interventions

- Maintain open airway
- **Position**
- Keep calm
- Oxygen
- IV fluid bolus  suspect severe rxn/BP
- Bronchospasm- albuterol
- Antihistamines
- Corticosteroids
- **Auto-injector epi**
- **Epinephrine (1:1000)**
 - 0.01 mg/kg (0.01 mL/kg)
IM- lateral thigh



Take Home Points

- Remember ABC's (both of them)
 - Airway, Breathing, Circulation
 - Asthma, Bronchiolitis, Croup
- **Basic interventions save lives:**
 - Positioning
 - Suction
 - Appropriate BVM
- Albuterol is not "All-better-ol"
 - Think about how/where it works and what you are treating
- All breathing issues are not a primary respiratory problem





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THE END

Questions?

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Thank You! Final Questions?



- Barends CRM, Yavuz P, Molenbuur B, Absalom AR. Performance of blow-by methods in delivering oxygen to pediatric patients during transport: A laboratory study. *Pediatr Anesth*. 2018; 28: 1142–1147. <https://doi.org/10.1111/pan.13515>
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