Blue Team Teaching Module: Simple Pneumonia

Format:

1. Case
2. Topic Summary
3. Questions
4. References

Case:

A 5 year old previously healthy boy was brought into the ED for abdominal pain. He had been in his usual state of good health until 5 days prior to admission when he developed mild upper respiratory tract infection symptoms of runny nose and nasal congestion. Two days prior to the ED visit, he had low-grade fever and an occasional dry cough. He also has had poor oral intake and is sleeping more than usual. He has not had any stools in the past few days nor has he had any vomiting. ROS is otherwise negative.

PMH: no previous hospitalizations or surgeries
IZ: UTD, PPD negative.
Medications: Tylenol for fever
SH: Attends kindergarten, lives with mother, father, older sister, dog and cat in a single family home; no tobacco exposure. No sick contacts, no family members with chronic cough. No recent travel.
FH: HTN in MGM, DM2 in PGF

PE: Temp 39.2, HR 128, RR 40, BP 108/70, O2 sat 91-96%, Wt and Ht at 50% for age
Sitting on mom's lap, drowsy but easily awakened then cooperative but quiet.
Normal HEENT except clear rhinorrhea at nares, posterior pharynx injected but no exudates or palatal petechiae
Neck supple with shotty bilateral LAD
Heart RRR, no murmurs
Lungs clear to auscultation bilaterally, fine crackles at right base but clears with cough, no wheezing, no grunting or flaring
Abdomen slightly decreased bowel sounds, soft, voluntary guarding in epigastric area but non-tender with distraction, no HSM
Extremities warm, no edema, cap refill 3-4 seconds
Skin no rashes

What is your differential diagnosis?
What is most important to rule out?
What labs or studies would facilitate a diagnosis, if any?
What interventions are appropriate at this time?

Topic Summary: Community Acquired Pneumonia

Definition: The presence of fever, acute respiratory symptoms, or both, plus evidence of parenchymal infiltrates on chest radiography.

Epidemiology: It is estimated that there are up to 155 million cases of pneumonia in children every year worldwide. In the United States, over 4 million children are diagnosed with pneumonia each year and more than 600,000 of these children require hospitalization. In North America, the annual incidence of pneumonia in children <5 years of age is 34-56 per 1000 but drops to approximately 16 cases per 1000 in children over 5 years of age. In developed nations, mortality from pneumonia is <1 per 1000 annually, but it kills approximately 4 million children per year in developing countries, which puts it ahead of deaths associated with gastroenteritis with dehydration and malaria.

Pathogenesis: Pneumonia is often preceded by an upper respiratory tract infection. The normally sterile respiratory tract is accessed by bacteria and viruses by inhalation, microaspiration, droplet, or hematogenous spread. Once the microbe colonizes the nasopharynx, the organisms may be inhaled into the lower respiratory tract (LRT). In the LRT, the host immune defenses work by physical defenses (e.g. mucociliary clearance, cough reflex) and microbe destruction (e.g. alveolar macrophage ingestion, opsonization, complement mediated lysis, or immunoglobulin mediated eradication). In neonates, pulmonary infections can be acquired congenitally (viruses, Listeria, Mycobacterium tuberculosis), during birth (Group B streptococci, Chlamydia trachomatis), or after birth (viruses).

Etiology:

Common Pathogens in Childhood Pneumonia

Neonates	1-3 months	3 mos – 5 years	> 5 years
• Group B Strep • Gram Negative Bacilli • CMV • HSV (perinatal) • Listeria • Strep pneumo • Ureaplasma urealyticum • Treponema pallidum (congenital)	• LRT viruses ** • Chlamydia trachomatis • Strep pneumo • Bordatella pertussis • Ureaplasma urealyticum	• LRT viruses** • Strep pneumo • Mycoplasma pneumoniae • Chlamydophila pneumoniae • H. flu (less significant now)	• Mycoplasma pneumoniae • Chlamydophila pneumoniae • Strep pneumo • Influenza A and B • Mycobacterium tuberculosis

** Includes RSV, adenovirus, parainfluenza 1, 2, and 3; influenza A and B; human metapneumovirus. Human bocavirus, rhinovirus (less common)

Presentation: Classically presents with sudden onset of fever, cough and tachypnea but the presentation is often diverse and nonspecific. Tachypnea is most sensitive sign, however pneumonia can exist without tachypnea or rales. Abdominal pain is a common presenting symptom, and patients may get worked up to rule out appendicitis, at which time the pneumonia

presents itself on the abdominal CT. New onset wheezing can occur with atypical bacterial (Mycoplasma pneumoniae, Chlamydophila pneumoniae) and viral pneumonia, however is not associated with pyogenic bacterial pneumonia. Atypical bacterial pneumonia often presents with gradual onset of headache, malaise, fever, pharyngitis with subsequent development of cough and dyspnea; however, up to 40% can have more acute presentations. Chlamydia trachomatis should be considered in infants 4-12 weeks of age who are tachypneic with diffuse rales or wheezes but afebrile; approximately 50% of these infants will also have conjunctivitis. In all patients, signs of lower respiratory tract infections include tachypnea, increased work of breathing (grunting, flaring, retracting), pleuritic chest pain and adventitious breath sounds.

Common Clinical Pneumonia Syndromes of Childhood

Syndrome	**Bacterial (Suppurative)**	**Atypical (Infancy)**	**Atypical (Older Children)**	**Viral**
Typical Cause	Strep Pneumo Staph Aureus GAS	Chlamydia trachomatis	Mycoplasma pneumonia	Multiple
Age Group	All ages <6 y more common	<3 months	>5 years	All ages 3 mo to 5 y more common
Clinical Features	• Abrupt onset • High fever • Ill appearance • Focal findings on exam • Chest/abdominal pain	• Afebrile • Tachypnea • Mild hypoxia • Wheezing	• Gradual onset • Low-grade fever • Diffuse exam findings	• URI symptoms • Low-grade or absent fever • Diffuse findings/wheeze on exam
CXR Findings	• Focal infiltrate	• Interstitial infiltrates	• Diffuse infiltrates	• Diffuse interstitial infiltrates

Differential Diagnoses: Includes bronchiolitis, asthma, foreign body aspiration, heart failure, malignancy (lymphoma), atelectasis, pulmonary embolism, pulmonary hemorrhage (e.g. pulmonary hemosiderosis, Wegner's granulomatosis), and sarcoidosis. Diseases that cause interstitial lung disease with pulmonary fibrosis such as systemic lupus, scleroderma, rheumatoid arthritis can also mimic infectious pneumonia. Environmental irritants such as noxious gases, radiation, hydrocarbon ingestion can lead to secondary pneumonias. Congenital lung anomalies such as pulmonary sequestration, congenital lobar emphysema, and congenital cystic adenomatoid malformations may also lead to pneumonia, often recurrent.

In children with underlying neuromuscular disorders, swallowing difficulties, seizures, or gastroesophageal reflux, aspiration pneumonia should be considered. The etiologies here include oral flora, anaerobes, and gram negative rods.

Work-Up: Many physicians treat pneumonia empirically, based on history, lung findings, and knowledge of epidemiology in the relevant clinical setting. In the outpatient setting, in a child who is only mildly ill, a chest radiograph (CXR) is not necessary or practical. However, for a

moderately ill appearing child or in the emergency department or in-patient setting, chest radiographs (PA and lateral views) are warranted to evaluate for infiltrate or complicated pneumonia. In addition, in those who are ill-appearing, dehydrated or in respiratory distress, a more aggressive work up would include blood cultures, chemistry profiles (azotemia, hyponatremia) and a complete blood count with differential. Sputum is difficult to obtain in patients younger than 8 years old. Specific viral testing for suspected pathogens can be helpful in certain groups (e.g. Chlamydia DFA or NP/conjunctival swab in young infants; PCR testing of a NP aspirate for B. pertussis; PCR testing of NP aspirate for Mycoplasma or chlamydophila pneumoniae; viral DFA of NP aspirate). Acute phase reactants (CRP, ESR) are mostly helpful in assessing response to therapy but not for distinguishing bacterial from viral causes.

Links to chest radiographs of uncomplicated pneumonia:
http://biomarker.cdc.go.kr/biomarker/diseaseimg/pneumonia-Community_acquired.jpg
http://img.medscape.com/pi/emed/ckb/pulmonology/295571-295572-300157-300288.jpg

Admission Criteria: Indications for hospital admission include 1) age less than 3 months, 2) hypoxemia requiring supplemental oxygen, 3) complicating factors such as dehydration or intolerance of oral intake, 4) toxic appearance or 5) the presence of a serious chronic illness.

Treatment: Children in the 3 month to 5 year age group most likely have viral pneumonia, therefore those who are mildly ill, afebrile and have diffuse findings on exam, generally do not need antimicrobials. If bacterial pneumonia is suspected, empiric treatment for Strep pneumoniae is warranted. Typical duration of treatment is 7-10 days. For presumed atypical pneumonia, a macrolide such as azithromycin can be used.

Empiric Treatment for Community-Acquired Pneumonia:

Suspected Cause	Oupatient (PO)	Inpatient (IV)
Strep pneumo	Amoxicillin Cefdinir Ceftriaxone	Ampicillin Ceftriaxone
MRSA	-	Vancomycin Clindamycin
Atypical Organisms	Azithromycin Doxycycline (>8y)	Azithromycin Doxycycline
Aspiration	Amoxicillin-Clavulanate Clindamycin	Ampicillin-Sulbactam Piperacillin-Tazobactam Clindamycin

Follow-Up: Repeated blood cultures in children with clinical improvement are not necessary to document resolution of bacteremia caused by S. pneumoniae, however they should be obtained to document resolution of S. aureus bacteremia. Repeat chest radiographs are not routinely required in patients who recover uneventfully from an episode of community-acquired pneumonia.

Questions:

1. What is the most sensitive sign for pneumonia in a child?

    a. fever
    b. cough
    c. fever and cough
    d. tachypnea
    e. respiratory distress

2. What is the most common etiology for community acquired pneumonia in a previously healthy 4 year old boy?

    a. streptococcus pneumoniae
    b. mycoplasma pneumoniae
    c. viruses
    d. staphylococcus aureus
    e. chlamydophila pneumoniae

3. In a nontoxic, febrile child with cough, tachypnea, and minimal respiratory distress in whom you suspect community acquired pneumonia, the work up should include:

    a. chest x-ray
    b. complete blood count with differential
    c. blood culture
    d. CRP or ESR
    e. None of the above

4. The best antibiotic agent for a 2 week old with pneumonia with an unknown bacteria is:

    a. vancomycin
    b. clindamycin
    c. ampicillin and cefotaxime or aminoglycoside
    d. ceftriaxone
    e. ampicillin alone

5. The best oral agent for community acquired lobar pneumonia in a 7 year old is:

    a. amoxicillin-clavulanate
    b. amoxicillin
    c. azithromycin
    d. high dose amoxicillin
    e. linezolid

6. A previously healthy 16 year old girl has bacterial community-acquired pneumonia. What is the most likely pathogen?

    a. Streptococcus pneumoniae
    b. Chlamydophila pneumoniae
    c. Viral pathogens
    d. Mycoplasma pneumoniae
    e. Staphylococcus aureus

7. Which of the following metabolic derangements is NOT commonly associated with pneumonia?

    a. metabolic acidosis
    b. azotemia
    c. respiratory acidosis
    d. hyponatremia
    e. elevated liver function tests

8. For community-acquired lobar pneumonia, an antibiotic with beta-lactamase inhibition is preferred over a simple beta-lactam antibiotic.
    True _____ False_____

9. An elevated acute phase reactant indicates a bacterial etiology versus a viral etiology.
    True _____ False_____

10. For a moderately ill patient hospitalized for community-acquired pneumonia, the following labwork would NOT be helpful:

    a. pulmonary function tests
    b. blood cultures
    c. chemistry panel
    d. complete blood count with differential
    e. sputum culture

Answers:

1. **Answer: d: Tachypnea is the most sensitive physical examination sign of pneumonia: most patients with pneumonia have tachypnea on physical exam.**

2. **Answer: c: Viruses are the most common pathogen for CAP in this age group. These commonly include (but not restricted to): RSV, adenovirus, parainfluenza 1, 2, and 3; influenza A and B; human metapneumovirus.**

3. **Answer: e: In the out-patient setting, a nontoxic child with clinical symptoms and signs consistent community-acquired pneumonia is often treated empirically, without any labwork or radiographs.**

4. **Answer: c: Ampicillin provides coverage for Listeria monocytogenes and Group B strep while the aminoglycoside would add coverage for gram negative organisms. A third generation cephalosporin provides coverage of both gram negatives and gram positives but NO coverage for Listeria (thus the ampicillin).**

5. **Answer: d: Since strep pneumoniae is the most common cause of community acquired pneumonia, amoxicillin is a good choice. The resistance pattern of strep pneumoniae to beta-lactams is via penicillin binding proteins and increasing the dose of the amoxicillin can overcome this mechanism. Beta-lactamase inhibitors such as clavulanic acid do not help in this case.**

6. **Answer: d: Mycoplasma is a more common cause of bacterial CAP than strep pneumoniae in this age group. Strep pneumoniae is the most common cause of bacterial CAP in children less than 5 years of age.**

7. **Answer: e: Although patients with bacterial CAP commonly present with abdominal pain, their liver function tests are normal. Bacterial CAP can be associated with metabolic acidosis and azotemia due to dehydration caused by large insensible losses and poor oral intake; in severely ill patients with CAP, respiratory acidosis is caused by hypoxia and poor ventilation; hyponatremia in CAP is due to inappropriate secretion of antidiuretic hormone (SIADH) and is relatively common.**

8. **Answer: False: Antibiotic resistance to beta-lactams by pneumococcus is via altered penicillin binding proteins. High dose beta-lactams can overcome this mechanism but beta-lactamase inhibitors cannot.**

9. **Answer: False: Elevated acute phase reactants are nonspecific signs of inflammation that can be seen with both viral and bacterial infections.**

10. **Answer: a: Pulmonary function tests do not add useful information in this setting.All of the other listed labs can be helpful in diagnosing and monitoring response to therapy (antibiotics and rehydration) in CAP. The utility of a blood culture in CAP has been debated. The yield is usually around 7-10% in patients hospitalized with CAP; the**

yield in the outpatient setting is <2%. The usual recommendation for hospitalized patients is to obtain blood cultures because it is assumed that the patient is moderately to severely ill if they necessitate hospitalization. Although sputum cultures are routinely used in adults, most children younger than 8 years of age cannot produce an adequate sample; however, if one can be obtained, the gram stain can guide initial therapy (e.g. adding coverage for staph if gram positive cocci in clusters are seen and the clinical picture fits).

References:

1. Bradley, JS et al. The Management of Community-Acquired Pneumonia in Infants and Children Older Than 3 Months of Age: Clinical Practice Guidelines by the Pediatric Infectious Diseases Society and the Infectious Diseases Society of America. *Clinical Infectious Diseases.* 2011;53(7):e25-e76.
2. British Thoracic Society Standards of Care Committee. British Thoracic Society Guidelines for the Management of Community Acquired Pneumonia in Childhood. *Thorax.* 2002; 57 Suppl 1:i1.
3. Biscardi S, Loorot M, Marc E, et al. *Mycoplasma pneumoniae* and asthma in children. *Clin Infect Dis*. 2004;38:1341-1346.
4. Durbin WJ, Stille C. Pneumonia. *Pediatrics in Review*. 2008;29:147-160.
5. Heiskanen-Kosma T, Korppi M, Jokinen C, et al. Etiology of childhood pneumonia: serologic results of a prospective, population-based study. *Pediatr Infect Dis J.* 1998;17:986-991.
6. Matthews B, Shah S, Cleveland RH, Lee EY, Bachur RG, Neuman MI. *Pediatrics in Review*. 2009;124:e29-e36.
7. McIntosh K. Community-acquired pneumonia in children. *N Engl J Med*. 2002;346:429-437.
8. Michelow IC, Olsen K, Lozano J, et al. Epidemiology and clinical characteristics of community-acquired pneumonia in hospitalized children. *Pediatrics.* 2004;113:701-707.
9. Peck AJ Holman RC, Curns AT, et al. Lower respiratory tract infections among American Indian and Alaska Native children and the general population of U.S. children. *Pediatr Infect Dis J*. 2005;24:342-351.
10. Pediatric Practice. Infectious Disease/editor, Samir S. Shah. McGraw-Hill Companies, 2009, 298-309.