

An aerial photograph of Madison, Wisconsin, taken at sunset. The sun is low on the horizon, casting a warm, golden glow over the city and the water. The Monona Reservoir is in the foreground, with several sailboats scattered across its surface. The city buildings are visible in the background, with the sun partially obscured by a hillside.

Pediatric Respiratory Care: Updates and Evidence- Based Practices

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Objectives



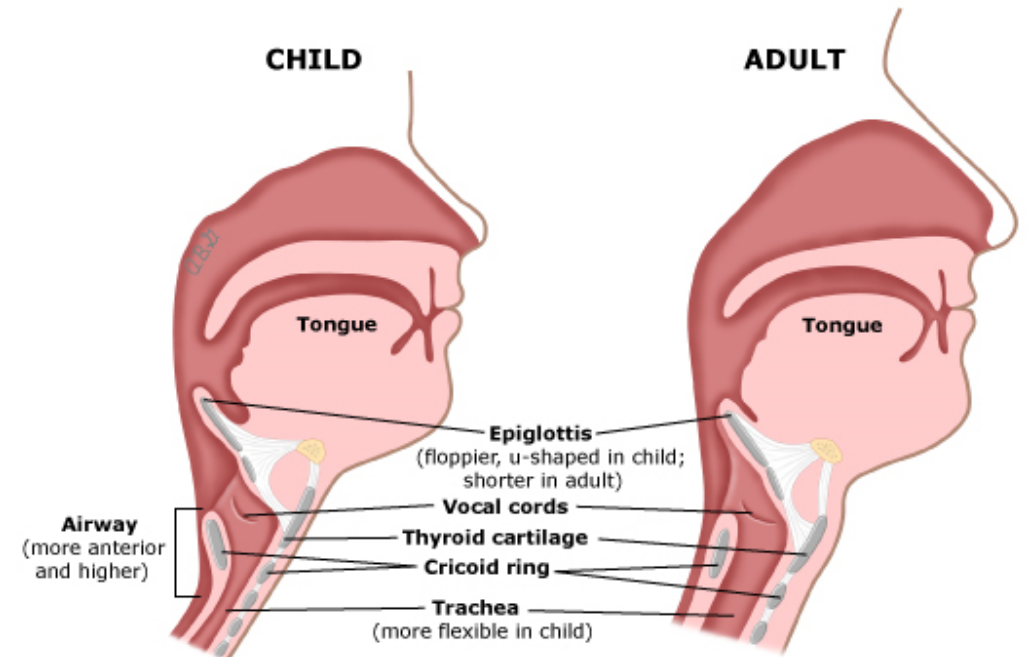
- Review asthma, bronchiolitis, croup, and pneumonia
- Discuss up-to-date treatments and care
- Review signs and symptoms that would require transfer to higher level of care

Pediatric Respiratory Physiology Basics



- Smaller airways
- Anterior-superiorly placed trachea/airway
- Large tongue
- Prominent occiput
- Smaller mouth
- Large tonsils/adenoids

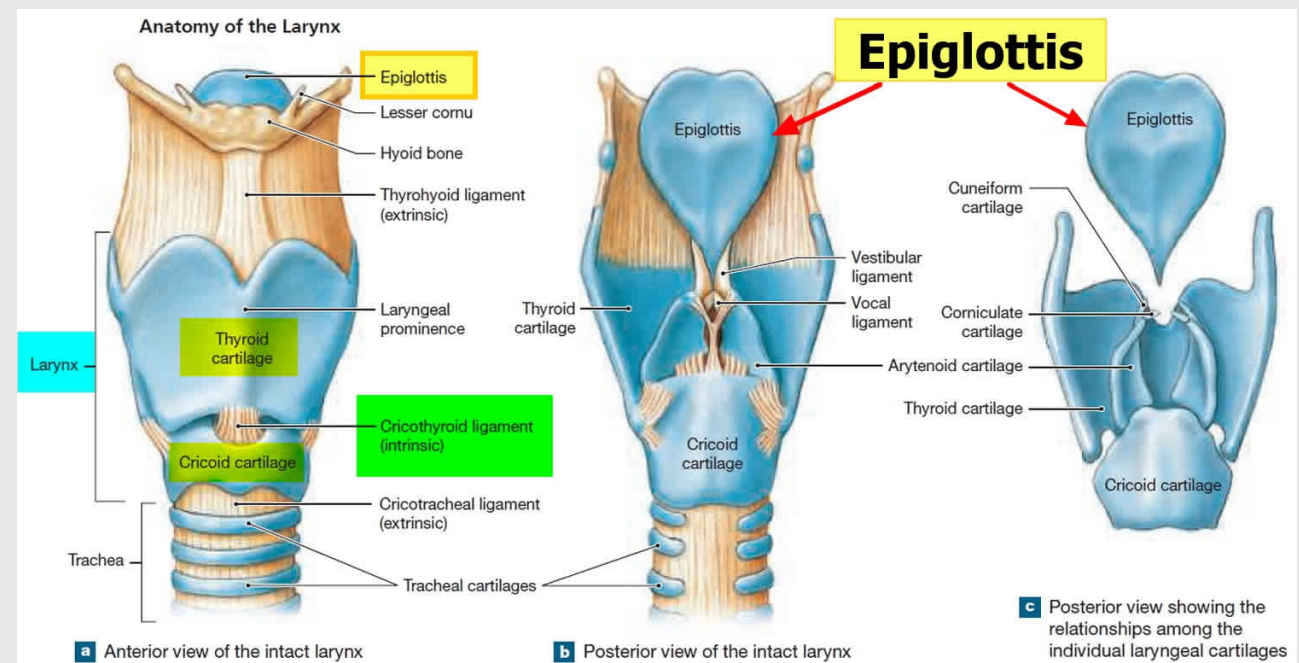
Anatomic differences between the pediatric and adult airway



Relative to adults, children have 1) large tongues relative to the size of the oral cavity 2) larger tonsils and adenoids 3) a more superior location of the larynx in the neck 4) a larger and floppy epiglottis and 5) the narrowest portion of the airway functionally occurring below the vocal cords. All of these differences make endotracheal intubation in children potentially more difficult than in adults.

More issues...

- Weak hyoepiglottic ligament
- Floppy epiglottis (<3y)
- Elliptical subglottis/cricoid cartilage
- Compliant chest wall



Mechanics Of Infant Breathing Increases Risk of Respiratory Failure

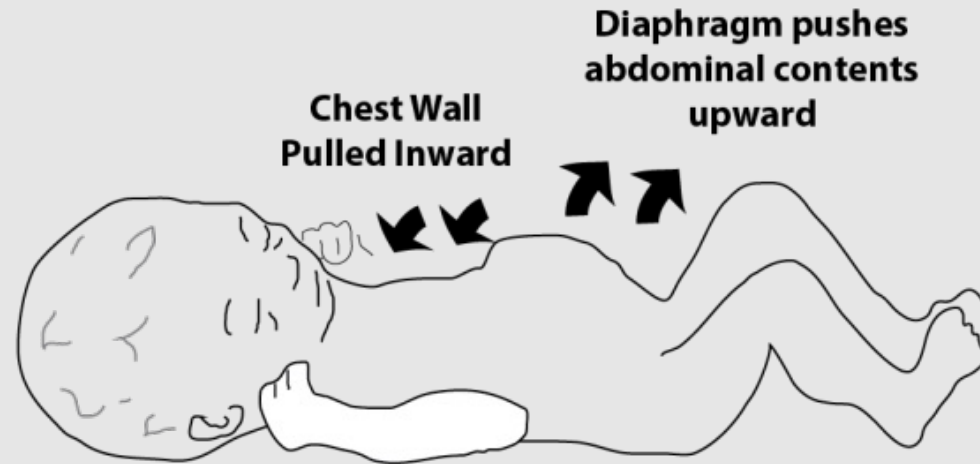


Chest Wall More Compliant

decreased elastic recoil
exhalation requires work

Abdominal Breather

abdomen rises as diaphragm descends
stomach distention limits tidal volume



Rocking Chest Wall Motion

Common With Stress And Even Partial Obstruction

Chest collapse on inhalation limits lungs expansion
Increased work of breathing
Harder infant tries to breathe, the less efficiently he breathes

Chest Wall More Box-Like

rib angles mechanically inefficient
limited lung expansion
limited tidal volume increases

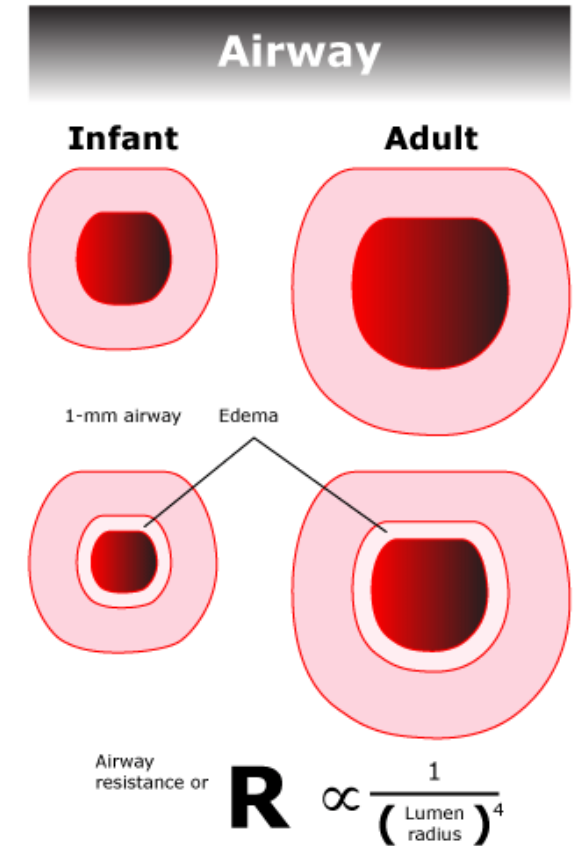
↑ alveolar ventilation is respiratory rate dependent

Muscles of Ventilation Tire Easily

Fatigue leads to respiratory failure

Continued

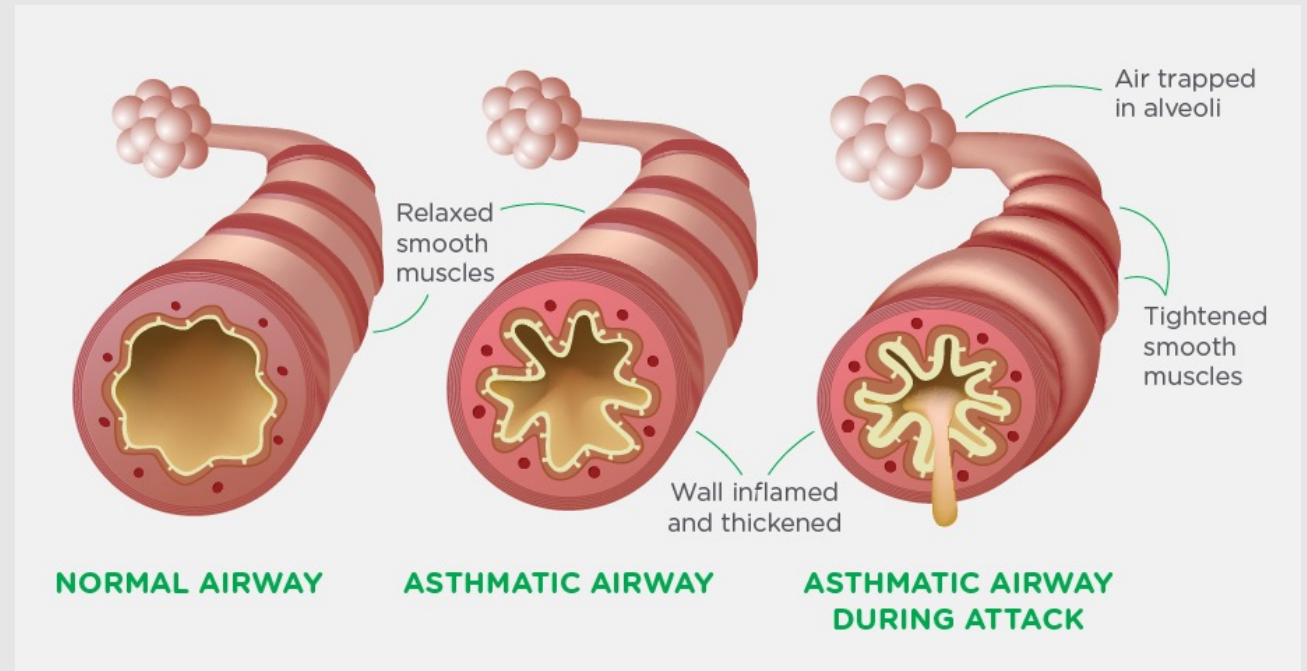
- Nasal breathing
 - About 50% of airway resistance – any obstruction = bad
- Lower FRC
- Increased O₂ metabolism
- Increased vagal tone



	Infant	Adult
Airway diameter	4 mm	8 mm
Airway diameter with edema	3 mm	7 mm
Airway resistance	↑ 16 x	↑ 3 x
Cross-sectional area	↓ 75 percent	↓ 44 percent

Asthma

- >2 yo
 - < 2 yo = Reactive Airway Disease
- Reactive airway response
 - Allergens (atopic)
 - Smoke
 - Viral
 - Environmental
- Inflammatory
 - Multiple cytokines involved
 - Smooth muscle contracts
 - Edema of epithelium
 - Mucous plugging
 - Airway remodeling



<https://www.choa.org/parent-resources/asthma/asthma-attacks>

Treatment



- Beta-agonists
 - Albuterol
 - Ipratropium (usually in combo with albuterol)
 - Work on smooth muscle (which is why it doesn't work in bronchiolitis)
 - 3 "Duonebs" back-to-back increases likelihood of breaking exacerbation
- Albuterol dosing
 - MDI
 - 5-10kg: 4 puffs
 - 10-20kg: 6 puffs
 - >20kg: 8 puffs
 - Nebes:
 - Spot/individual: 2.5mg nebs
 - Continuous
 - 5-10kg: 5-7.5 mg/hr
 - 10-20kg: 10-12.5 mg/hr
 - >20mg: 15-20mg/hr

Steroids



- Oral
 - Dexamethasone 0.6mg/kg (max 10mg) – 2 doses total, 48 hours apart
 - Prednisone/Prednisolone 1-2mg/kg (max 60mg) – 5 day course
- IV
 - Methylprednisolone 1-2mg/kg IV



Refractory

- IV Magnesium 40-50 mg/kg (max 2 gram)
 - Always give with a fluid bolus!
 - Causes vasodilation due to smooth muscle relaxation
- IM Epi
- Terbutaline
 - 10mcg/kg bolus (over 10 mins)
 - Drip: 0.3-0.5 mcg/kg/min (max 3 mcg/kg/min)
- Positive Pressure Ventilation
 - BiPAP
 - Can run albuterol through BiPAP
 - Avoid intubation if at all possible – increased mortality risk



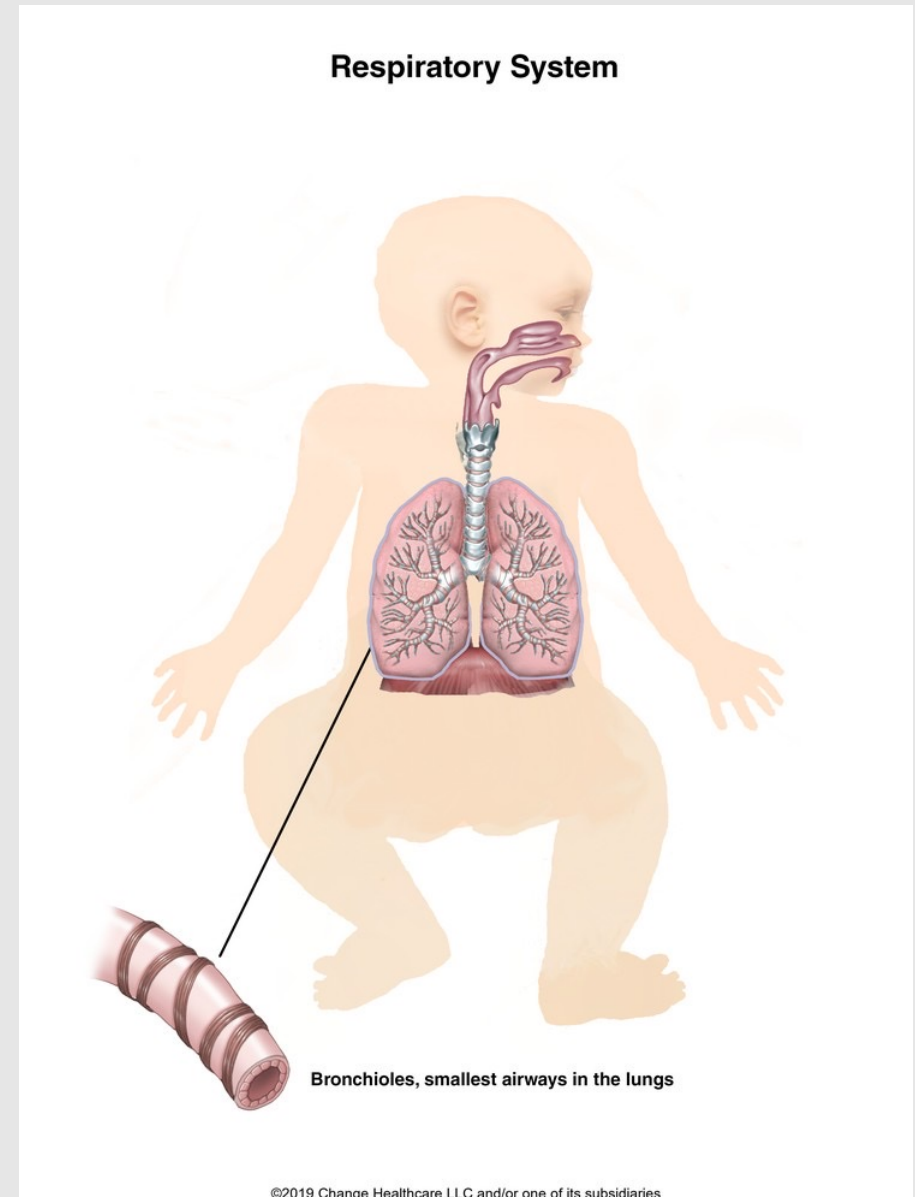
Further Diagnostics/Therapies

- Chest X-ray usually not necessary
 - Caveats
 - Prolonged fevers
 - Lack of responsiveness to B-agnosts/treatments
 - Concern for Foreign Body or unilateral wheezing that doesn't change
- Racemic epinephrine
 - Doesn't harm but also likely not to help!
 - Increases tachycardia
- Fluid Boluses
 - Yes!



Bronchiolitis

- Pediatric disease
- 0 days old – 2 years old
- > 2 years = viral pneumonitis
- Caused by viruses (any)
- Copious mucous production with plugging
 - Edema, sloughed epithelial cells
 - Respiratory distress and failure



Course



- Peak at 3-5 days?
 - Maybe not
 - In hospitalized patients, peak 3-5 days into illness
 - Cough resolves in 50% by 13 days
 - 90% by 21 days
- < 2 months of age
 - High-risk of apnea
 - Respiratory failure
- Higher complications in:
 - Premature infants
 - Congenital heart/lung diseases
 - < 6 months – longer course of illness potentially



What it isn't

- Asthma
- Bacterial Pneumonia*

- Studies show:
 - Albuterol doesn't help
 - Saline nebs/hypertonic doesn't help (can cause bronchospasm)
 - Steroids don't help
 - CXRs non-contributory
 - Antibiotics are not necessary*
 - And now.... High-flow nasal cannula doesn't help much! (in most healthy kids)

Quality Care in Bronchiolitis



- National measures established to follow up-to-date evidence-based medicine standards
- Decrease:
 - Albuterol use
 - Steroids
 - Saline nebs
 - CXRs
 - Antibiotics
 - High-flow use



- Project HIFLO: Time to Stop Going with the Flow!
- National quality initiative to decrease use of HFNC
- Observational studies initially showed possible improvement in LOS, decreased intubation, PICU admits
- Recent RCTs show this is likely not true for the majority
 - LFNC works to stabilize approx. 70% of mild-moderate bronchiolitis
 - HFNC 16x more expensive than LFNC
 - Does not prevent PICU admission, intubation, or decrease LOS



Treatment

- Suction, suction, suction!
- Hydrate
- Defervesce
- If desaturating or has WOB -> low-flow oxygen (mask or nasal cannula)
 - If this doesn't work, can still do high-flow!
 - Does work in select patients
 - In respiratory failure?
 - Can start with HFNC
 - PPV – CPAP, BiPAP, or intubate



How to suction

- 5-10 drops PER nostril saline
- Wall suction with nasal aspirator (no deep suction)
- Either:
 - Obstruct contralateral nostril, flood open one with saline, and suction saline directly out
 - Flood one nostril with saline while suctioning out the contralateral side at the same time
- At home:
 - Nose Frida (bulb suction is too big!)
 - Mechanical aspirators
 - Saline, saline, saline!



What if they're wheezing?

- Mucous plugs can make noises like wheezing
 - Suction
- Strong family hx of asthma and still having WOB & wheezing after suctioning?
 - Can trial albuterol, just may not help
 - If it does help, then may have reactive airway disease, not just bronchiolitis!
 - Then can also give steroids, treat more as an asthma exacerbation
 - RAD = wheezing kids < 2 yo
 - Consider CLD if premature
- Multiple, recurrent episodes of bronchiolitis associated w asthma development

Secondary Infections in Bronchiolitis



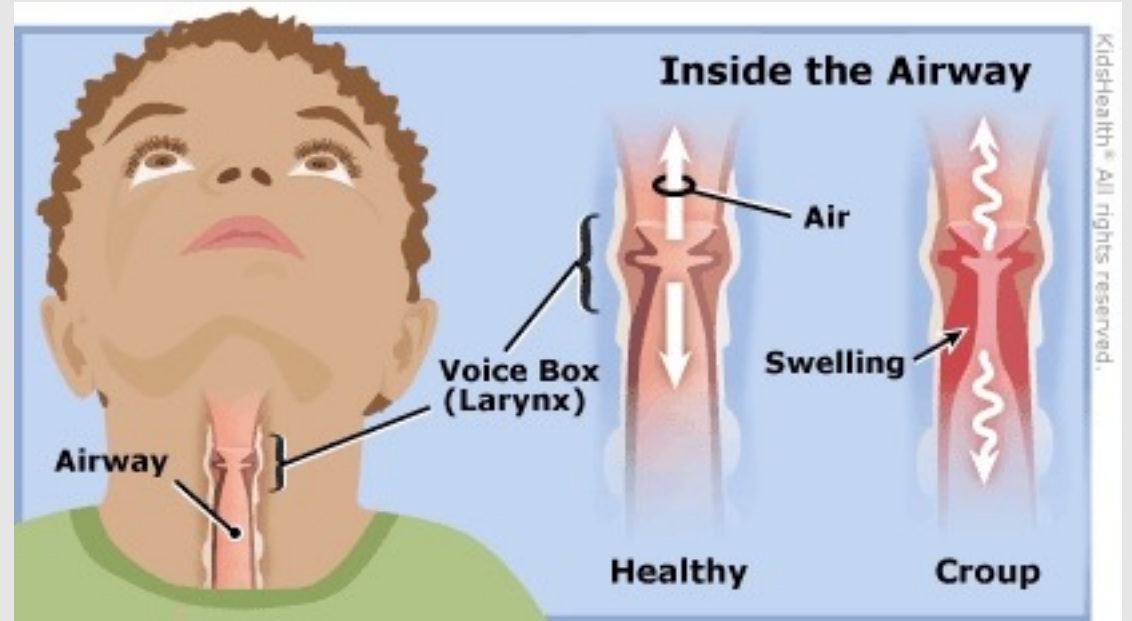
- Aside from AOM, rare
- Bacterial infections = 1.2%
- Bacterial pneumonia = 0.9%

- Makes antibiotics *mostly* unnecessary

Croup



- Laryngeal swelling
- Viral causes
- Can have co-infections
 - Bronchiolitis, asthma exacerbation



<https://www.akronchildrens.org/kidshealth/en/parents/az-croup.html>

Treatment



- Home Therapies
 - Cool outside air
 - Steamy bathroom
- Emergency Treatment
 - Steroids 0.3-0.6 mg/kg (max 10mg)
 - + stridor at rest:
 - Racemic Epinephrine 0.25mg neb
 - IM Epi

 - PPV (not always helpful)
 - Intubation (scary)

Additional Diagnostics

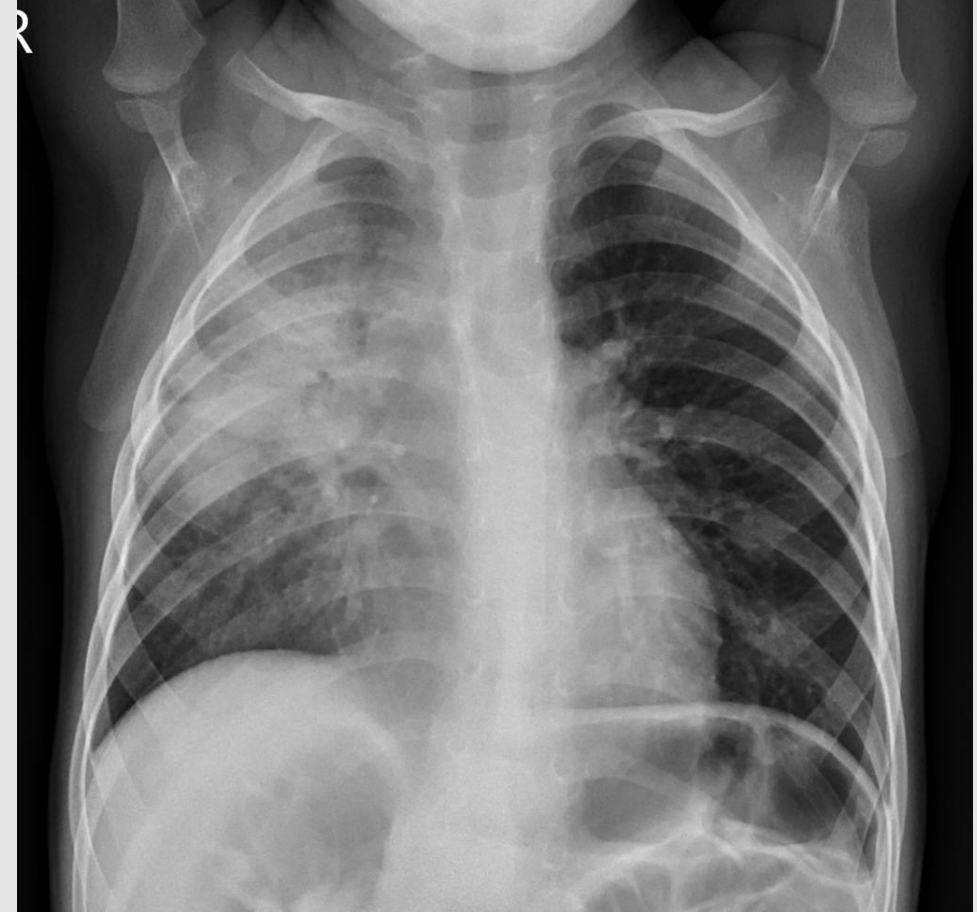


- Neck XR
 - Not always helpful
 - Foreign body concerns? Won't show if radiolucent!
 - Lateral view can give insight into epiglottitis, but not very specific

Pneumonia



- Bacterial infection in lungs
- Often post-viral
 - Increased inflammation
 - Mucous plugging
 - Bacteria get trapped
- Can be viral alone
 - Mucous plugging
 - Atelectasis
- Usually presents:
 - 1 week after URI/cold
 - New fever
 - Hypoxic
 - Tachypneic
 - +/- increased WOB



<https://radiopaedia.org/cases/paediatric-pneumonia?lang=us>

Diagnostics



- CXR
 - Not very sensitive! Only finds PNAs >2.5 cm
 - Doesn't differentiate viral from bacterial PNA
- POCUS
 - Very sensitive! >1cm subsegmental consolidation = PNA
 - <1cm likely subsegmental atelectasis
- Labs
 - Cultures discouraged now – often negative or false positive
 - +/- CBC, procal

Treatment



- Oxygen
 - Treat hypoxia/WOB
 - HFNC can help this
 - PPV
 - Intubation
- Antibiotics
 - Home: Amoxicillin 30mg/kg TID for 5-7 days
 - Inpatient: Ampicillin 25mg/kg q6h
 - Very sick/septic: Ceftriaxone 50mg/kg QD, +/- vancomycin, flagyl, unasyn (G+ or anaerobic coverage)
- Beta-Agonists/Nebs
 - Not usually recommended if no history of asthma/RAD

Transfers



- Patients escalating to HFNC or PPV
- Patients who are in distress, altered (sleepy or agitated) and not improving after initial therapies here
- Concern or potential need for intubation
- Initial therapies aren't working
 - Consider alternate diagnoses (e.g. foreign bodies, epiglottitis, tracheitis, etc.)
 - Call Peds/Neo Med Flight or EM Flight team (comes with an EM physician)
 - If stable, local EMS

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Questions?

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