PULMONARY EMERGENCIES

I. Pneumonia

A. Bacterial Pneumonia (most common cause of a focal infiltrate)

1. Epidemiology
   a. Accounts for up to 10% of hospital admissions in the U.S.
   b. Most pneumonias are the result of a single species of bacteria:
      (1) *Streptococcus pneumoniae*
      (2) *Hemophilus influenza*
      (3) *Pseudomonas aeruginosa*
      (4) *Klebsiella pneumoniae*
      (5) *Staphylococcus aureus*
      (6) *Escherichia coli*
      (7) *Group A streptococci*
      (8) *Moraxella catarrhalis*
   c. Mechanisms of infection
      (1) Aspiration of oropharyngeal secretions is the primary mechanism of acquisition.
         (a) 50-70% of normal healthy individuals aspirate in their sleep.
         (b) An abnormal swallowing mechanism (e.g., altered mental status), GI disease, leads to increase frequency of aspiration.
      (2) Other mechanisms
         (a) Hematogenous spread from another site
         (b) Colonization
         (c) Direct introduction of organisms into the pleura or lungs, both of which are uncommon.
   d. Predisposing factors
      (1) Impaired cough and gag reflex
         (a) Altered mental status
         (b) Seizures
         (c) Syncope
         (d) CVA
      (2) Impaired mucociliary transport
         (a) Smoking
         (b) Viral or mycoplasmal infection
         (c) COPD
      (3) Chronic underlying disease
         (a) Hepatic/renal failure
         (b) Diabetes mellitus (DM)
         (c) CHF
      (4) Impaired immunity
         (a) AIDS
         (b) Chemotherapy
         (c) Alcoholism
         (d) Cystic fibrosis

(e) Malnutrition
(f) Sickle cell disease/splenectomy
(g) Congenital immune deficiencies
(5) Underlying lung pathology
(a) Bronchial obstruction (FB, tumor)
(b) Pulmonary embolus/contusion
(c) Atelectasis
(6) Chest wall dysfunction
(a) Neuropathies/myopathies
(b) Postoperative pain
(c) Chest trauma
(7) Mechanical bypass of normal defense mechanisms
(a) ET tube
(b) NG tube
(c) Chest tube
(d) Bronchoscopy
(8) Altered upper respiratory tract flora
(a) Recent antibiotic therapy/hospitalization

e. Defense mechanisms
(1) Cough and gag reflex prevents gross aspiration.
(2) Tracheobronchial tree cilia remove particles > 5μm.
(3) Alveolar macrophages remove particles < 5μm.
(4) Surfactant, complement IgG and IgA limit bacterial growth.

2. Diagnostic studies
a. White blood cell count (a normal count does not exclude pathology)
(1) In a young normally healthy patient, a markedly elevated WBC count (> 15,000) should lead you to **consider** pneumonia as a diagnosis.
(2) In an elderly or debilitated patient, WBCs may be increased, normal or decreased (even if there is an associated sepsis); the only clue may be a left shift.
(3) A very high or very low WBC count is associated with increased mortality.

b. Chest radiograph
(1) Certain patterns suggest, but do not prove, a specific organism
(a) *S. pneumoniae* (most common cause of lobar pneumonia)
1 Singular lobar infiltrate in the LLL, RLL or RML
2 Small pleural effusion
3 Abscess formation
(b) *Group A strep*
1 Patchy, multilobar infiltrates (usually lower)
2 Large pleural effusion
(c) *H. influenza*
1 Patchy (frequently basilar) infiltrates
2 Occasional pleural effusion
(d) *Klebsiella pneumoniae*
1 Upper lobe infiltrates
2 Bulging fissure
3 Abscess formation

(e) *S. aureus*
1 Patchy, multicentric infiltrates
2 Abscess formation
3 Empyema
4 Pneumothorax
(f) *Pseudomonas aeruginosa*
1 Patchy, mid or lower lobe infiltrates
2 Abscess formation
(g) *E. coli* — patchy, bilateral lower lobe infiltrates

(2) When infiltrates (patchy or lobar) are identified, always scan the films for other associated findings:
(a) Pneumothorax
(b) Pleural effusion
(c) Abscess formation

(3) Although CT scan may show pneumonia earlier, the radiation exposure makes it less desirable than a plain chest radiograph.

(4) Leukopenic or dehydrated patients may have normal-appearing x-rays.

(5) Other diagnoses to consider when you see pneumonitis on chest radiograph:
(a) Pulmonary infarction
(b) Pulmonary edema
(c) Metastatic cancer
(d) Pleural thickening
(e) Parenchymal scarring
(f) Atelectasis

c. Pulse oximetry/arterial blood gases

(1) In patients with pneumonia, the lungs are adequately perfused but poorly ventilated; the result is hypoxia.

(2) If the saturation on pulse oximetry is < 95%, obtain blood gas to determine the actual pO_2 with pCO_2 levels.

(3) If the pO_2 is < 60mmHg on room air, the patient should probably be hospitalized.

d. Sputum analysis (Consider primarily for high-risk patients who are hospitalized)

(1) Obtaining an adequate specimen is important in high-risk patients who will be hospitalized.

(2) Specimen collection is facilitated by heated saline nebulization, postural drainage or both. However, samples are not usually clinically useful unless they are obtained via an invasive method (e.g. bronchoscopy, tracheal suctioning).

(3) Sputum gram stain results are helpful in making therapeutic decisions in only a minority of patients.

(4) Fiberoptic bronchoscopy is the standard invasive procedure of choice for seriously ill or immunocompromised patients.

(5) Gross exam findings (may suggest a particular organism)
(a) Bloody or rusty → pneumococcus
(b) Thick "currant jelly"
1 *Klebsiella*
2 Type 3 pneumococcus
(c) Foul-smelling → anaerobic infection
(d) Green color
1 *Pseudomonas*
2 *H. flu*
3 *S. pneumoniae*
(6) Microscopic exam findings of a gram-stained specimen*
(a) > 5 squamous epithelial cells is a contaminated specimen.
(b) < 5 squamous epithelial cells and > 25 PMNs is an adequate specimen.
(c) A predominate bacterial form suggests infection; sensitivity is 40-60%.

order sputum culture

(7) Smears for AFB should be done in patients at risk for TB (immigrants, patients with AIDS, IV drug abusers).

e. Blood cultures
(1) A CMS core compentency requirement to be ordered on all admitted patients for pneumonia.
(2) Only be ordered in patients who are seriously ill as well as those with presumed bacteremia, comorbid disease, immunosuppression or rigors.
(3) "Routine" cultures on patients with pneumonia are discouraged due to a low yield of clinically useful data.

f. Pleural fluid aspiration, although not generally an ED procedure, is helpful in excluding empyema and, in the case of a large pleural effusion, drainage can reduce respiratory embarrassment as well. With smaller effusions, determination of the fluid pH is helpful in determining treatment: pH > 7.3 → antibiotics; pH < 7.3 → drainage.

3. Pneumococcal pneumonia
a. Etiology
(1) Caused by *S. pneumoniae*, a gram-positive lancet-shaped, encapsulated diplococcus.
(2) At least 83 serotypes have been isolated:
(a) Types 1,3,4,6,7,8,12,14,18,19 = adult disease
(b) Types 1,6,14,19 = children's disease

b. Most common cause of community-acquired bacterial pneumonia and the number one cause of bacterial pneumonia in HIV-infected patients.
(1) Occurs 1 in 500 persons annually.
(2) Peak incidence is in winter/early spring.
(3) Mortality rate is < 5% if treated, but up to 30% if left untreated.
(4) Pneumococcal vaccine has changed the epidemiology of this disease; the most common strain in 2009 was type 19A, which is resistant to ceftriaxone. Still, if one looks at all *S. pneumoniae* infections, over 90% are sensitive to ceftriaxone.

* Sputum gram stain results are helpful in making therapeutic decisions in only about one-third of patients.

c. Classic Clinical Scenario
The patient appears acutely ill and he can usually tell you exactly when he became very ill (abrupt onset). The presence of tachypnea and tachycardia is coupled with sharp pleuritic chest pain associated with marked splinting on the affected side. There may be a history of a single acute **shaking chill** followed by a cough productive of a rust-colored sputum. Flank or back pain, anorexia and vomiting are additional symptoms. On physical exam, the skin may be cyanotic or jaundiced, auscultation reveals crackles in the involved region and there are signs of pulmonary consolidation (bronchial breath sounds, egophony, increased tactile and vocal fremitus). If you listen carefully, you may also pick up a pleural friction rub.

d. Diagnostic studies
   (1) WBCs 12,000-25,000 but may be higher; a low count suggests severe sepsis.
   (2) Chest radiograph
      (a) Single lobar infiltrate (patchy in infants and the elderly)
      (b) Bulging fissures are occasionally present.
      (c) Pleural effusion (25%)
   (3) Sputum
      (a) Gram stain reveals a single predominate gram-positive organism in pairs or chains.
      (b) Sputum culture is positive in 50% and blood cultures are positive in 30% of cases.

e. Treatment (See algorithm next page)
   (1) Despite the prevalence of increasingly resistant strains (up to 40%), penicillin is still the drug of choice.
   (2) Macrolides or doxycycline are preferred for uncomplicated infections in outpatients.
   (3) Fluoroquinolones are no longer recommended for emperic outpatient therapy in otherwise healthy patients; they are reserved for outpatients with comorbidities (COPD, diabetes, renal failure, CHF or malignancies) and for those who have recently received antibiotics for another infection.
   (4) For those patients requiring IV therapy, one of the following protocols is recommended:
      (a) Cefotaxime or ceftriaxone and a macrolide* or
      (b) Monotherapy with an extended spectrum fluoroquinolone
   (5) For inpatients with one of the following conditions requiring general medical admission:
      (a) Suspected aspiration with infection → amoxicillin-clavulanate or clindamycin
      (b) Recent antibiotic therapy for another condition → azithromycin or clarithromycin plus a beta-lactam or a respiratory fluoroquinolone alone — the regimen selected will depend on the nature of the recent antibiotic therapy.

* Preferred regimen by the CDC