Wheezin' Season: Pediatric Respiratory Emergencies

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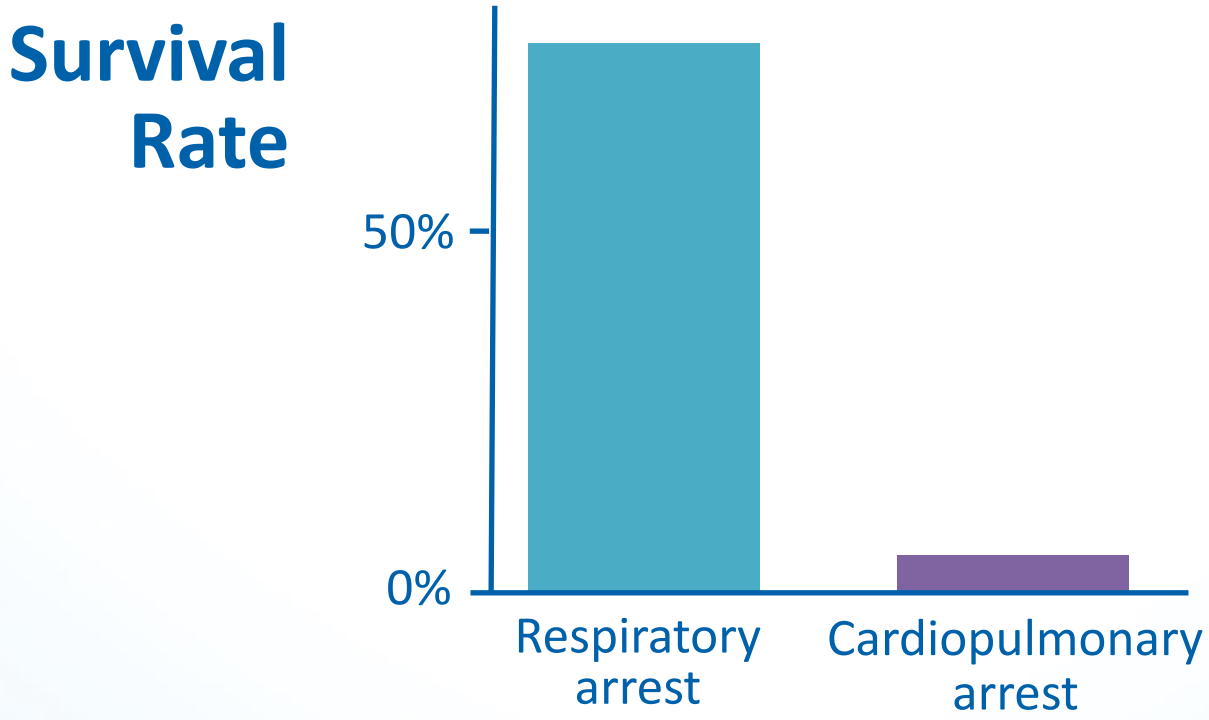
Why Is This Topic Important?

- Respiratory arrest is the most common cause of cardiopulmonary arrest in children
- Failure to manage airway is the leading cause of preventable death
- Early recognition is key
- Simple Interventions can work

Survival Following Respiratory Arrest vs. Cardiopulmonary Arrest in Children



Objectives

- Define Respiratory Distress and Respiratory Failure
- Identify anatomic and physiologic factors specific to the pediatric airway and the challenges they present
- Discuss options for early interventions to increase success in managing pediatric patient in respiratory distress
- Discuss modalities available when patient is in respiratory failure

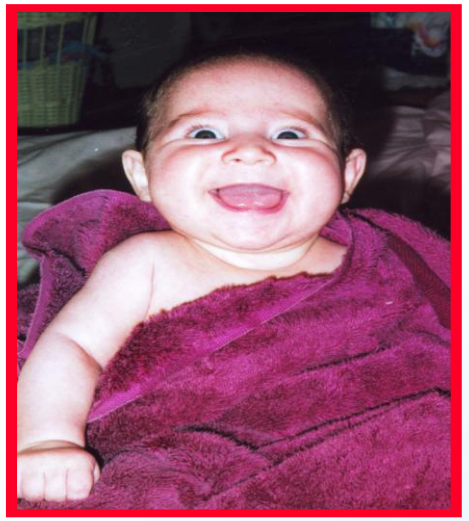
Pediatric Keys to Success

Prevent **HYPOXEMIA** !!

Basic treatments save lives:

STAY CALM!

- Get Vital Signs (no matter how young)
- Intervene and **Reassess**
  - **Remember kids can change**



Respiratory Distress & Failure

Distress:

State of increased **respiratory rate** and increased **respiratory effort**:

- Tachypnea
- Nasal flaring
- Retractions

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

Respiratory Distress & Failure

Failure:

Inadequate gas exchange by the respiratory system

*Usually follows period of distress

Most common pathway to cardiopulmonary arrest!!!

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 BMV, intubating

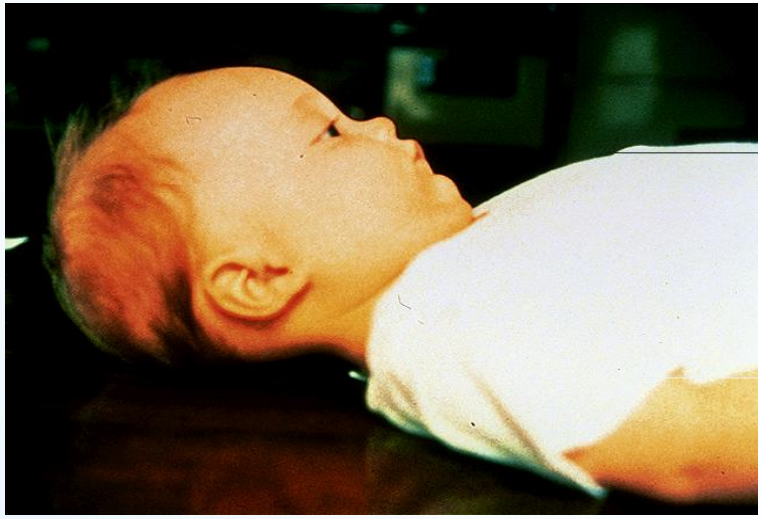
Everything is smaller

- Smaller nasal passages makes them more susceptible to marked increase resistance to airflow

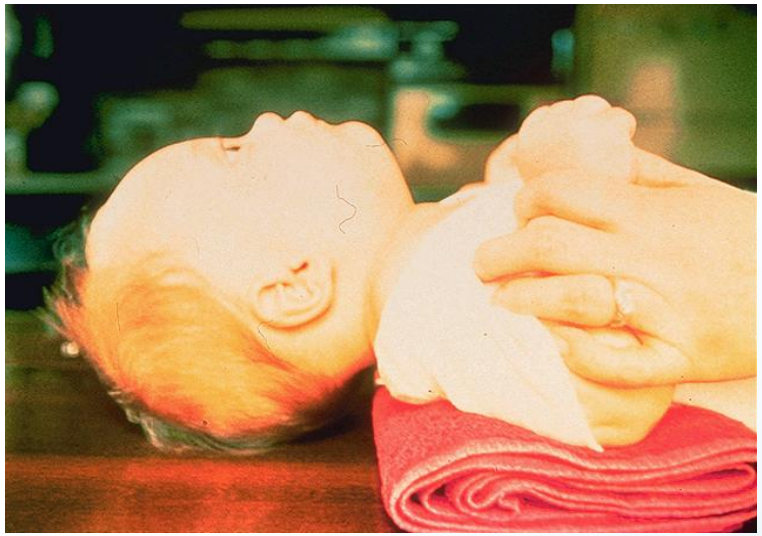
The Occiput Challenge

Proportionally larger head, particularly the occiput (up to ~8yrs)

Laying flat will obstruct the airway



Positioning with towel rolls can straighten the neck and open the airway



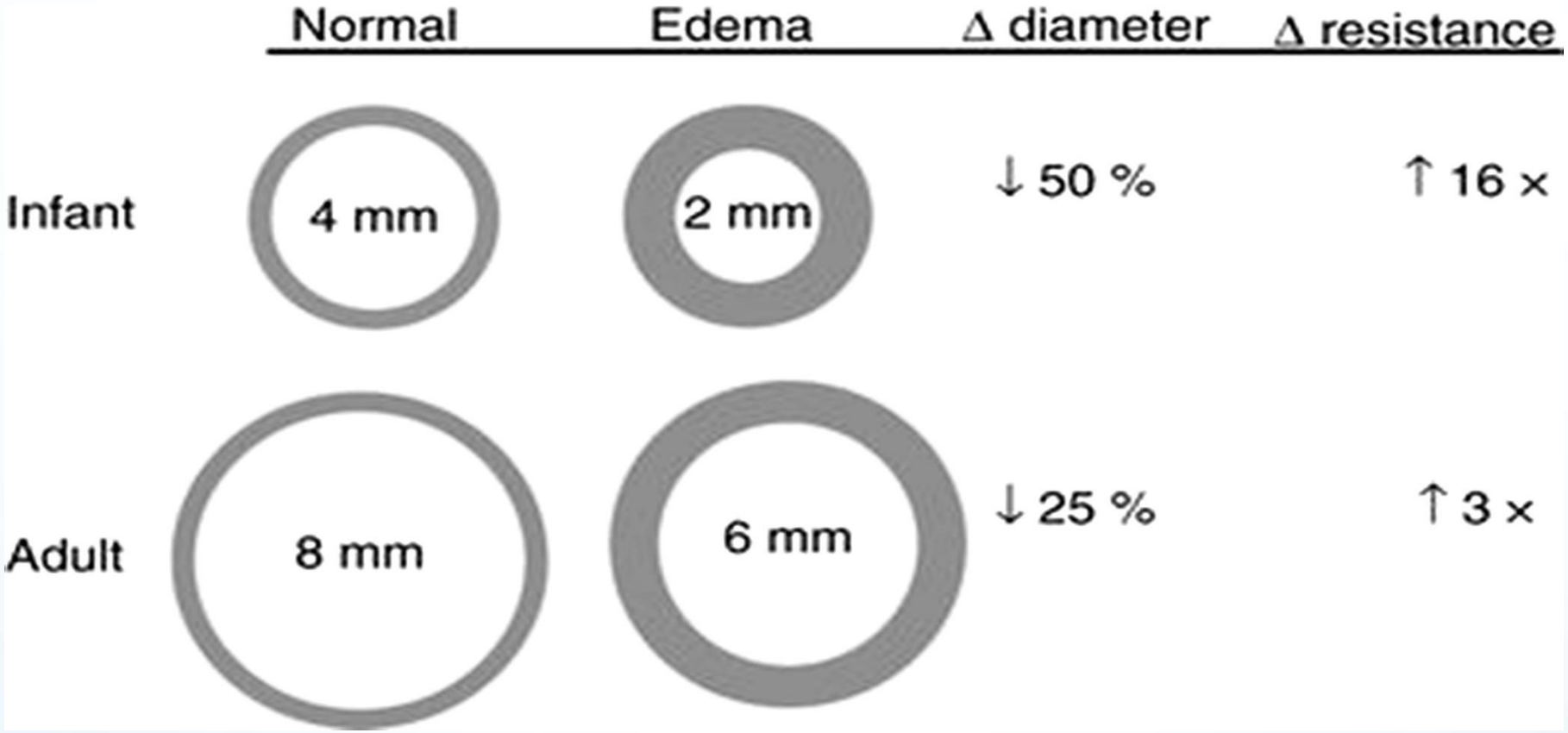
The Mouth Challenge

Larger tongue

Loose teeth

Large tonsils

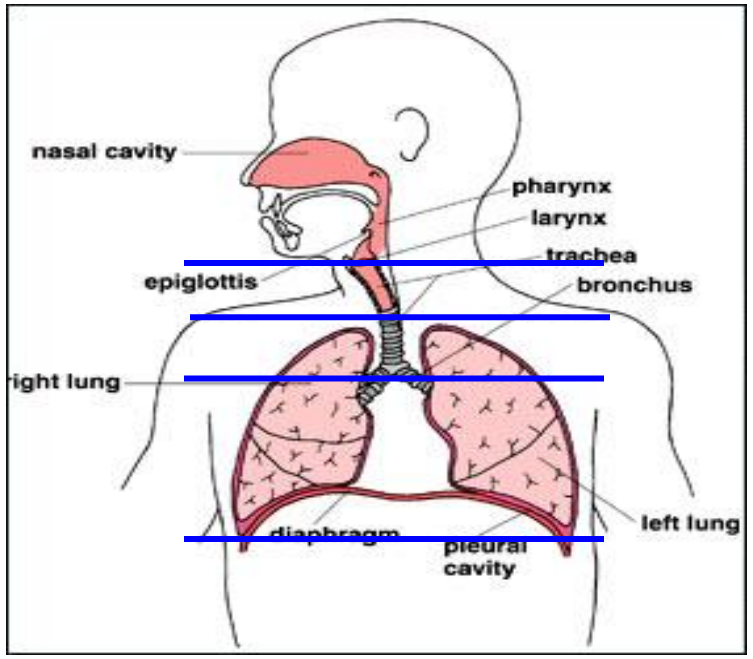
Airway Resistance



Define the Problem

Is this a primary respiratory problem?

Which part of the respiratory tree is involved?



Pediatric Respiratory Emergencies

Upper Airway

- Distress occurs when structures of upper airway are occluded
  - Edema
  - Secretions
  - Foreign bodies
  - Anatomical defects
- Examples
  - Croup
  - Epiglottitis
  - Bacterial tracheitis
  - FB obstruction
  - Anaphylaxis

Lower Airway

- Distress occurs when lower airway structures are occluded
  - Edema
  - Bronchoconstriction
- Examples
  - Asthma
  - Bronchiolitis
  - Pertussis
  - Pneumonia
  - Anaphylaxis

Airway/Respiratory Management

Options

- Suction
- Positioning/calming
- Supplemental oxygen
- Nebulized medications
- Other medications
- Oral or nasal airways
- Bag-mask ventilation
- Positive Pressure Treatment
- Advanced airway

Nasal suction= LIFESAVER

Positioning

- Put head of bed up if helps
  - Tripod position
- Sit on parent's lap (calm patient)
  - Position of comfort

Supplemental Oxygen

Nasal Cannula

NO BLOW BY OXYGEN

Simple mask

Non-rebreather

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 FiO2 >50%

At 5 cm only at 10 L/min flow blow-by methods were able to maintain an FiO2~50%

At distance greater than 5cm from face or at flow rates less than 10 L/min, FiO2 decreased to ~21%.

The decrease in FiO2 typically started within 6-12 meters from the start of the transport

Nebulized Medications

UPPER AIRWAY

- Epinephrine
- Mist
- Heliox*

LOWER AIRWAY

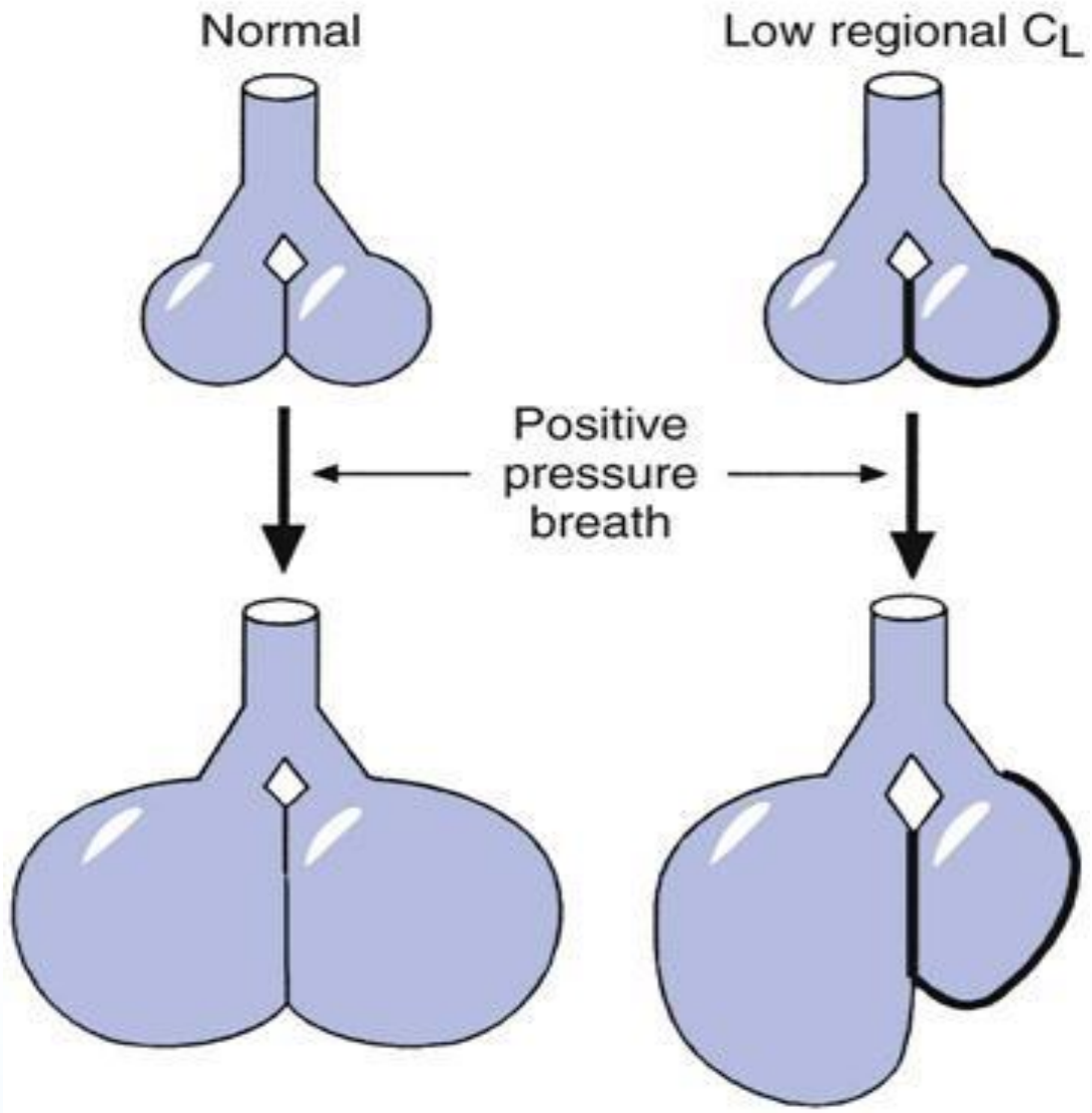
- Albuterol
- Ipatropium Bromide
- Epinephrine

Additional Medications

- Steroids oral, IM, IV
  - Dexamethasone, prednisone, prednisolone
- Magnesium IV (bolus)
- Epinephrine IM
- Terbutaline SQ, IV and then drip

Non- Invasive Positive Pressure Additional Oxygen and Ventilation Modalities

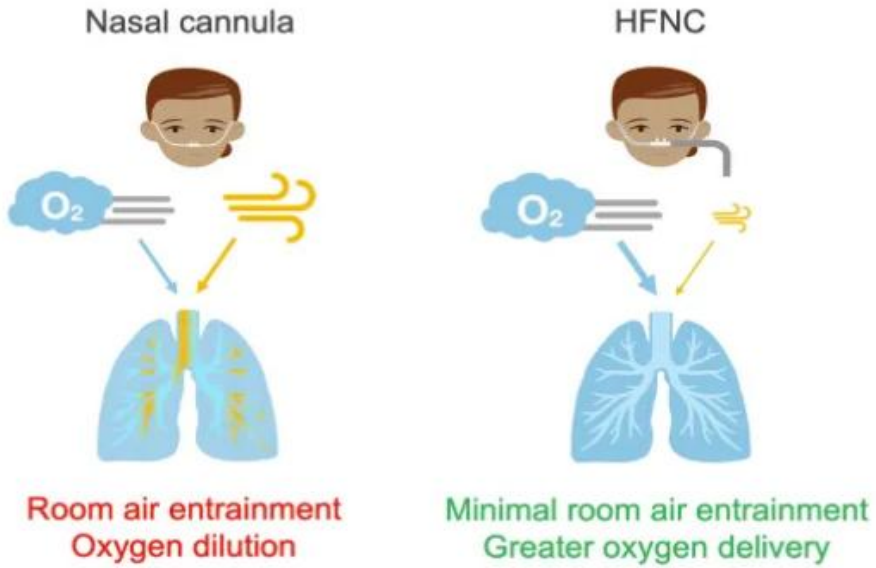
- HHFNC/Vapotherm
- BMV
- CPAP
- BiPAP
- AVAPS

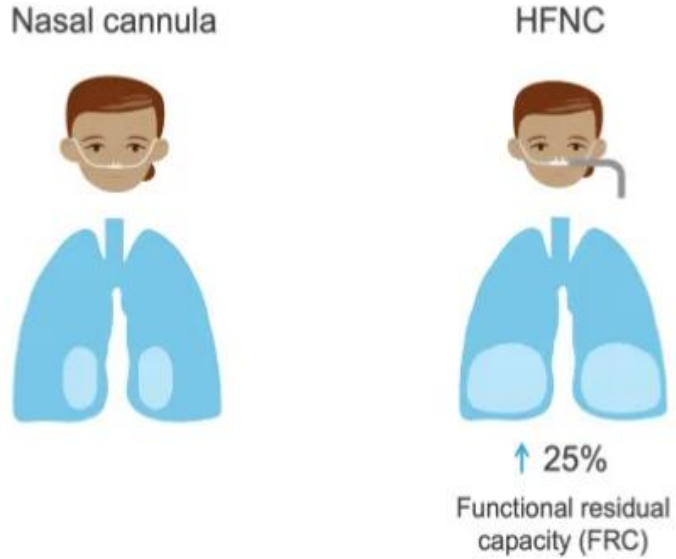

Normal
Low regional C_L
Positive
pressure
breath

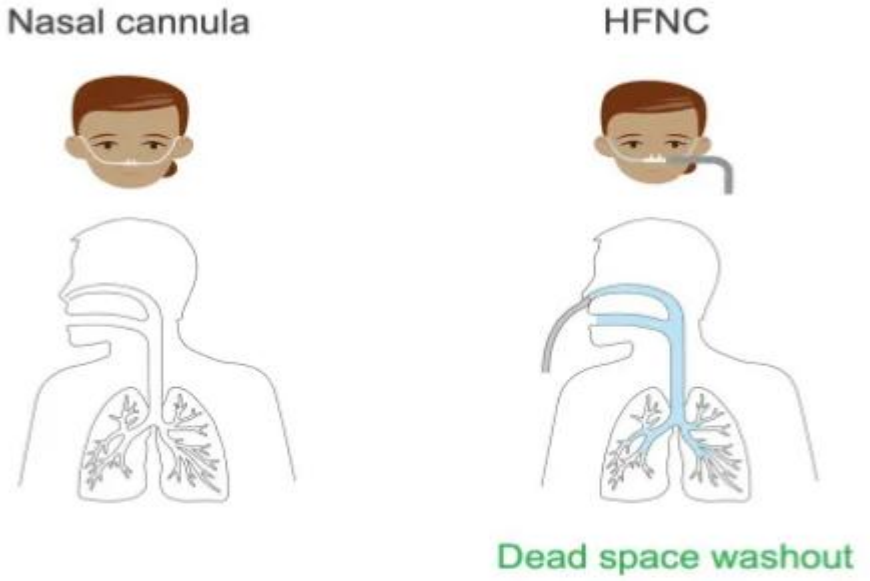
How does Vapotherm (HHF) work

There are three main proposed benefits of HFNC:

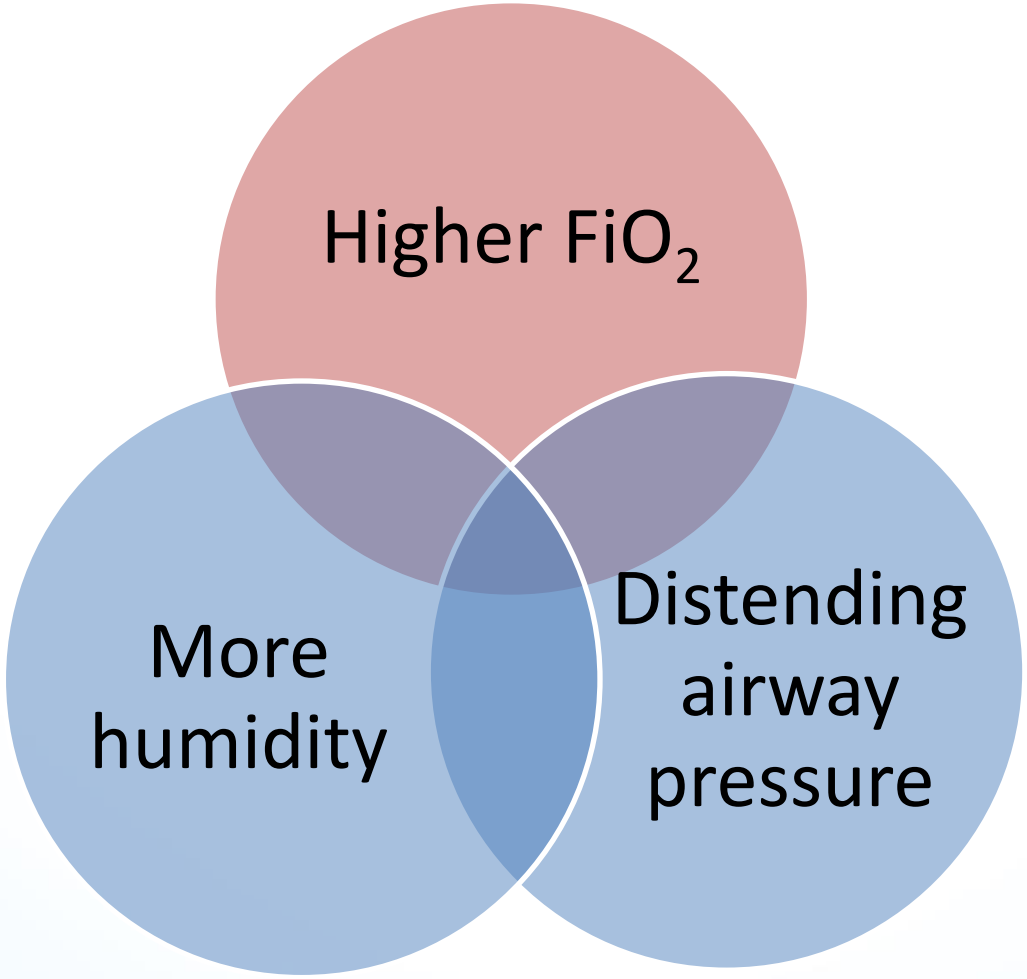
1. Precise oxygen delivery
2. Functional residual capacity enhancement
3. Dead space washout







HFNC: Advantages compared to LFNC



Oxygen flow settings for high-flow nasal cannula use in infants and children

Patient weight (kg)	Starting flow (L/minute)	Maximum flow (L/minute)
<5	6	8
5 to 10	8	15
10 to 20	15 to 20	20
20 to 40	25 to 30	40
>40	25 to 30	40 to 60

HFNC: high-flow nasal cannula.

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HHFNC at CHCO

CHCO is 1-2ml/kg initially start

*okay to start max and wean as able

Would like to see improvement in both RR and HR within 60 minutes

*HR should drop 20-30 b/h

Bag-Mask Ventilation

<u>THE</u> single most important life-saving skill

C-E technique : 2 hand Thenar technique/v-clamp

Jaw thrust

Not as easy as it looks- PRACTICE!

Always observe for chest rise

CPAP

Settings: Pressure, FiO2

Why it helps

- Relieves airway obstruction
- Improves functional residual capacity (FRC)
  - Improved gas exchange, improve V/Q match
  - Improved lung compliance
- Effectively closed circuit → % O_2 ≈ FiO_2

Disadvantages:

- Does not directly alter ventilation (beyond improving obstruction and FRC)
- Excessive CPAP/EPAP may reduce preload, stroke volume, and cardiac output
- Risk of barotrauma
- More difficult to tolerate than HFNC, LFNC

BPAP S (spontaneous)

Settings: IPAP, EPAP,FiO2

What it adds compared to CPAP:

- Overcomes airway resistance
- Increases tidal volume
- Greater capacity to relieve extrathoracic obstruction

Disadvantages:

- Does not work in apneic patients
- May not work in weak patients
- Risk of barotrauma

BiPAP S/T (spontaneous/timed)

Settings: IPAP, EPAP, backup rate, Ti, FiO2

What it adds to BPAP S:

Increased control of minute ventilation

- Especially when lung compliance low

Can ventilate apneic and weak patients

Disadvantages:

Discomfort in awake patients when backup rate > spontaneous rate

Tidal volume and minute ventilation will fluctuate with changes in lung compliance

Risk of barotrauma

BiPAP

Per CHCO RT/PICU physician recommendations:

Start at pressures you would start in adult : 12/6

IPAP: inspiratory pressure

EPAP: expiratory pressure

PEEP: start at 5 – in infants start at 6

IPAP: inspiratory pressure

EPAP: expiratory pressure

AVAPS S/T and PC – Volume

Settings: IPAPmin, IPAPmax, EPAP, Vt, (backup) rate, Ti, FiO2

What it adds to BPAP S/T:

- More stable Vt in patients with fluctuating lung compliance

Disadvantages:

- Risk of barotrauma
- Lack of efficacy data relative to BPAP S/T
- Risk of delaying identification of clinical deterioration
- Proprietary. More potential for error?

AVAPS - Volume

Per CHCO RT/PICU recommendations:

Vt:

Start at 8ml/kg

IPAPmax: 25

EPAP : 10

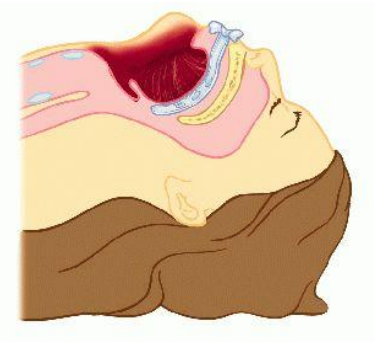
A

B

Airway Adjuncts

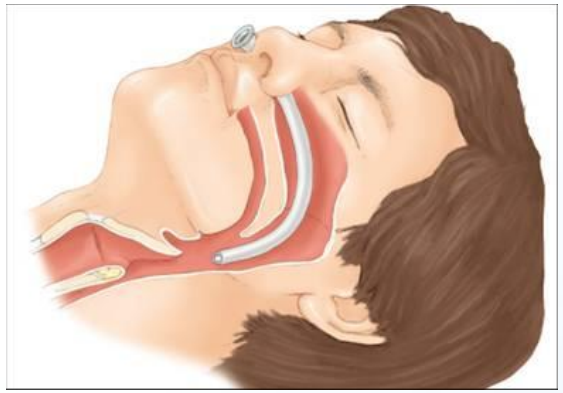
Oral Airway

- Keeps tongue out of the way
- Only in unconscious patients



Nasal Airway

- Great for children with copious secretions but breathing on their own.

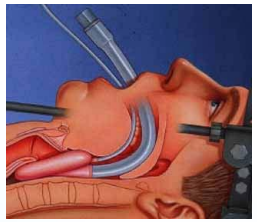


Advanced Airways – Supraglottic

I-Gels

AirQsp3g

LMAs



Pediatric sizes based on **weight**.

Easy, blind insertion

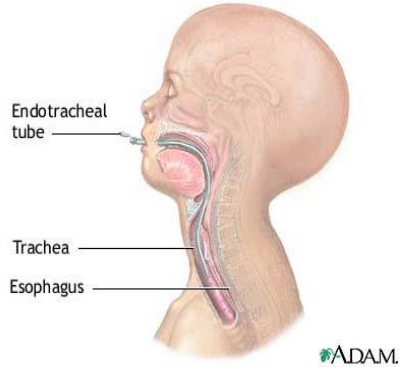
Easier to maintain than BMV

Faster than ETI and better success rate

Does not definitively protect airway

Advanced Airways – ETT

Endotracheal Tube -ETT



Pediatric sizes based on **age**

Only way to provide high pressure ventilation

Takes time and direct visualization

Prevents aspiration

CHILDREN'S HOSPITAL COLORADO

Pediatric Initial Ventilator Settings Recommendations

AGE	ETT SIZE	ETT DEPTH	RESPIRATORY RATE	TIDAL VOLUME VS PRESSURE	PEEP	PRESSURE SUPPORT	FIO2
< 3 mo.	3.0 - 3.5 Cuffed or Uncuffed	Weight + 6 (weight in kg)	25-30	6-7 ml/kg (PIP < 28)	5-6	5-8	1.0
3-12 mo.	3.0 - 4.0 Cuffed ETT	ETT size x 3 (size in mm)	20-25	6-8 ml/kg (PIP < 30)	5-6	6-8	1.0
1 -8 years	(Age / 4) + 4 Cuffed ETT	ETT size x 3 (size in mm)	16-20	6-8 ml/kg (PIP < 35)	5-6	6-10	1.0
> 8 years	(Age / 4) + 4 Cuffed ETT	ETT size x 3 (size in mm)	12-16	6-8 ml/kg (PIP < 35)	5-6	8-10	1.0

**Please note, 100% FiO2 is not appropriate for all patients, for example some congenital cardiac lesions.

The Hamilton Ventilator will suggest initial settings!

- Adjust patient height until the weight (kg)
- It will start with a VT of 6 mls/kg
- Titrate settings based on your assessment
- Follow Hamilton's manufacturer instructions for use (MIFU)

Pediatric Vent Settings

If patient is hypoxic:

* Fi02 and PEEP

If patient with elevated PC02:

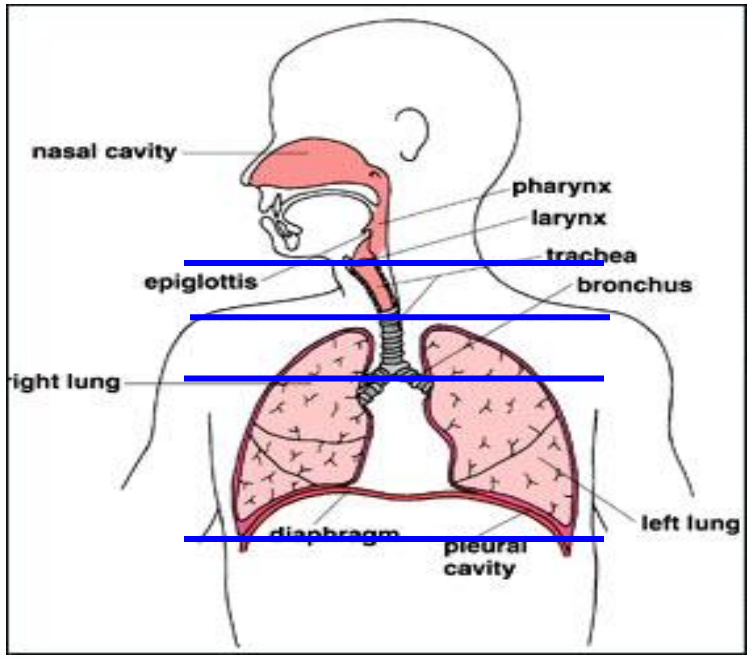
*Tidal Volume and rate

Rate of 20 is appropriate ***

Define the Problem

Is this a primary respiratory problem?

Which part of the respiratory tree is involved?



3 y/o trouble breathing

3 year old child presented to PCP office with respiratory distress

Sx: 1 day of barky cough, audible wheezing, retractions, drooling

Pt received Albuterol neb x1 with minimal improvement

EMS transferred child from PCP office to CHCO

EMS reports child was in respiratory distress

- Gave Duoneb and Racemic Epi x1 en route

3 year old trouble breathing

- Upon arrival in ED:
- T 98.4, RR: 32, HR 153, BP 123/88 and 95% RA
- Awake, alert, no drooling, + barky cough with stridor at rest
- HEENT: + congestion , MMM, slightly red throat
- CV: Tachycardic, RR, no m/r/g, pulses 2+
- Lungs: Suprasternal retractions, good aeration, symmetric, no crackles, wheezing, rales, rhonchi

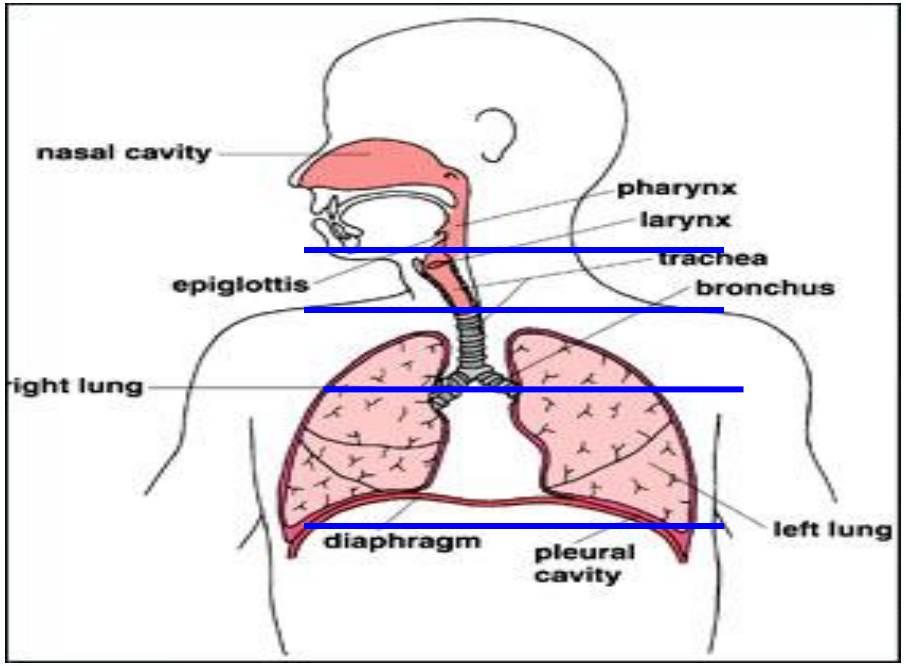
Thoughts?

Differential?

What to you want to do?

Define the Problem

Which part of the respiratory tree is involved?



Stridor

- Harsh, high pitched airway sound
- Characteristic of significant upper airway obstruction from swelling

Differential of Stridor

Infection

- Croup
- Bacterial tracheitis
- Retropharyngeal abscess
- Epiglottitis

Foreign Body-(especially starting in middle of the day)

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

Accounts for over 90% of stridor with fever

Common illness: ages 6 months- 5 years

More common in spring to summer and summer to fall

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

Croup-Symptoms

- Signs/symptoms: barky cough, hoarse voice, fever, inspiratory/exp stridor, tachypnea, tachycardia, retractions
- **Sick vs not sick**= inspiratory/exp stridor and increased WOB
- Stridor at rest

Croup- Interventions

#1 Rule…

Keep Calm!!

Croup- Interventions

Treatment:

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*

Croup- Interventions

- Position of comfort
- Monitor O2 sats- cover up the probe!!
- Encourage cold fluids

Croup- Interventions

#1 Rule…

Keep Calm!!

But intervene when needed….

Croup- Interventions

Treatment:

Mild-Barky cough, no stridor at rest

- Decadron: standard dose 0.6mg/kg (max 16 mg)*
  - 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**

Case #1- ED Interventions

- Racemic Epi neb over 15 minutes
- Dexamethasone
- Cardiac monitor and pulse ox
- Observation x 2 hours- watch for rebound
- Popsicle and juice, then discharged home

Questions?

15 mos old with difficulty breathing

CC: My child is having a hard time breathing and has a fever

15 mos old with 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

15 month with difficulty breathing

PMHx: None

Allergies: Amoxicillin

Family Hx: None

Immunizations: UTD

What else do you need to ask?

15 month with difficulty breathing

Physical Exam:

HR 173 RR: 54 Pulse Ox: 91% Temp: 38.8

Gen: Tired appearing in MOC's arms. cough

HEENT: + nasal discharge; TM: erythematous bilat

Lungs: + retractions; coarse BS with intermittent crackles and wheezing.

Heart: S1S2 no m/r/g. Tachycardiac

Abd: soft, NT/ND. No HSM

Ex: Cap refill 2-3 sec.

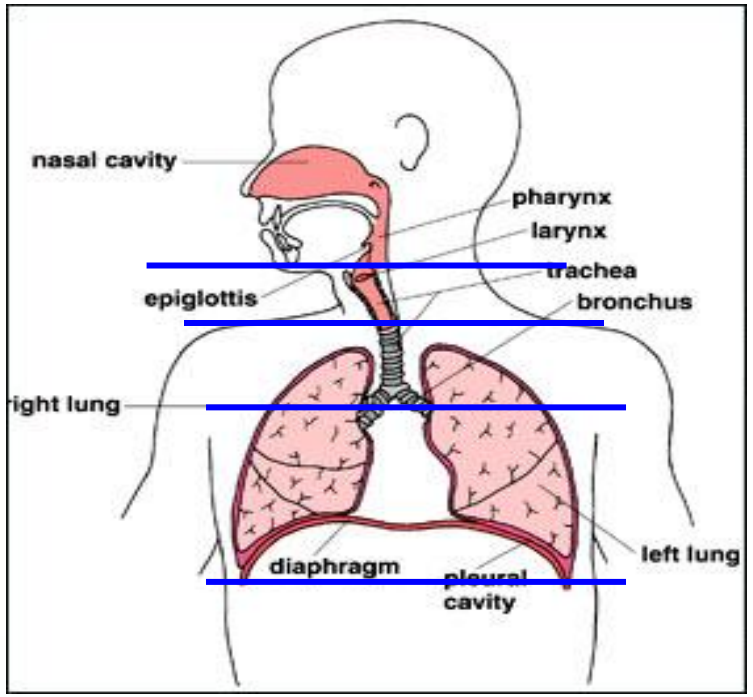
Thoughts?

Differential?

What to you want to do?

Define the Problem

Which part of the respiratory tree is involved?



Bronchiolitis

- Acute viral infection- most commonly RSV
- Age ≤ 2 years of age
- Infant's sx are worsen for the first 3-5 days
- Infectious process → **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
  - Oxygen-heated high flow
  - Treat fever
  - ORT with Pedialyte
  - Positive pressure
  - SUCTION again

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?

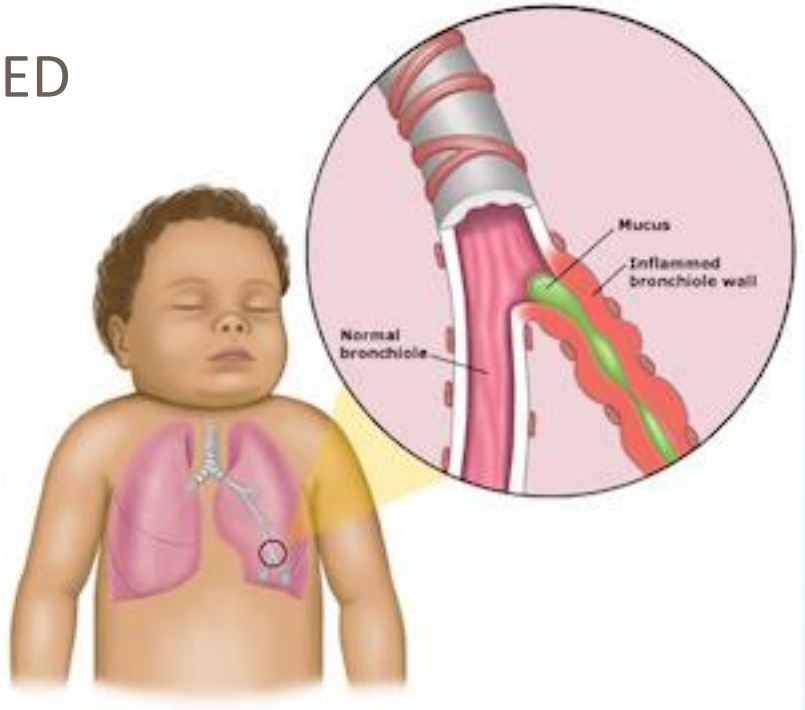
Clinical diagnosis—NO TEST NEEDED

CXR-

- Unlikely to be helpful
- Charge: ~$450

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

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

Bronchiolitis

* Vaccines

Maternal (abrysvo): 32-36 weeks

- protects infant until 6 mos of age

Infant: (nirsevimab)

- monoclonal ab; provides immediate protection

- infant <8 mos, high risk 8mos-19mos

Bronchiolitis

Interventions

American Academy of Pediatrics on Bronchiolitis:2014 Clinical Practice Guideline Stated:

"Clinicians should not administer albuterol or racemic epinephrine to infants and children with a diagnosis of bronchiolitis. Evidence Quality: B Strong Recommendation"

Albuterol in bronchiolitis

1. How does albuterol work?

2. Where does it have its effect?

Remember the Basics!!

Albuterol ain’t the answer!

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?

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?

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

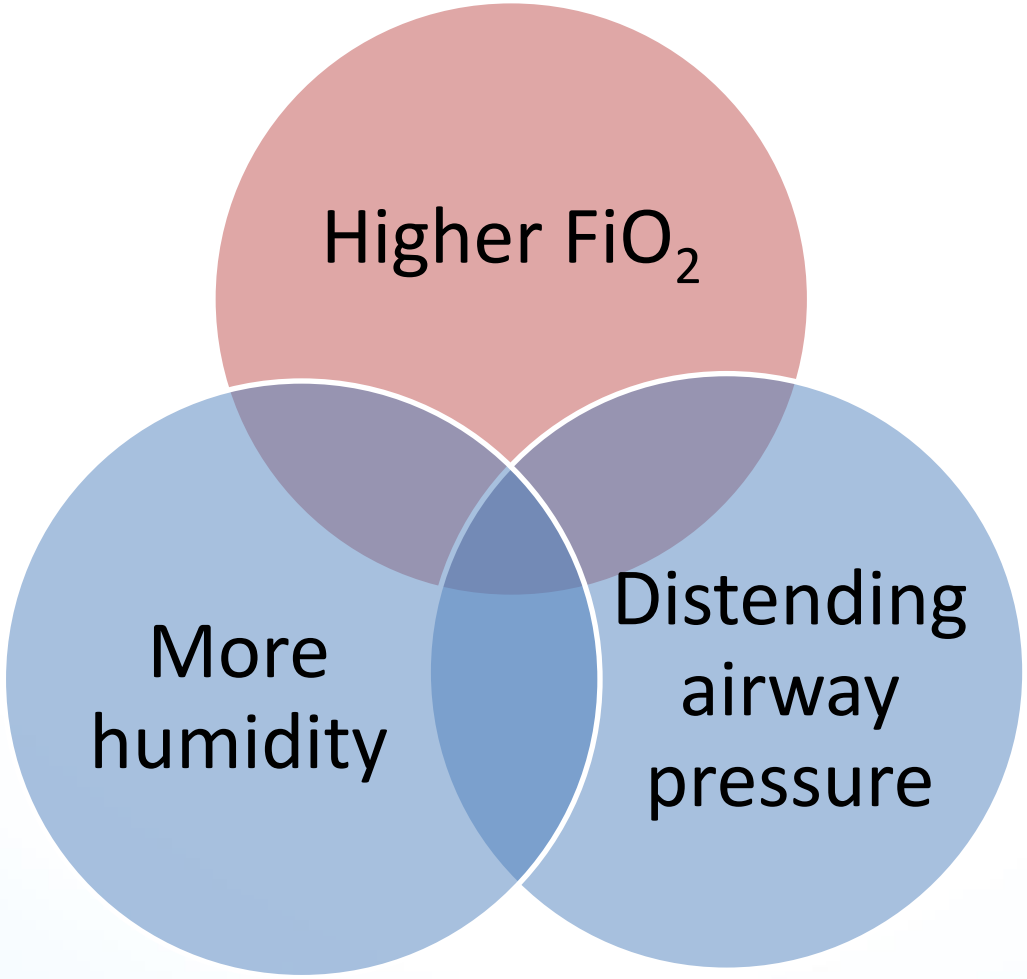
Now what?

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 HHFNC/Vapotherm

HFNC: Advantages compared to LFNC



Oxygen flow settings for high-flow nasal cannula use in infants and children

Patient weight (kg)	Starting flow (L/minute)	Maximum flow (L/minute)
<5	6	8
5 to 10	8	15
10 to 20	15 to 20	20
20 to 40	25 to 30	40
>40	25 to 30	40 to 60

HFNC: high-flow nasal cannula.

UpToDate®

15 month old difficulty breathing

30 minutes later:

HR: 150 RR: 55 (continues with retractions and head bobbing)

Pox: 92% on HHFNC/Vapotherm

Now what?

15 month old with difficulty breathing

Decision made to increase respiratory support and place patient on BiPAP

Scuba mask

IVF (Pt needs to be NPO)

Sedation:

Dexmedetomidine (Precedex)

Admitted to PICU

Questions?

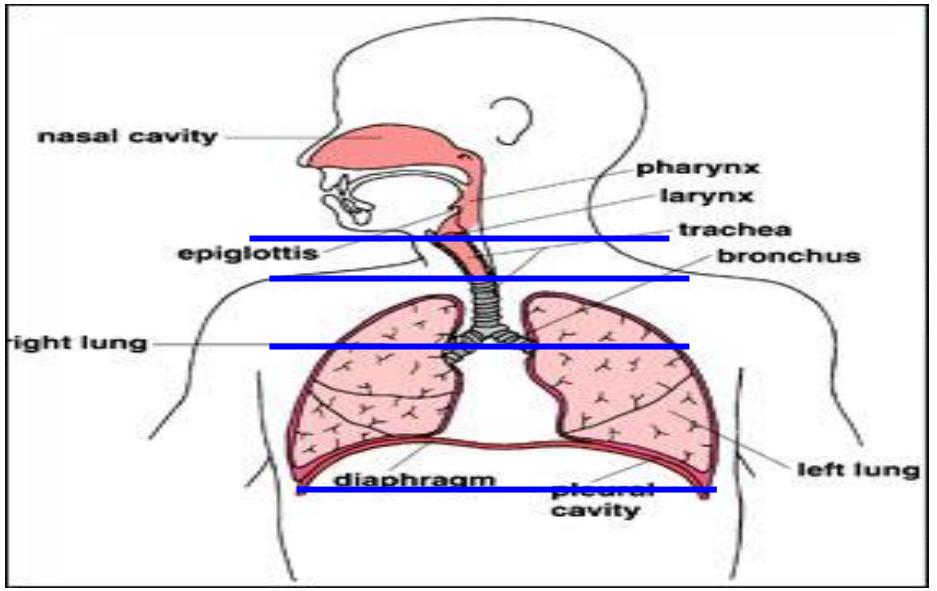
Lower Airway- Asthma

- Most common chronic illness in children
- Affects 9.3% of children in US
- CHRONIC inflammatory disorder of the airways
- Characterized by:
  - Hyper - reactiveness of airway
  - Widespread inflammatory changes
  - Bronchospasm
  - Mucous plugging
- Dx is delayed until child has repeated episodes and is

>2 years old

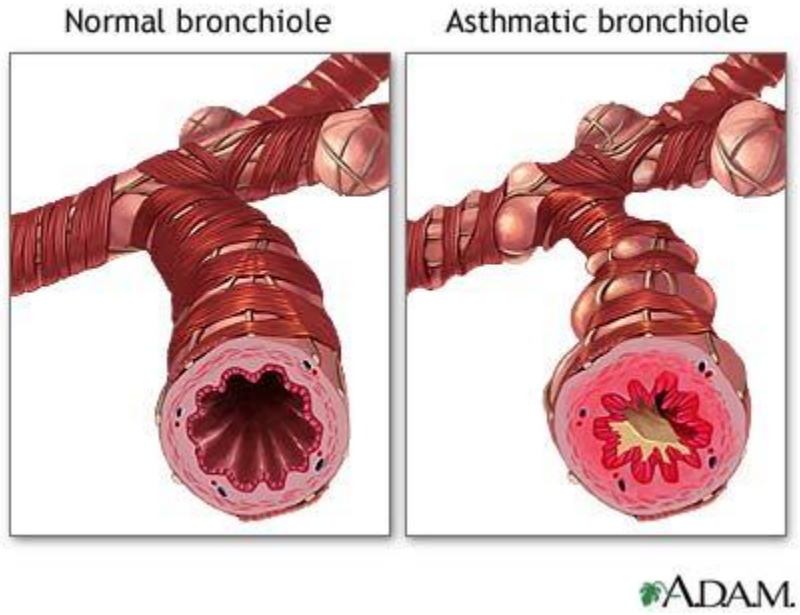
Define the Problem

Which part of the respiratory tree is involved?



Asthma-Symptoms

- Wheezing
- Prolonged expiratory phase
- Decreased or unequal breath sounds
- Tachypnea
- Retractions
- Coughing
- Nasal flaring

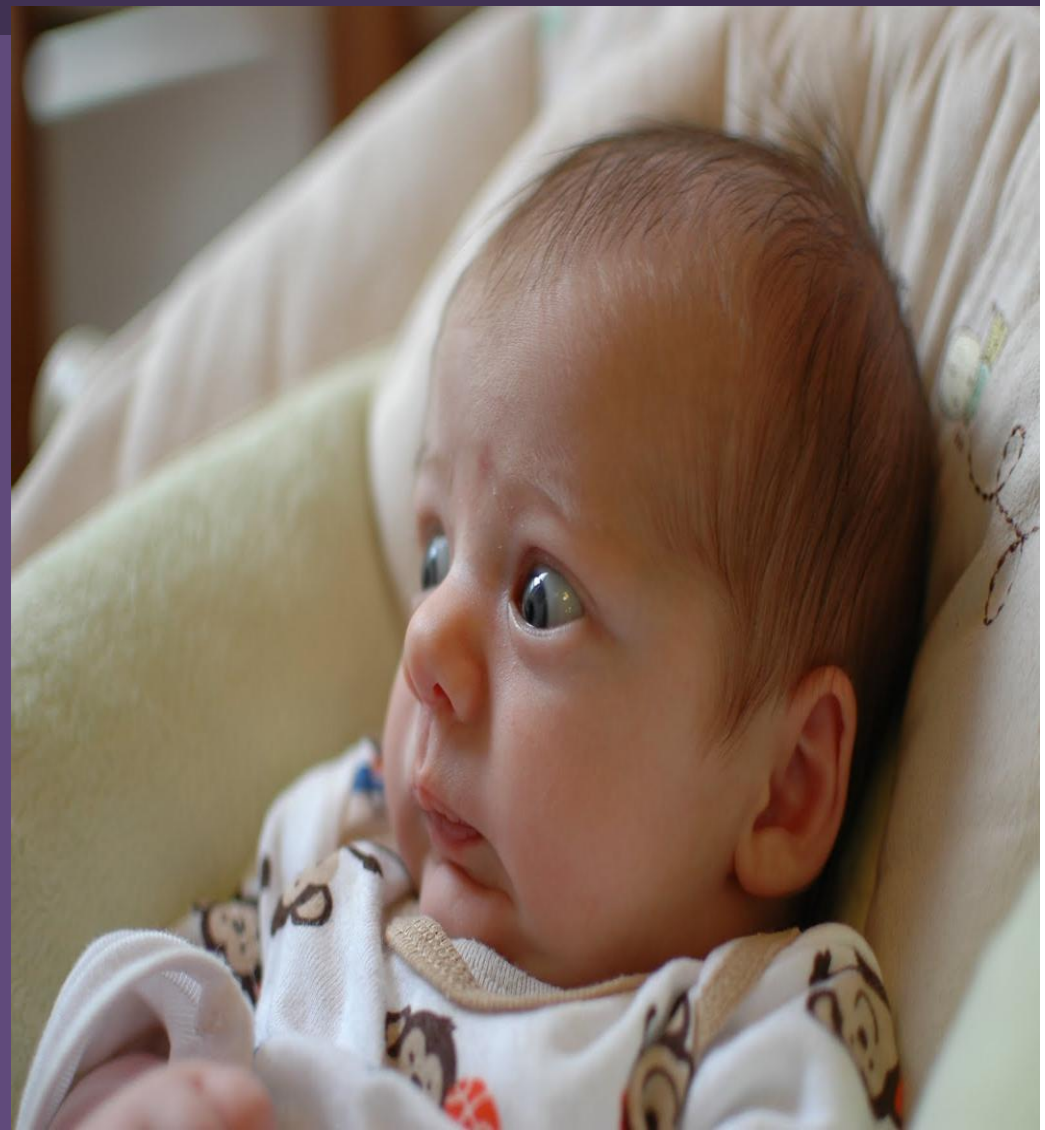


Asthma: Interventions

- Oxygen
- Monitor pox and HR
- Medications
  - Albuterol
    - <20 kg: 2.5 mg
    - >20 kg: 5 mg
  - Atrovent
    - 0.5 mg bullet
  - Steroids- Dexamethasone
  - Magnesium
  - EPI, Terb if needed

In Summary…

- Be good at the basics- basic treatments can save lives!
- Keep Calm; take a big breath!
- Distinguish Upper vs Lower
- Remember your options for interventions
  - Suction
  - Oxygen
  - Appropriate support
- Aggressively treat respiratory distress and intervene
- Reassess and treat as needed



Thank You! Final Questions?


YOU!
KEEP BEING
AWESOME!