Community-Acquired Pneumonia

(See also *Harrison's Principles of Internal Medicine*, 17th Edition, Chapter 251)

Definition

- Community-acquired pneumonia (CAP) is an infection of the alveoli, distal airways, and interstitium of the lungs that occurs outside the hospital setting.
  - See also Hospital-Acquired Pneumonia.
- Characterized clinically by:
  - Fever, chills, cough, pleuritic chest pain, sputum production
  - At least one opacity on chest radiography
- Manifests as four general patterns
  - *Lobar pneumonia*: involvement of an entire lung lobe
  - *Bronchopneumonia*: patchy consolidation in one or several lobes, usually in dependent lower or posterior portions centered around bronchi and bronchioles
  - *Interstitial pneumonia*: inflammation of the interstitium, including the alveolar walls and connective tissue around the bronchovascular tree
  - *Miliary pneumonia*: numerous discrete lesions due to hematogenous spread

Epidemiology

- Incidence: U.S.
  - 800–1500 cases per 100,000 persons annually
  - Affects 4 million adults per year
    - ~20% require hospitalization.
  - Annual cost: $9.7 billion
- Age
  - Incidence highest at extremes of age
- Sex
  - Rate higher among men than among women
- Race
  - More common among African Americans than among whites
- Seasonality
  - More common during the winter months

Risk Factors

- Independent risk factors for CAP include:
  - Alcoholism [relative risk (RR) 9]
  - Asthma (RR 4.2)
  - Immunosuppression (RR 1.9)
  - Age >70 years (RR 1.5 vs. 60–69 years)
- Risk factors for pneumococcal pneumonia include:
  - Dementia
  - Seizures
  - Congestive heart failure
  - Cerebrovascular disease

    - Tobacco smoking
    - Alcoholism
    - Chronic obstructive pulmonary disease (COPD)
    - HIV infection
        - Risk up to 40 times that in age-matched patients not infected with HIV
- Risk factors for invasive pneumococcal disease include:
    - Male gender
    - African-American race
    - Chronic illness
    - Current tobacco smoking (strongest independent predictor among immunocompetent young adults)
    - Passive exposure to tobacco smoke
    - Immunologic defects
        - Multiple myeloma
        - Nephrotic syndrome with low serum immune globulin levels
        - Splenectomy
        - HIV infection
        - Others
- Risk factors for Legionnaires' disease include:
    - Male gender
    - Current tobacco smoking
    - Diabetes
    - Hematologic malignancy
    - Cancer
    - End-stage renal disease
    - HIV infection
- Risk factors for gram-negative bacterial pneumonia (including that caused by *Pseudomonas aeruginosa*)
    - Probable aspiration
    - Previous hospital admission
    - Previous antimicrobial treatment
    - Bronchiectasis
    - Neutropenia
- Alcohol use
    - Heavy drinkers (i.e., those consuming >100 g of ethanol per day for the preceding 2 years)
        - Higher incidence of gram-negative bacterial pneumonia
        - Worse clinical symptoms
        - Require longer courses of IV antibiotic therapy than do nondrinkers
    - More prolonged fever, slower resolution, and a higher rate of empyema have been noted in pneumococcal pneumonia patients with chronic alcoholism than in their nondrinking counterparts.
    - The clinical entity designated ALPS—alcoholism, leukopenia, and pneumococcal sepsis—is associated with a mortality rate of 80%.
    - Excessive alcohol use is an independent risk factor for the development of acute respiratory distress syndrome (ARDS).

Etiology

- Most cases of CAP are caused by a few common respiratory pathogens, including:
    - *Streptococcus pneumoniae*
        - Accounts for ~50% of all cases of CAP requiring hospital admission
    - *Haemophilus influenzae*
    - *Staphylococcus aureus*
    - *Mycoplasma pneumoniae*

    - *Chlamydia pneumoniae*
    - *Moraxella catarrhalis*
    - *Legionella* spp.
    - Aerobic gram-negative bacteria
    - Influenza viruses
    - Adenoviruses
    - Respiratory syncytial virus
    - Other rare organisms
        - Viral: hantavirus, Nipah virus, Hendra virus, metapneumovirus, severe acute respiratory syndrome (SARS) virus
        - Nonviral: Pneumocystis, *Mycobacterium tuberculosis* , fungi, bioterrorism agents (e.g., those of Q fever, tularemia, anthrax, plague), etc.
- The relative frequency of these pathogens differs with the age of the patient and the severity of the pneumonia.
- Pathogenesis
    - Microaspiration of oropharyngeal secretions colonized with pathogenic microorganisms (e.g., S. pneumoniae, *H. influenzae*) is the most common route.
    - Gross aspiration
        - Central nervous system disorders that affect swallowing (e.g., stroke, seizures)
        - Impaired consciousness (e.g., in alcoholism, IV drug use)
        - Anesthesia or intubation
        - Pathogens include anaerobic organisms and gram-negative bacilli.
    - Aerosolization (e.g., of *M. tuberculosis*, *Legionella* spp., viruses)
    - Hematogenous spread (e.g., seeding of the lungs by *S. aureus* during endocarditis)
    - Contiguous spread from another site

Associated Conditions

- Infections with encapsulated organisms such as *S. pneumoniae*, *H. influenzae*, and *Neisseria meningitidis* may suggest underlying immunodeficiency due to multiple myeloma, nephrotic syndrome, etc.
- Pneumococcal CAP is particularly common among patients with HIV infection.

Symptoms & Signs

- History
    - Most typical signs/symptoms
        - Fever
        - Cough (nonproductive or productive of purulent sputum)
        - Pleuritic chest pain
        - Chills and/or rigors
        - Dyspnea
    - Frequent signs/symptoms
        - Headache
        - Nausea
        - Vomiting
        - Diarrhea
        - Fatigue
        - Arthralgia/myalgia
        - Falls and new-onset or worsening confusion (in elderly patients)

- Physical findings
  - Fever
  - Tachypnea
    - In two studies, patients with a respiratory rate of >25/min had a pneumonia likelihood ratio of 1.5–3.4.
  - Tachycardia
    - Patients with a heart rate of ≥100/min, a temperature of ≥37.8°C, and a respiratory rate of ≥20/min were 5 times more likely to have pneumonia than patients without these findings in one study.
  - Chest examination
    - Dullness to percussion
    - Increased tactile and vocal fremitus
    - Egophony
    - Whispering pectoriloquy
    - Crackles
    - Pleural friction rub

Differential Diagnosis

- Infections
  - Lung abscess
  - Bronchitis
- Noninfectious illnesses
  - Pulmonary embolism
  - Pulmonary hemorrhage
  - Pulmonary edema
  - Pulmonary fibrosis/scarring
  - Inflammatory disorders
    - Sarcoidosis
    - Wegener's granulomatosis
    - Other rheumatologic/vasculitic diseases
  - Lung cancer
  - Hypersensitivity pneumonitis
  - Bronchiolitis obliterans organizing pneumonia
  - Others

Diagnostic Approach

- Assess pneumonia severity.
  - Pay attention to vital signs, including oxygen saturation.
  - Always count the respiratory rate yourself for 1 min.
    - The single most useful clinical sign of severity is a respiratory rate of >30/min in a person without underlying lung disease.
  - Ensure adequate oxygenation and support of circulation during the evaluation.
- Consider possible etiologies.
  - Carefully collect information on:
    - Travel
    - Occupational and other exposures
    - Underlying illnesses
    - Prior infections
  - Never forget tuberculosis and *Pneumocystis* infection as possible etiologies.
  - Consider pulmonary embolus in all patients with pleuritic chest pain.
- Perform etiologic workup.
  - Chest x-ray
  - Sputum stains and cultures

- Blood cultures, if bacteremia is likely
- Urine antigen tests for *S. pneumoniae* and *Legionella pneumophila* type 1 can be helpful.
- Serology can be helpful in identifying certain pathogens.

Laboratory Tests

Nonspecific studies

- Assessment of the severity of pneumonia and coexisting disease
  - Arterial blood gas
  - Complete blood count
  - Serum electrolyte and glucose measurements
  - Blood urea nitrogen (BUN) and creatinine measurements

Sputum stains and culture

- Gram's stain
  - Useful in screening a sputum sample for suitability for culture and in making a presumptive etiologic diagnosis
    - A sputum sample with >25 white blood cells (WBCs) and <10 squamous epithelial cells per low-power field is suitable for culture.
    - Significant interobserver variability exists in the interpretation of gram-stained sputum smears.
  - The presence of any gram-positive diplococci has a sensitivity of 100% but a specificity of 0 for a diagnosis of pneumococcal infection.
    - The presence of >10 gram-positive diplococci per oil-immersion field has a sensitivity of 55% and a specificity of 85% for this diagnosis.
- Other sputum stains that may be helpful in some patients
  - Stains for
    - Acid-fast bacilli
    - *Pneumocystis*
    - Fungi
    - Cytology
  - Rapid antigen testing for viral pathogens (e.g., influenza)
- Culture
  - Results should always be correlated with those of Gram staining.
    - If an organism is isolated from sputum and its morphologic correlate is not seen on Gram staining, the isolate may be colonizing the upper airway.
  - Certain microorganisms, if isolated from sputum, should always be considered pathogens. These include:
    - *M. tuberculosis*
    - *Legionella* spp.
    - *Blastomyces dermatitidis*
    - *Histoplasma capsulatum*
    - *Coccidioides immitis*
  - Only about one-third of elderly patients admitted with CAP produce sputum suitable for culture.
    - One-third of these specimens fail to yield a pathogen.

Blood culture

- Blood should be obtained for culture from patients to be treated on an ambulatory basis if they have been receiving antibiotic therapy and have presented because of any of the following:
    - Hyperthermia (body temperature >38.5°C)
    - Hypothermia (body temperature <36°C)
    - Homelessness
    - Alcohol abuse
- All patients admitted to the hospital for CAP should have 2 sets of blood cultures done before initiation of antibiotic therapy (positivity rate: 6–20%).
- The most common isolates, in descending order, are *S. pneumoniae* (~60%), *S. aureus*, and *Escherichia coli* .

Detection of antigens of pulmonary pathogens in urine

- *L. pneumophila* (see Legionellosis)
    - Serogroup 1 antigen can be detected in the urine of patients with Legionnaires' disease by enzyme-linked immunosorbent assay (ELISA).
        - Sensitivity: 69–72% on average, 88–100% in severe disease, 40–53% in mild disease
        - Sensitivity: low in nosocomial Legionnaires' disease
        - The results may be negative early in the illness, and antigen excretion can be prolonged.
    - This test should be used for patients in whom Legionnaires' disease is strongly suspected, including those with rapidly progressive pneumonia.
    - The urine antigen test is now the most frequently used diagnostic method for Legionnaires' disease.
    - Infection with *Legionella* spp. other than *L. pneumophila* serogroup 1 gives a negative test result.
- *S. pneumoniae*
    - Urinary antigen detection by ELISA has a sensitivity of 80% and a specificity of 97–100% in patients with bacteremic pneumococcal pneumonia.
        - The antigen may be detected for up to 1 month after the onset of pneumonia, and the results can be available in 15 min.
        - In children, nasopharyngeal carriage of *S. pneumoniae* can result in a positive urinary antigen test.

Serology

- Detection of IgM antibody or demonstration of a 4-fold rise in titer of antibody to a particular agent between acute- and convalescent-phase serum samples generally is considered good evidence that this agent is the cause of CAP.
- The following etiologic agents often are diagnosed serologically:
    - *M. pneumoniae*
    - *C. pneumoniae*
    - *Chlamydia psittaci*
    - *Legionella* spp.
    - *Coxiella burnetii*
    - Adenovirus
    - Parainfluenza viruses
    - Influenza virus A
- The serologic tests include complement fixation, indirect immunofluorescence, and ELISA.
- Separate IgM and IgG antibody detection tests can be performed with the latter 2 assays.

- One difficulty in relying on serology is that a polyclonal antibody response to one agent may result in a 4-fold rise in antibody titer to others.
    - Thus, results may be nonspecific.
- Serologic testing is not recommended for routine use.
    - If agents such as *C. burnetii* are suspected, serologic testing is necessary.
    - Serology is a useful part of the workup of outbreaks of pneumonia associated with negative blood and sputum cultures.

Polymerase chain reaction (PCR)

- Amplification of the DNA or RNA of microorganisms that are not part of the pharyngeal flora (from microbial cells collected by throat swab) has been used to infer that the implicated microorganism is the cause of pneumonia.
- A multiplex PCR allows detection of DNA of *Legionella* spp., *M. pneumoniae*, and *C. pneumoniae.*
- This test is expensive and is not routinely available.

Imaging

- Chest x-ray
    - Diagnostic test of choice for pneumonia
    - May show lobar consolidation, interstitial infiltrates, cavitation, associated pleural fluid, etc.
    - Occasionally, an etiologic diagnosis is suggested by chest radiography findings.
        - A cavitating upper-lobe lesion raises the likelihood of tuberculosis.
        - Pneumatoceles suggest *S. aureus* pneumonia.
        - An air-fluid level suggests a pulmonary abscess, which often is polymicrobial.
        - In the immunocompromised host, a crescent (meniscus) sign suggests aspergillosis.
    - In most instances, no etiologic inference can be made from radiographic abnormalities, despite the traditional teaching that a lobar vs. interstitial appearance may be more suggestive of "typical" bacterial vs. "atypical" bacterial or nonbacterial etiologies.
    - If pneumonia is strongly suspected on clinical grounds and no opacity is seen on the initial chest radiograph, it is useful to repeat the radiograph in 24–48 hours or to perform CT.
        - Correction of dehydration may lead to development of chest film infiltrates.
    - Opacity visible on the chest radiograph may not be due to pneumonia; many other disease processes can result in opacities (see Differential Diagnosis).
- High-resolution CT
    - Occasionally detects pulmonary opacities in patients with symptoms and signs suggestive of pneumonia and negative chest x-ray
    - More likely than chest radiography to show bilateral involvement, pleural fluid/empyema, adenopathy, etc.

Diagnostic Procedures

- Thoracentesis
    - If a pleural effusion of >1 cm is detected on lateral decubitus chest x-ray, the fluid should be sampled for studies including Gram's stain, culture, cell counts, and measurements of protein, lactate dehydrogenase (LDH), glucose, and pH.
    - See Pleuritis.

- Bronchoscopy/bronchoalveolar lavage/lung biopsy:
  - May be required to obtain material for further studies when the diagnosis defies other diagnostic efforts and the patient does not improve despite empirical therapy

Treatment Approach

- Site of care: 3-step process recommended in IDSA guidelines (2003)
  - Assessment of preexisting conditions that compromise safety of home care (e.g., baseline cognitive function, coexisting conditions, hemodynamic instability, ability to take oral medications)
  - Calculation of the pneumonia PORT (Pneumonia Outcomes Research Team) Severity Index (PSI)
    - Risk classes are based on age, gender, place of residence (nursing home or not), coexisting illness, physical examination findings, and laboratory/radiographic data.
    - Algorithm to calculate score: http://www.chestx-ray.com/Practice/PORT/PORT.html
    - Home care is recommended for patients in risk classes I, II, and III.
    - Patients in risk class IV or V generally should be admitted to the hospital.
  - Clinical judgment: other factors suggesting the need for inpatient treatment
    - Older age (especially when patients are nursing home residents)
    - Social issues (e.g., homelessness, substance abuse) that may compromise outpatient recovery
    - Respiratory rate of >28/min
    - Systolic blood pressure of <90 mmHg or 30 mmHg below baseline
    - Altered mental status
    - Hypoxemia: P_{O2} of <60 mmHg while patient is breathing room air or oxygen saturation of <90%
    - Unstable comorbid illness (e.g., decompensated congestive heart failure, uncontrolled diabetes mellitus, alcoholism, immunosuppression)
    - Multilobar pneumonia, if hypoxemia is present
    - Pleural effusion that is >1 cm on lateral decubitus chest x-ray and has the characteristics of a complicated parapneumonic effusion on pleural fluid analysis
- Antibiotic therapy
  - Factors that lower the mortality rate include:
    - Antibiotic administration within 8 h of arrival in the emergency room
    - Use of ≥2 agents in bacteremic pneumococcal pneumonia
  - Guidelines recommend empirical treatment based on:
    - Likely pathogens
    - Clinical trials showing efficacy of agents
    - Risk factors for antimicrobial resistance (e.g., age >65 years, β-lactam therapy within the past 3 months, alcoholism, immunosuppressive illness, multiple medical comorbidities, exposure to a child in a day-care center)
    - Medical comorbidities (may influence the likelihood of a specific pathogen's involvement and contribute to clinical failure)
    - Severity of illness (inpatient vs. outpatient treatment, medical ward vs. ICU care)
  - IV antibiotics can be switched to oral agents when:
    - The WBC count is returning toward normal.
    - Two temperature readings taken 16 h apart are normal.
    - The patient's clinical condition has improved and the patient can take oral medications with adequate absorption.

- Other issues
  - Assess risk of aspiration.
  - Counsel about smoking cessation.
  - Assess vaccination status (influenza, pneumococcus).
  - Consider end-of-life decision making.
  - Optimize immune function if the patient is immunosuppressed.

Specific Treatments

Outpatient (dosing for adults with normal renal function)

- Patients with no comorbidities and no risk factors for drug-resistant *S. pneumoniae* (DSRP) infection
  - Clarithromycin XL (1000 mg PO qd for 7 days) **or**
  - Azithromycin (500 mg PO once, then 250 mg/d PO for 4 days or 500 mg/d PO for 3 days or 2 g PO once) **or**
  - Doxycycline (100 mg PO bid for 7–10 days)
- Patients with comorbidities (COPD, diabetes, renal or congestive heart failure, malignancy) and/or risk factors for DRSP infection **or** a high DRSP prevalence in the community
  - One of the following
    - Quinolone with enhanced activity against *S. pneumoniae*
      - Levofloxacin (500–750 mg PO qd) **or**
      - Moxifloxacin (400 mg PO qd) **or**
      - Gatifloxacin (400 mg PO qd)
    - β-lactam (cefpodoxime, 200 mg PO bid; or cefprozil, 500 mg PO bid; or amoxicillin, 1000 mg PO tid; or amoxicillin/clavulanic acid, 875/175 mg PO tid or 1000/62.5 mg PO tid) **plus**
      - Macrolide (clarithromycin or azithromycin dosed as above) **or**
      - Doxycycline dosed as above
    - Telithromycin (800 mg q24h for 7–10 days)

Hospital ward (dosing for adults with normal renal function)

- Quinolone with enhanced activity against *S. pneumoniae* (see above) **or**
- Azithromycin (1 g IV; then, 24 h later, start 500 mg IV q24h) **plus**
  - β-lactam
    - Cefuroxime (750 mg IV q8h) **or**
    - Ceftriaxone (1–2 g IV qd) **or**
    - Cefotaxime (1–2 g IV q6–8h) **or**
    - Ampicillin/sulbactam (1.5–3 g IV q6h)

ICU (dosing for adults with normal renal function)

- Patients with no risk factors for *P. aeruginosa* infection
  - β-lactam (ceftriaxone, 1–2 g IV q24h; or cefotaxime, 1–2 g IV q6–8h) **plus**
    - Quinolone IV (dosed as above) **or**
    - Azithromycin (1 g IV; then, 24 h later, start 500 mg IV q24h)
- Patients with risk factors for *P. aeruginosa* (e.g., bronchiectasis, malnutrition, treatment with >10 mg of prednisone qd, HIV infection, broad-spectrum antibiotic therapy for >7 days in the past month, prior *P. aeruginosa* infection)
  - Carbapenem **or** antipseudomonal cephalosporin **or** piperacillin/tazobactam (doses below) **plus**
    - Quinolone dosed as above **or**
    - Azithromycin (1 g IV; then, 24 h later, start 500 mg IV q24h)

    - Dosing
        - Carbapenem: imipenem, 500 mg IV q6h; or meropenem, 1g IV q8h
        - Antipseudomonal cephalosporin: cefepime, 2 g IV q8h; or ceftazidime, 2 g IV q8h
        - Piperacillin/tazobactam: 4.5 g IV q6h
- Severely ill patients
    - Consider coverage for methicillin-resistant *S. aureus* (MRSA) as well (vancomycin, 1 g IV q12h) until microbiology data become available.
- Monotherapy with a quinolone is not recommended for severely ill patients with CAP.
- Note: Quinolone treatment is not recommended for patients with pneumococcal meningitis.

Nursing home treatment (dosing for adults with normal renal function)

- As for outpatients with comorbidities or risk factors for DRSP (see above)
- May use ceftriaxone (500–1000 mg/d IM) or cefotaxime (500 mg IM q12h) in place of PO β-lactam
- Patients from a nursing home who are admitted to the hospital with pneumonia should be treated the same as other hospitalized/ICU patients.

Aspiration pneumonitis (dosing for adults with normal renal function)

- Aspiration pneumonitis (presumed to be due to effects of gastric acid or other irritants)
    - Wait 24 h.
    - If symptoms persist, give antibiotic therapy delineated below for aspiration pneumonia.
- Aspiration pneumonia; poor dental hygiene or putrid sputum, alcoholism (anaerobic infection suspected)
    - Quinolone, ceftriaxone, or cefotaxime (doses as above) plus anaerobic coverage
        - Clindamycin (450 mg PO qid or 300–900 mg IV q6–12h) **or**
        - Metronidazole (500 mg q12h PO) **or**
        - β-lactam (piperacillin/tazobactam, 4.5 g IV q6h; or ampicillin/sulbactam, 1.5–3 g IV q6h) **or**
        - Imipenem (500 mg IV q6h)
- Aspiration pneumonia, community-acquired
    - Levofloxacin, moxifloxacin, gatifloxacin, ceftriaxone, or cefotaxime
- Concomitant meningitis (suspected pneumococcal)
    - Vancomycin (1 g IV q12h) **plus**
    - Ceftriaxone (2 g IV q12h)

Monitoring

- Outpatients
    - Follow up by telephone within 48 h.
        - Most patients feel better by this time.
        - ~10% are unchanged.
        - ~5% feel worse and should be reassessed by a physician.
        - Patients should receive written information about warning signs of pneumonia exacerbation, including:
            - Shortness of breath while walking on level ground (assuming no underlying lung disease)
            - Temperature of >38.5°C (101.3°F) after 72 h of antibiotic therapy
            - New onset of confusion or pleuritic chest pain
            - Hemoptysis

- Inpatients
  - Monitor temperature curve and WBC count for resolution.
    - Follow up on culture results and adjust therapy accordingly.
    - Watch for superinfection with *S. aureus.*
    - Monitor comorbid conditions (e.g., COPD, renal disease)
- Follow up to ensure radiographic clearance of pneumonia.
  - All patients >40 years old and all tobacco smokers should have a follow-up chest radiograph to document pneumonia resolution, which may lag behind clinical improvement for several weeks.
    - Nonsmokers <50 years old who lack underlying lung disease: 6 weeks
    - Elderly patients with COPD: 8–12 weeks
  - Up to 2% of patients hospitalized with CAP have cancer in the lung (with pneumonia distal to an obstructed bronchus)
    - 50% of these cancers are evident on the initial chest film.
    - 50% manifest as failure of pneumonia resolution and are diagnosed at bronchoscopic evaluation for unresolving pneumonia.
- Considerations when pneumonia fails to improve despite treatment
  - Reconsider the diagnosis.
    - Is another illness presenting as pneumonia?
      - For example, collagen vascular diseases involving the lung often are initially diagnosed as pneumonia.
    - Are you treating the wrong pathogen?
      - For example, if you are treating conventional bacterial causes of pneumonia, is this case actually due to *M. tuberculosis* or to *Pneumocystis* or another fungus?
    - Are you treating the right pathogen with the wrong drug?
      - For example, if you are using nafcillin or cloxacillin to treat *S. aureus* and your patient is infected with MRSA, you should be using vancomycin or linezolid.
  - Is there a mechanical reason for the patient's failure to improve (e.g., an obstructed bronchus due to carcinoma or sequestration of a segment of the lung)?
  - Have you overlooked an undrained or metastatic pyogenic focus (e.g., empyema, brain abscess, endocarditis, splenic abscess, osteomyelitis)?
  - Does the patient have drug-associated fever?
- Workup when pneumonia fails to improve
  - Careful physical examination
  - Blood, urine, and sputum cultures
  - Repeat chest film
  - Chest CT
  - Bronchoalveolar lavage to obtain fluid for microbiologic studies and cytology

Complications

General complications

- Since most patients hospitalized with pneumonia are elderly and have multiple comorbid conditions, complications during the hospital stay are not uncommon.
- The most common complications are:
  - Respiratory failure
  - Congestive heart failure
  - Shock
  - Atrial dysrhythmias
  - Myocardial infarction
  - Gastrointestinal bleeding
  - Renal insufficiency

- Only ~30% of patients hospitalized for the treatment of pneumonia have no complications.
- The major systemic complication is bacteremia.
    - Can lead to metastatic infection, including septic arthritis or meningitis

Complicated pleural effusion

- Pleural effusion is seen in ~40% of patients hospitalized for CAP.
- All patients with a pleural effusion should have a lateral decubitus chest radiograph with the affected side down.
- If the effusion is >1 cm, the fluid should be aspirated.
- If the fluid has a pH of <7, a glucose level of <2.2 mmol/L, and an LDH content of >1000 units and is positive on Gram's staining or culture, it should be drained.
- If frank pus is aspirated, insertion of a large-bore chest tube is recommended.
    - Loculated collections may be manageable with multiple chest tubes placed into loculated compartments.
    - The utility of treatment with intrapleural lytic agents is controversial.
- The goal is eradication of the collection.
    - Follow-up with postdrainage imaging is required to confirm adequate catheter placement and complete pleural fluid drainage.
- Thoracotomy and decortication may be necessary.
- All patients with a complicated pleural effusion, as defined above, should have a consultation with a thoracic surgeon.

Lung abscess

- Incidence
    - Uncommon; 4–5 cases/10,000 hospital admissions
- Risk factors
    - Conditions associated with impaired cough reflex and/or aspiration, such as alcoholism, anesthesia, drug abuse, epilepsy, and stroke
    - Dental caries
    - Bronchiectasis
    - Bronchial carcinoma
    - Pulmonary infarction
- Etiology
    - Most aspiration-associated lung abscesses are due to a combination of aerobic and anaerobic bacteria.
    - On average, 6 or 7 bacterial species are identified in an individual case.
    - Anaerobic bacteria include:
        - *Bacteroides fragilis* group
        - *Bacteroides gracilis*
        - *Prevotella* spp. (*intermedia, denticola, melaninogenicus*, *oralis*)
        - *Fusobacterium nucleatum*
        - *Peptostreptococcus* spp. (*micros*, *anaerobius*, *magnus*)
    - Aerobic pathogens include:
        - *Streptococcus milleri* (one of the principal pathogens)
        - *S. aureus*
        - *S. pneumoniae*
        - *H. influenzae*
        - *P. aeruginosa*
        - *E. coli*
        - *Klebsiella pneumoniae*
    - Rarely, *S. pneumoniae* alone (usually capsular type 3) can cause a lung abscess.
    - In HIV-infected patients, lung abscesses can be due to *Pneumocystis*, *Rhodococcus equi*, and *Cryptococcus neoformans* as well as the bacteria noted above.

- See Lung Abscesses and Empyema for further details, including treatment.

Recurrent pneumonia

- Of patients hospitalized for the treatment of CAP, 10–15% have another episode within 2 years.
- If the recurrence affects the same anatomical location as the previous episode, the most likely cause is an obstructed bronchus due to either a tumor or a foreign body.
- COPD and repeated macroaspiration are the most common causes of recurrent pneumonia.
- Persons without COPD, with pneumonia in a different location from the previous episode, and with no risk factors for aspiration should undergo evaluation for immunodeficiency (including HIV testing), immunoglobulin determination, protein electrophoresis, and enumeration of T and B cells.
- CT of the chest often detects pulmonary anatomical defects (e.g., bronchiectasis) that might be the cause of the recurrence.

Prognosis

- Outpatients
  - Young, otherwise healthy adults
    - Those treated as outpatients usually feel well enough to return to work in 4 or 5 days; almost all recover in 2 weeks.
    - Those with relatively severe symptoms may require longer to recover.
  - ~2–4% of those treated as outpatients experience a progression of symptoms and require hospital admission.
- Inpatients
  - Patients generally stabilize within 3–7 days.
  - The in-hospital mortality rate from pneumonia is ~8%.
    - The most common immediate causes of death are respiratory failure, heart disease, and sepsis.
    - ~50% of deaths are related to pneumonia and ~50% to comorbid illnesses.
    - Pneumonia-related deaths are much more likely to occur during the first week of hospitalization.
    - Increasing age and evidence of aspiration independently predict both pneumonia-related and comorbidity-related mortality.
  - Factors independently associated with pneumonia-unrelated mortality include:
    - Dementia
    - Immunosuppression
    - Active cancer
    - Systolic hypotension
    - Male gender
    - Multilobar pulmonary infiltrates
  - Mortality associated with PORT score (see Treatment Approach)
    - Class I: 0–0.5%
    - Class II: 0.4–0.9%
    - Class III: 0–1.25%
    - Class IV: 9.0–12.5%
    - Class V: 27.1%
- Mortality is related to the specific etiology.
  - Rates are highest (>50%) for *P. aeruginosa*, followed by *Klebsiella* spp., *E. coli*, *S. aureus*, and *Acinetobacter* spp. (all 30–35%).
  - Pneumococcal capsular serotype 3 is associated with a much higher mortality rate than serotype 1, as are group A streptococcal M serotypes 1 and 3 (compared with other serotypes).
- Early, appropriate antibiotic therapy is associated with decreased mortality rates.

Prevention

- Influenza and pneumococcal vaccination status should be ascertained and vaccines offered when appropriate.
- All patients with pneumonia who are tobacco smokers should be encouraged to join smoking cessation programs.
- When a patient is prone to aspiration, preventive measures should be taken, including attention to oral hygiene.
- Only sterile water should be used in humidifiers in long-term-care facilities.
- Antimicrobial prophylaxis should be given in special situations—for example:
    - Latent tuberculosis prophylaxis (see Tuberculosis)
    - *Pneumocystis* prophylaxis for selected immunocompromised patients (see Pneumocystis Infections)

ICD-9-CM

- 486 Pneumonia, organism unspecified Community-Acquired Pneumonia

See Also

- Empyema
- *Escherichia coli* Infections
- *Haemophilus influenzae* Infections
- Hospital-Acquired Pneumonia
- Legionellosis
- Lung Abscesses
- *Mycoplasma pneumoniae* Infections
- Miscellaneous Gram-Negative Bacterial Infections
- Pneumococcal Infections

Internet Sites

- Professionals
    - Infectious Disease Information - Pneumonia
      National Center for Infectious Diseases, CDC
- Patients
    - Pneumonia
      MedlinePlus
    - Pneumonia Fact Sheet
      American Lung Association

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PEARLS

- The finding of bullous myringitis, which occurs in 5% of patients with *M. pneumoniae* infection, is approximately equal to serologic testing in its specificity for the diagnosis of this infection.
- Patients with recurrent episodes of CAP should be evaluated for aspiration, anatomic abnormality (such as bronchial obstruction/cancer), and immune deficiency (e.g., common variable immunodeficiency, HIV infection, nephrotic syndrome, multiple myeloma).
- Daptomycin should not be used to treat pneumonia; trials have shown inferior outcomes.
- CAP due to *Legionella* spp. or to *P. aeruginosa* (or other aerobic gram-negative bacilli) warrants a longer course of therapy (~21 days) than CAP of other etiologies.
- Consider *C. immitis* and *H. capsulatum* as causes of CAP in patients who have traveled to endemic areas (the southwestern U.S. and the Ohio/St. Lawrence River valleys, respectively).
- Consider melioidosis, tuberculosis, and viral infections (SARS, avian influenza) if the patient has spent time in Southeast Asia.
- Review patients' prior microbiologic isolates to gauge their likelihood of harboring resistant organisms.