CASE 9.4
Pneumonia | Level 2

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1. What is the subjective and objective evidence that supports the diagnosis of community-acquired pneumonia?

SUBJECTIVE FINDINGS: The most common symptoms associated with pneumonia in children are fever and cough, which is present in this patient.

OBJECTIVE FINDINGS: Vital sign abnormalities include a fever, pulse oximetry of 89% on room air, and an elevated WBC count with high neutrophil count. On physical exam, the patient demonstrates nasal flaring and dyspnea. The diagnosis of pneumonia is supported by this clinical presentation along with the presence of abnormal chest radiography that is consistent with pneumonia with effusion versus empyema.

Signs of respiratory distress in children with pneumonia include tachypnea, dyspnea, retractions, grunting, nasal flaring, apnea, altered mental status, and pulse oximetry measuring less than 90% on room air. The patient has some of these signs of respiratory distress, warranting hospitalization for management of her pneumonia.

The patient's pneumonia is classified as community-acquired, as opposed to healthcare-associated pneumonia, due to the absence of recent exposure to healthcare facilities and antibiotic use in the past 90 days.

One possible unifying diagnosis for this patient is a viral illness causing her acute gastroenteritis prior to current hospital admission with subsequent development of a superimposed lobar pneumonia. Although uncommon, children with pneumonia may have nonspecific symptoms of emesis and abdominal pain.

2. What are the most likely pathogens causing community-acquired pneumonia in this patient, and what complication associated with pneumonia is presented?

Both viruses and bacteria can cause pneumonia. Given the age of the patient and lobar nature of the pneumonia, bacterial pneumonia is more likely than viral pneumonia. The potential bacterial pathogens causing pneumonia in this patient are the following:

- *Streptococcus pneumoniae*
- *Staphylococcus aureus*, including methicillin-resistant (MRSA), especially if empyema present

- Group A *Streptococcus*, particularly with possible recent enteric viral infection
- Atypical pneumonia, primarily *Mycoplasma pneumonia, Chlamydophila pneumoniae*

Pneumonia may progress to pulmonary complications that consist of pleural effusion, empyema (or collection of pus), abscess, and necrotizing pneumonia. The chest x-ray of this patient reveals left pleural effusion with opacity that is consistent with pleural effusions or empyemas. Admission to the intensive care unit and/or mechanical ventilation may be required if any of these complications occur. Children infected with typical bacterial organisms, such as *Streptococcus pneumoniae*, and those co-infected with viruses are more likely to develop pleural effusions. Pathogenic bacteria most commonly associated with empyema are *S. pneumoniae*, *S. aureus* (including MRSA), and group A *Streptococcus.* Determination of a definitive organism is typically acquired via direct sampling of the infected space through various means (e.g., thoracentesis, assistance by interventional radiology).

3. Design a pharmacologic treatment regimen and monitoring plan for the treatment of complicated community-acquired pneumonia in this patient.

Pneumonia is the greatest cause of death in children worldwide; it is important to treat this disease to reduce the mortality and morbidity associated with it. Complications of untreated pneumonia include the development of lung abscesses, bacteremia, infections of other organ systems, respiratory failure, and death.

Children presenting with respiratory distress due to suspected complicated pneumonia (as is evident in this patient) should be hospitalized for appropriate management of infection. For presumed bacterial pneumonia in a fully-immunized patient with a potential life-threatening complication such as an empyema, empiric therapy should provide coverage for *S. pneumoniae* and *S. aureus,* including possible MRSA. Hence, the antibiotic regimen should consist of a third-generation cephalosporin such as ceftriaxone 100 mg/kg/day with a maximum dose of 2 g/day (1 g IV q 12 hr) with vancomycin 15 mg/kg (375 mg) IV every 6 hours (which is equivalent to 60 mg/kg/day) or clindamycin 40 mg/kg/day (250 mg) IV every 6 hours. Clindamycin should *not* be used empirically when community resistance rates for MRSA exceeds 10%. The criteria to select an antibiotic with activity versus atypical organisms for a hospitalized patient is not well defined and depends on the clinical presentation as well as the patient's age. It is suggested that patients greater than 7 years old or patients receiving outpatient treatment benefit the most from macrolide or tetracycline antibiotics.

A thoracentesis or video-assisted thoracoscopic surgical procedure may be necessary for drainage of the empyema to promote lung function. If performed, bacterial cultures should be obtained during the surgical intervention to tailor definitive antibiotic therapy. Literature extrapolated primarily from adult data suggests vancomycin concentrations should be measured and doses adjusted to achieve the pharmacodynamic target of AUC/MIC ≥400; currently, most institutions utilize trough concentrations, so trough levels of 15 to 20 mcg/mL serve as an adequate surrogate for this target. Ceftriaxone can be used as monotherapy for treatment of empyema caused by susceptible *S. aureus,* and *S. pneumoniae* (even when the penicillin MIC is ≥4 mcg/mL). If MRSA is isolated and therapy with clindamycin is considered, a double-disk diffusion test (also called a *D-test*, in which one disk is impregnated with erythromycin and another disk with clindamycin) should be performed to exclude the presence of inducible clindamycin resistance mediated by the *erm* gene. The duration of therapy is typically 10 to 14 days, although longer duration of up to 4 weeks may be necessary in children who have pneumonia complicated with empyema.

Daily assessment of clinical improvement (increased level of activity, increased appetite, decreased fever, consistent pulse oximetry measurements of greater than 90% on room air, normalization of laboratory measurements such as WBC count and markers of inflammation as applicable) should be observed, with a goal of improvement within 48 to 72 hours after initiation of empiric antibiotics. If this goal is not