Pediatric Pneumonia and Bronchiolitis Diagnosis and Treatment:
An Evidence-Based Approach

Presented By:
John Lazar, MD
Licking Memorial Health Systems

Disclosures: Nothing to Declare!

Today's Road Map

- Pneumonia topics
- Bronchiolitis topics
- Case Study
- Summary & Questions
- <u>After this talk you will</u>:
  - Understand that most pediatric CAP is viral
  - Know why narrow spectrum antibiotics are best AND know best amox CAP dosing
  - Reserve labs/imaging only for potentially hospitalized CAP pt's
  - Know that evidence supports minimal bronchiolitis tx (and what the tx's are)

Pneumonia- Epidemiology

- US: affects 2.6% of children under 17
- PNA hospitalization decreases with age:
  - <2 y/o: 62 per 10,000
  - 10-17 y/o: 4 per 10,000
- PNA is #1 cause of pediatric hospitalizations: $1 billion annually

Pneumonia- Definitions

- PNA- LRTI usually associated with fever, resp sx's, evidence of parenchymal involvement (exam or infiltrates)
- Community acquired pneumonia (CAP)- acute lower respiratory tract infection in previously healthy pt

Pneumonia- Side Note on Antibiotic Stewardship/Overuse

Increased abx resistance

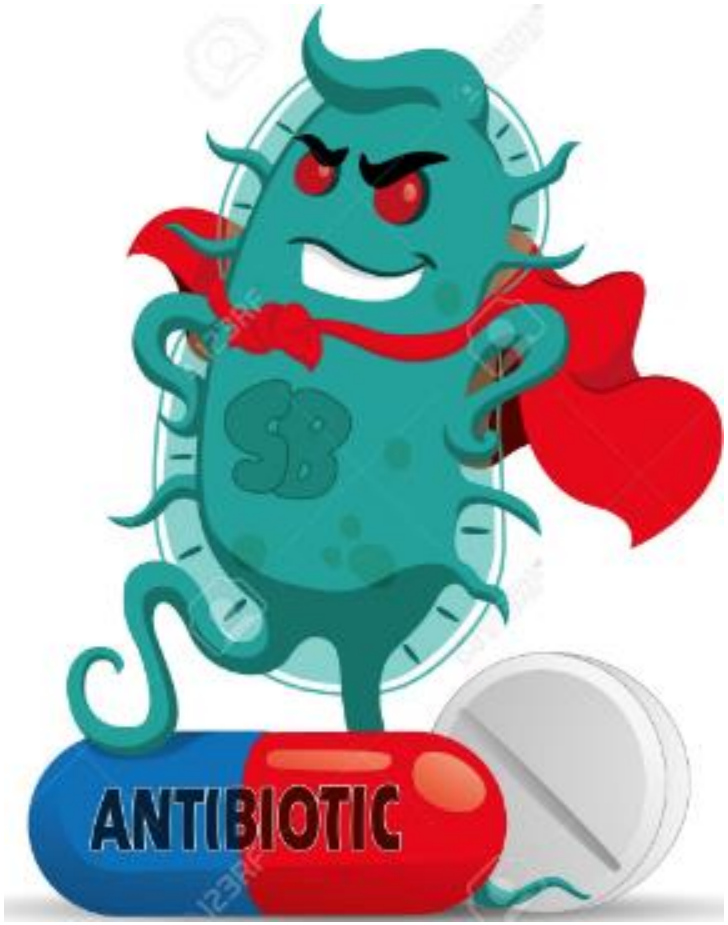
- 2 million annual abx-resistant infections
- 23,000 resultant deaths
- 50% of pediatric abx are not needed or sub-optimally prescribed

Increased *c. difficile*

Increased atopy/asthma

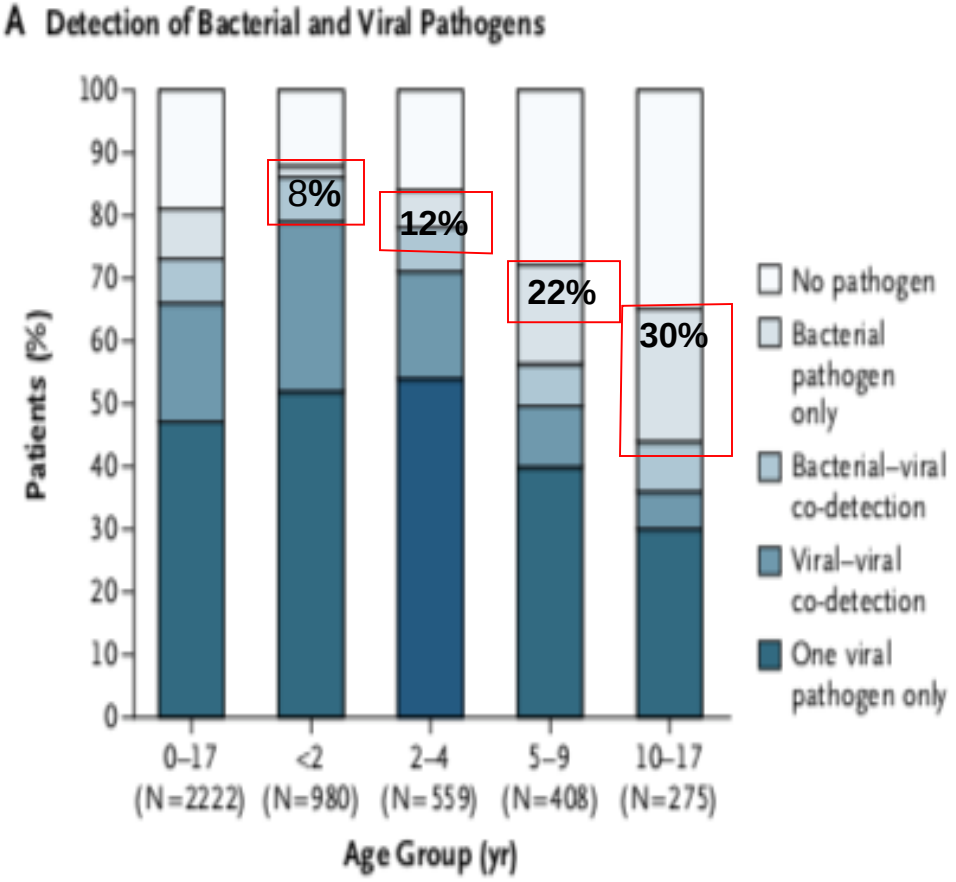
Broad spectrum abx in AOM, strep throat, sinusitis:

- not more effective
- increase risk of AE's
- lower QOL



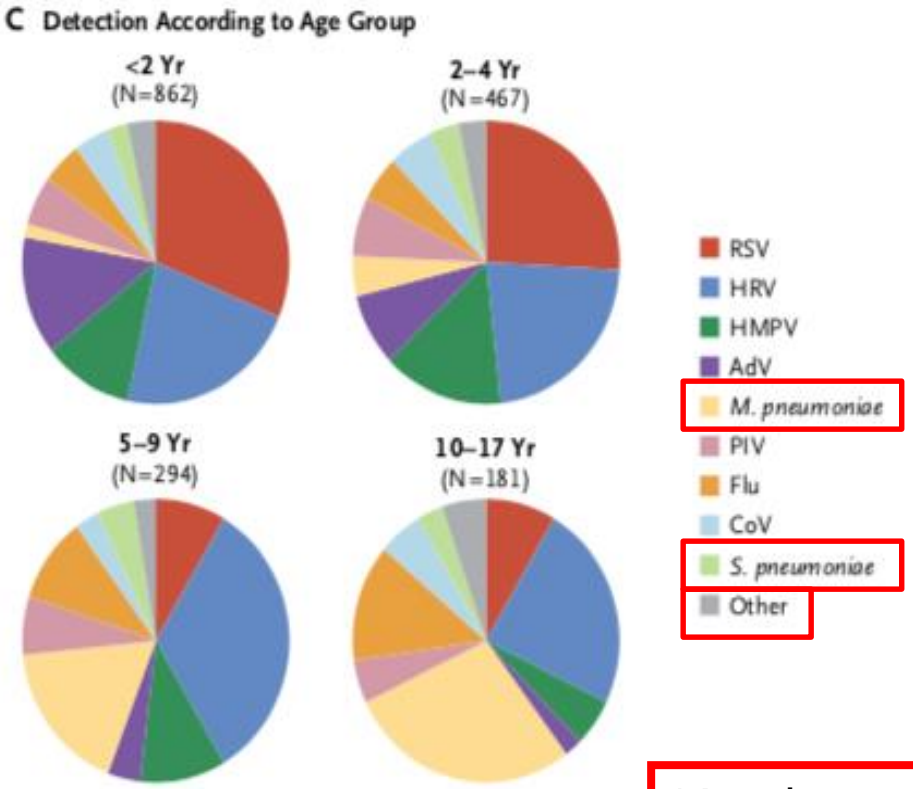
Pneumonia- Etiologies

- CAP 3 main bacterial suspects: *S. pneumoniae, S. aureus, S. pyogenes*
- EPIC 2015 Study:
  - >2300 pts 0-17 admitted with PNA
  - **Only 15% had bacteria (% increases with age; largely *mycoplasma*-driven)**



*Any bacterial etiology percentage

Pneumonia- Etiologies: EPIC Study Continued



- Mycoplasma only exceeds 5% in 5-9 y/o group
- *S. pneumo* and other group increase slightly but stay in 5-10% range

*Any bacteria

Pneumonia- Diagnosis

Combo of H&P, imaging, labs

Exam-

- Fever, cough, increased WOB, hypoxia, tachypnea
- Tachypnea is most sensitive; decreases w/ age
- Lower lobe: possible ab pain
- Younger pt's: nonspecific signs/symptoms
- Consolidation: crackles, fremitus ("ninety-nine"), egophany ("E" sound), bronchophony, dullness to percussion

CXR-

- **Don't need for mild disease with consistent H&P**
- Uses:
  - Severe illness/admitted pt's
  - Rule out other entities (foreign body, PTX, etc) *when suspected*
  - Inconclusive H&P
  - Treatment failure/complications
  - Febrile infant with leukocytosis
  - Recurrent PNA or suspected anatomic PNA set-up
- Returns to normal in 2 months in 90% of pts

US/CT-

- US for empyema/effusion
- CT for abscess/fistula suspicion

Pneumonia- Diagnosis: Labs

Reserve for severe dz or hospitalization candidates

Bloodwork-

- Blood culture- if admitted, tx failure, complicated dz
- Inflammatory markers-
  - One piece of puzzle; not sole determinant
  - **Procalcitonin-**
    - **<0.1 ng/ml: zero pt's with typical bacteria**
    - **<0.25 ng/ml: 96% NPV for typical bacteria**
  - ESR > 35 mm/h PPV = 38%
  - CRP > 6.0 mg/dL PPV = 43%
  - ESR/CRP PPV increases when combined
  - **CBC not useful to determine viral vs. bacterial**
  - Aids in disease monitoring, esp complicated/severe cases

PCR's and viral studies-

- Viral PCR's- only if results will change mgmt.
- Upper-airway samples can help diagnose: mycoplasma pneumoniae, Chlamydophila pneumoniae, Bordetella pertussis, Bordatella parapertussis
- Mycoplasma PCR- more sensitive when done alone compared to viral panel array

Other specimen studies-

- Pleural fluid analysis- only if complicated dz
- Consider sputum sample in older, mod/severe hospitalized patients

Pneumonia- Diagnosis: Bacterial, Atypical, or Viral?- THIS IS CHALLENGING!

Hints at bacterial:

- Abrupt onset, possibly following URI sx's
- Ill appearance
- Complicated pneumonia
- Truly focal exam (note: viruses cause focal pneumonia too)
- Elevated inflammatory markers (esp if both CRP and procalcitonin)

Viral hints:

- Insidious onset
- Non ill appearance
- Coincident URI symptoms
- Diffuse (non-focal) auscultation
- Proven virus (e.g. respiratory infection panel)
- Wheezy, hypoxic kid more likely viral
- Diffuse x-ray pattern

Hints at atypical (*c. pneumoniae* or *mycoplasma*): See next slide

Pneumonia- Diagnosis: Hints at Atypical Bacteria

Labs-

- CRP, WBC, % PMN's lower in atypical vs. *S. pneumo* (although std deviations overlap)

CXR- no studies have shown differences bw typical and atypical PNA via CXR

H&P- Mycoplasma: URI and LRTI sx's; also hemolytic anemia, rash/SJS, polyarthritis, GI (pancreatitis, hepatitis), carditis

Clinical-

- **Pt age: mycoplasma rates <5% in pt's < 5 y/o**
- Milder, longer course (~3-5 days)
- Low-grade fever
- Wheezing
- Diffuse x-ray exam/findings
- Constitutional findings
- Mycoplasma can also cause effusion (usually small)
- **Mycoplasma may start w sore throat & myalgia**

Parameter	Infection due to: *Streptococcus pneumoniae* (*n* = 48)	Atypical bacteria (*n* = 46)	Mixed *S. pneumoniae* and atypical bacteria (*n* = 16)	Undiagnosed cases (*n* = 86)
WBC count, mean cells/μL ± SD	16,669 ± 8831[a,b,c]	12,554 ± 5404	13,141 ± 4540	12,960 ± 5670
Neutrophils	69 ± 17[a,b,c]	59 ± 18	63 ± 16	62 ± 16
Lymphocytes	22 ± 15	28 ± 17	25 ± 16	27 ± 17
Monocytes	7 ± 3	8 ± 3	7 ± 3	8 ± 3
Eosinophils	1 ± 2	1 ± 1	1 ± 2	1 ± 2
Basophils	0.3 ± 0.6	0.4 ± 0.7	0.3 ± 0.4	0.3 ± 0.6
CRP level, mean μg/dL ± SD	109 ± 110[a,b]	59 ± 88	77 ± 79	69 ± 82
ESR, mean mm/h ± SD	57 ± 28	47 ± 27	52 ± 44	49 ± 39

NOTE. Data are mean % of WBCs ± SD, unless otherwise indicated. Unless indicated, differences were not significant. CRP, C-reactive protein; ESR, erythrocyte sedimentation rate.

[a] $P < .05$ compared with atypical bacterial infection.
[b] $P < .05$ compared with mixed *S. pneumoniae*–atypical bacterial infection.
[c] $P < .05$ compared with undiagnosed cases.

Pneumonia- Diagnosis: Bacterial, Atypical, or Viral?

Clinical and radiographic clues to the etiology of pneumonia in children*

Etiology	Clinical features	Radiographic features
Bacteria (most commonly *Streptococcus pneumoniae*)	▪ Children of all ages ▪ Abrupt onset ▪ Ill-appearance ▪ Chills ▪ Moderate to severe respiratory distress ▪ Focal auscultatory findings ▪ Localized chest pain ▪ WBC count >15,000/microL (if obtained) ▪ Elevated acute phase reactants (if obtained)	▪ Alveolar infiltrates ▪ Segmental consolidation ▪ Lobar consolidation ▪ "Round" pneumonia Complications: ▪ Pleural effusion/empyema ▪ Lung abscess ▪ Necrotizing pneumonia ▪ Pneumatocele
Atypical bacterial (*Mycoplasma pneumoniae*, *Chlamydia pneumoniae*)	▪ Children of all ages (most common in children >5 years) ▪ Abrupt onset with constitutional findings (malaise, myalgia, headache, rash, conjunctivitis, photophobia, sore throat, headache) ▪ Gradually worsening nonproductive cough ▪ Wheezing ▪ Extrapulmonary manifestations or complications (eg, Stevens-Johnson syndrome, hemolytic anemia, hepatitis, etc)	Interstitial infiltrates
Viral	▪ Usually children <5 years ▪ Gradual onset ▪ Preceding upper airway symptoms ▪ Nontoxic appearing ▪ Diffuse, bilateral auscultatory findings ▪ Wheezing ▪ May have associated rash (eg, measles, varicella)	Interstitial infiltrates
Afebrile pneumonia of infancy (most commonly *Chlamydia trachomatis*)	▪ Usually in infants 2 weeks to 4 months ▪ Insidious onset ▪ Rhinorrhea ▪ Staccato cough pattern ▪ Peripheral eosinophilia (if CBC obtained)	Hyperinflation with interstitial process

Pneumonia- When to Admit for CAP?

TABLE 1. Criteria to Consider Hospitalization for Pediatric Pneumonia

- Hypoxemia (oxygen saturations <90% to 92% at sea level)
- Infants <3 to 6 months of age with suspected bacterial community-acquired pneumonia
- Tachypnea:
  - Infants <12 months of age: respiratory rate >70 breaths per min
  - Children: respiratory rate >50 breaths per min
- Respiratory distress: apnea, grunting, difficulty breathing, and poor feeding
- Signs of dehydration or inability to maintain hydration or oral intake
- Capillary refill time >2 s
- Infants and children with toxic appearance
  - Suspected or confirmed to have infection with a virulent organism (community-acquired methicillin-resistant *Staphylococcus aureus* or group A *Streptococcus*)
- Underlying conditions/comorbidities that:
  - May predispose patients to a more serious course (eg, cardiopulmonary disease, genetic syndromes, neurocognitive disorders, neuromuscular disorders)
  - May be worsened by pneumonia (eg, metabolic disorder)
  - May adversely affect response to treatment (eg, immunocompromised host, sickle cell disease)
- Complications (eg, effusion and/or empyema)
- Failure of outpatient therapy (48–72 h with no clinical response)
- Caretaker unable to provide appropriate observation or to comply with prescribed home therapy

Indications for intensive care unit admission include:

- Severe respiratory distress or impending respiratory failure that requires:
  - Intubation and mechanical ventilation
  - Positive pressure ventilation
- Recurrent apnea or slow irregular respirations
- Cardiopulmonary monitoring due to cardiovascular compromise secondary to:
  - Sustained tachycardia
  - Inadequate blood pressure
  - Requirement of pharmacological support for blood pressure or perfusion
  - Altered mental status due to hypercarbia or hypoxemia
  - Pulse oximetry measurement of <92% on fractional inspired oxygen concentration of >0.50
- Pediatric Early Warning Score >6

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Pneumonia- Outpatient Mgmt

Tx is empiric

Abx not routinely recommended in preschool age (unless strong bacterial suspicion)

Oral cephalosporins are inferior to amox

Beta-lactam allergy-

- Mild: amox w/ observation, PO cephalosporin (e.g. cefpodoxime, cefprozil, cefuroxime)
- Severe: levoflox, linezolid, macrolide (resistance often high)

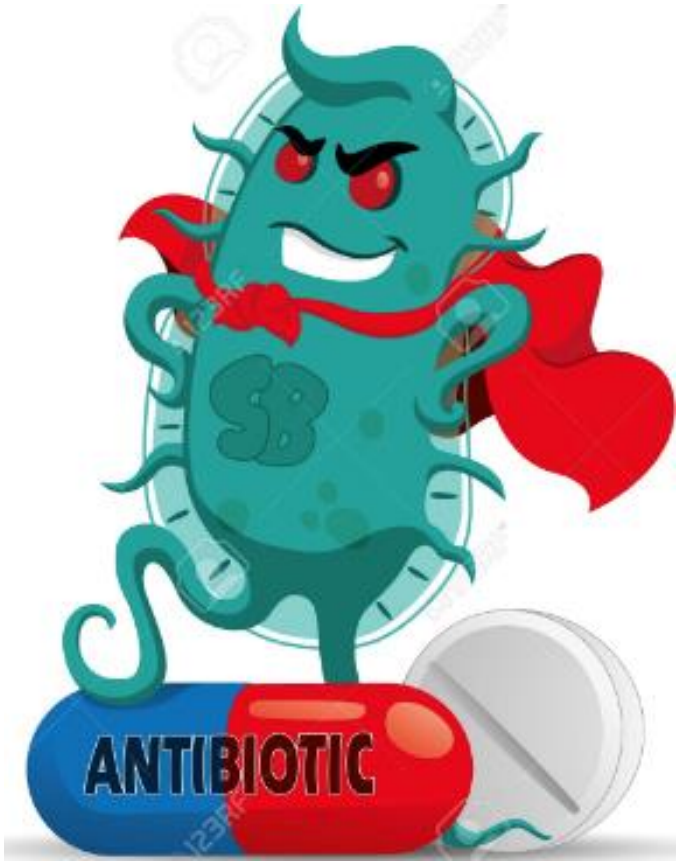
Amox dosing: 33 mg/kg TID (MDD 4 g)

Duration- 5-7 days

Amox-clavulanate- adds HiB and *M. catarrhalis* coverage (not needed in fully immunized, normal child)

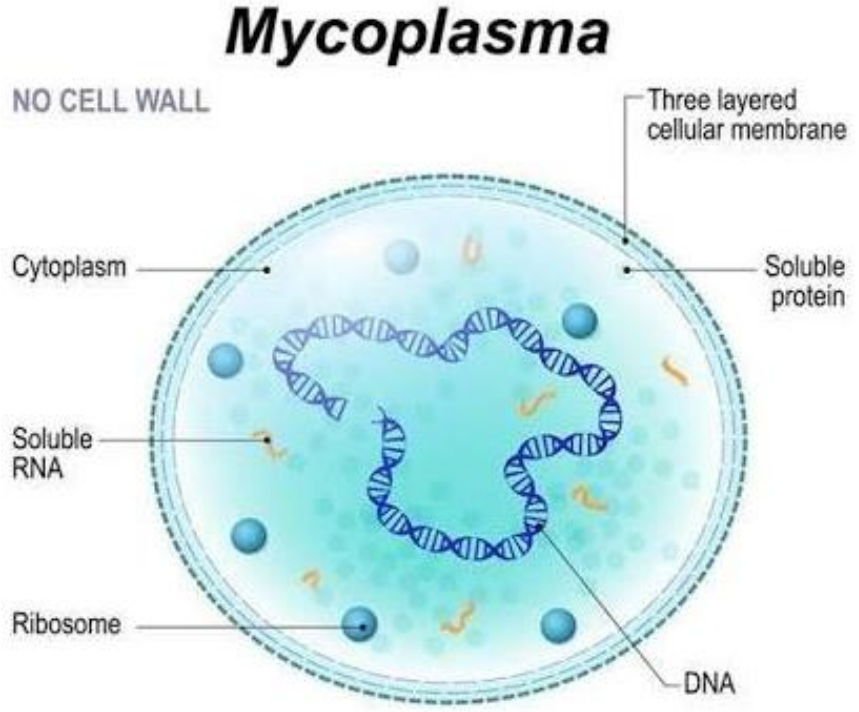
Mycoplasma- azithro for 5 days

Remember your local antibiogram



Pneumonia- Outpt Mgmt: Should I Test and Treat Mycoplasma?

- Azithro will not adequately treat most CAP bugs
- Testing- consider if unclear H&P; results are not immediate
- Treatment- when high suspicion based on H&P/testing



Pneumonia- Outpt Mgmt: Tx Failure

- Definition- clinical worsening despite *48 hours properly chosen/dosed abx*
- Consider repeat CXR/hospitalization
- If hospitalized, expand abx if more virulent bugs (*S. aureus, S. pyogenes*)

Pneumonia- Inpt Mgmt Basics

1st line (generally)- ampicillin

Broaden your microbial ddx-

- *S. pneumo* still most common
- Flu with superimposed bacterial PNA: suspect *S. aureus*
- Rapidly progressive or sepsis/shock: consider *S. aureus* or *S. pyogenes*
- Likely do not need to cover for HiB or *M. catarrhalis* (unless under-immunized)
- Complicated dz: *consider* ceftriaxone first line plus staph coverage. Amp OK for simple effusion.

PCN allergy- ceftriaxone

- Ceftriaxone other cases: under-immunized, high local PCN-R strains, severe/complicated disease

Beta-lactam allergy- levofloxacin

- *Confirmed* atypical- *azithro
- MRSA coverage- Vanc. Add clinda for toxin-mediated (complicated) process.
- Duration-
  - Uncomplicated: 7-10d
  - Complicated: longer
- Steroids- Consider in asthma pt when signs of reversible obstruction
- Chest physiotherapy- no benefits in outcomes or LOS
- No improvement or worsening 48-72 hours of appropriate abx- assess for other cause, consider resistance, look for complications

*no change in outcomes when azithro used

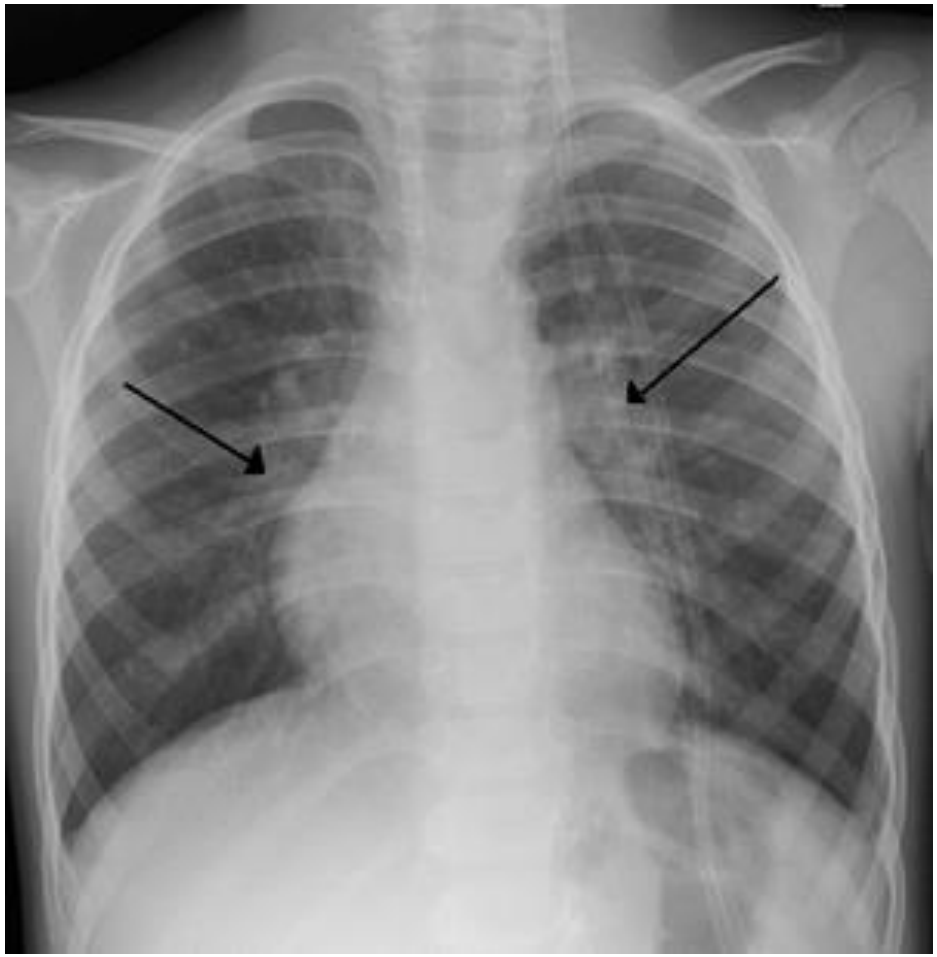
Pneumonia- Inpt Mgmt: Complications

- Will save most of this for another talk!
- Complicated CAP- effusion, empyema, abscess, fistula, necrotizing PNA.
- Few pointers-
  - Small uncomplicated effusion <10 mm on lateral CXR or <1/4 opacification of hemithorax: can still tx empirically only w amp
  - Broaden abx coverage beyond 3 main suspects: *HiB*, *mycoplasma*, *Legionella/Aspergillus* (necrotizing), anaerobes/*Klebsiesla* (abscess)

Pneumonia- Summary

- Reserve labs/imaging for potentially hospitalized pt
- Bacteria only involved in 15% of hospitalized PNA pt's; increases with age
- Hints at etiology-
  - Age-
    - mycoplasma only 5% in <5 y/o; increases substantially age 5
    - Bacterial is 8-12% of cases age 0-4
  - Signs & Symptoms-
    - Hints at viral/atypical-
      - Preceding/coincident URI/constitutional symptoms
      - Wheezing
      - Diffuse exam
      - Mild illness/appearance
- Treatment-
  - Abx not indicated in preschool age (unless strong evidence for bacteria)
  - Outpt: amox 33 mg/kg TID (MDD 4 g) for 5-7 days
  - Inpatient- amp first line. Broaden your ddx/pathogens. *Consider* azithro only for *proven mycoplasma*

Bronchiolitis



Bronchiolitis- Epidemiology

- 90% of kids infected with RSV in first 2y; 40% of these will have LRTI
- Most common cause of infant hospitalization: 100,000 hospitalizations annually in US = $1.73 billion
- Preterm infants have higher hospitalization rates

Bronchiolitis- Definition, Pathophysiology, Clinical

- Common LRTI in infants, characterized by acute inflammation, edema, epithelial necrosis, increased mucus production in small airways (bronchioles)
- Almost always virally-mediated: RSV>> rhinovirus > flu > hMPV > paraflu/others
- Usually URI prodrome followed by respiratory distress (retractions, grunting, tachypnea, nasal flaring), wheezing, hypoxia, extrapulmonary signs/symptoms (AMS, decreased PO)

Bronchiolitis- Mgmt

- Assess severity and risk factors for severe dz
  - Severe dz RF's: age < 12 w/o, prematurity, immunodeficiency, underlying cardio-pulm dz
- **Diagnose clinically; labs/imaging not routinely recommended**
  - Viral testing for infants on palivizumab to assess breakthrough RSV
    - *Can help when dx is in question*
  - CXR- often abnormal, but clinical significance unclear
    - Again, may assist if diagnosis is in question
    - LRTI kids with CXR were more likely treated with abx without difference in clinical outcome
- Pulse ox- unclear significance of hypoxia (<90%) on outcomes or borderline low (90-95%) on progression or need for follow-up

Bronchiolitis- What is Tachypnea Anyways?

WHO criteria:

- 0-2 months: > 60
- 2-12 months: > 50
- 1-5 years: > 40
- > 5 years: > 20

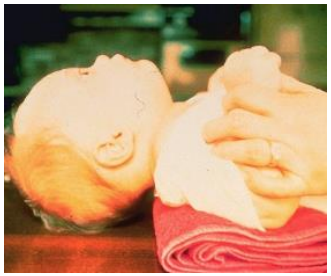
Bronchiolitis- Treatment

- Repositioning- Yes
- Albuterol- Not recommended
  - May improve symptoms scores
  - No change in LOS, disease resolution, hospitalization rate
  - May take into account h/o wheezing or atopy
- Hypertonic (3%) saline aerosol- Not in the ED, OK when admitted
- Steroids- Universally contraindicated
- Chest physiotherapy- No
- Suction- Nasal (non-invasive) probably OK. Deep suction may have negative effect
- Antibiotics- no, unless strong suspicion for bacterial infection

Bronchiolitis- Treatment (continued)

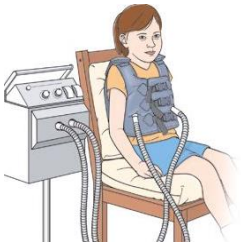
- Oxygen-
  - Only for persistent sats < 90%
  - Pulse oximetry is optional
  - High-flow nasal cannula- early data suggest *modest* improvement

Bronchiolitis Treatment Summary: Always Sometimes, *Never



Reposition

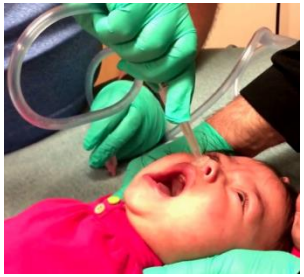
Hypersaline



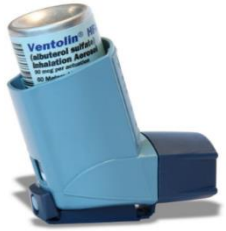
Physio-tx

Steroids

Oxygen



Deep suction



Albuterol*

Antibiotics*

Bronchiolitis- Summary

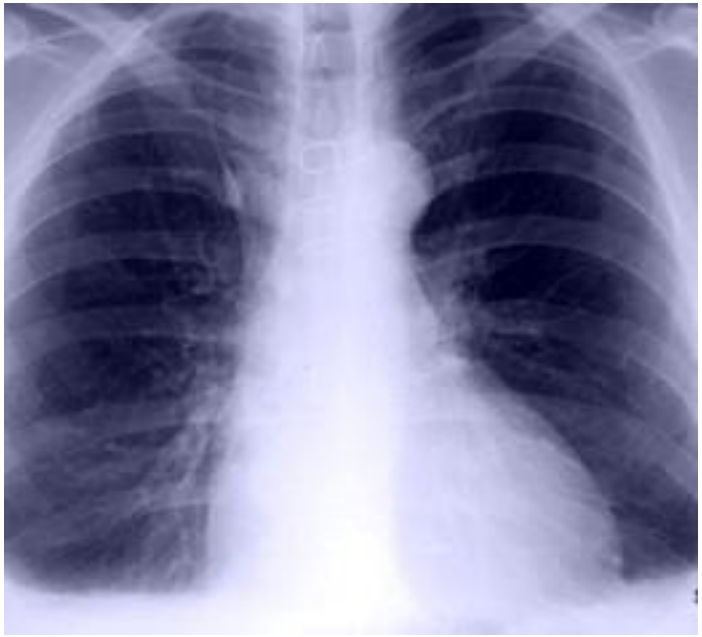
- Clinical diagnosis; labs/imaging only if strong suspicion for something else
  - CXR abnormal in ~25% of pt's without difference in etiology or outcome
- Tx:
  - No routine abx, no steroids ever, no physiotherapy
  - Albuterol: not recommended, but can take into account atopic history
  - Supportive: positioning, suction
  - 3% hypersaline aerosol when admitted
  - O2 only if pulse ox < 90%

Case Study- Ariel

- HPI: 3 y/o healthy female presents with 1 day h/o respiratory distress after 3-4 days rhinorrhea, congestion, sore throat, cough.
- Came from UC: pulse ox 88%, CXR obtained
- Vitals: T 100.9, RR 36, BP 96/60, P 120, P.O. 92-95%
- Exam: Non-toxic, grumpy, + clear rhinorrhea, b/l lateral cervical nodes, mild oropharyngeal erythema, faint diffuse wheezing, no increased WOB.

Case Study (continued)

- CXR- bilateral lower lobe opacity (infiltrate vs. atelectasis)



Case Study (continued)- Admit or Not?

- Any admission criteria?
  - No!

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Case Study (continued)- Workup?

- Blood work?
  - No since not sick enough for admission
- Viral testing?
  - No since viral identification not going to change management
- Mycoplasma testing?
  - Probably not based on pt's age and classic viral findings/symptoms
- Was it wrong to get the CXR?
  - Probably OK since hypoxic at initial presentation

Case Study (continued)- Treatment

- Consider observation period in ED for hypoxia redevelopment.
- Could consider bronchodilator if family h/o atopy
- Discharge with instructions for supportive care.

4 Points You MUST Remember!

1. Most pediatric CAP is viral, esp in the young
2. Narrow abx are best (superbugs, efficacy) for routine CAP
   - Amox CAP dosing: 33 mg/kg TID (MDD 4 g)
   - Evidence for adding azithro is *tenuous*
3. Reserve labs/imaging for potentially hospitalized patients
4. Bronchiolitis tx is minimal:
   - Yes: reposition, O2 (<90%)
   - Maybe: O2 (<90%)
   - Probably not: Deep suction, hypersaline, abx, albuterol
   - NO: steroids, chest physiotherapy

With your help, we can:

- Keep our kids safe (duh!)
- Fight the good fight against abx resistance
- Reduce medical costs
- Reduce radiation exposure and other overdiagnosis

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