Chapter 22

Pulmonary Infections
Objectives

- State the incidence of pneumonia in the United States and its economic impact.

- Discuss the current classification scheme for pneumonia and be able to define hospital-acquired pneumonia, health care–acquired pneumonia, and ventilator-associated pneumonia.

- Recognize the pathophysiology and common causes of lower respiratory tract infections in specific clinical settings.
Objectives (cont.)

- List the common microbiological organisms responsible for community acquired and nosocomial pneumonias.

- Describe the clinical findings seen in patients with pneumonia.

- State the radiographic findings seen in patients with pneumonia; state why some patients with pneumonia may have a normal chest radiograph.

- Describe the risk factors associated with increased morbidity and mortality in patients with pneumonia.
Objectives (cont.)

- State the criteria used to identify an adequate sputum sample for Gram stain and culture.

- Describe the techniques used to identify the organism responsible for a nosocomial pneumonia.

- List the latest recommendations regarding the antibiotic regimens used to treat various types of pneumonia, both empiric and pathogen specific.
Objectives (cont.)

- Discuss strategies that can be used to prevent pneumonia.
- Describe how the respiratory therapist aids in diagnosis and management of patients with suspected pneumonia.
Introduction

- Infection involving the lungs is called “pneumonia” or “lower respiratory tract infection.”
- A major cause of morbidity and mortality in the United States and around the world
- In the United States, about 4 million cases of pneumonia occur each year.
- The sixth leading cause of death in the United States
Classification

- Community-acquired pneumonia (CAP)
  - Acute
  - Chronic

- Health care–associated pneumonia (HCAP)
  - Pneumonia occurring in any patient hospitalized for 2 or more days in the past 90 days or
  - Any patient with pneumonia who, in the past 30 days, has resided in a long-term care facility
Classification (cont.)

- Hospital-acquired pneumonia (HAP)
  - An acute lower respiratory tract infection that occurs in hospitalized patients more than 48 hours after admission
  - Second most common nosocomial infection

- Ventilator-associated pneumonia (VAP)
  - Pneumonia that develops more than 48 to 72 hours after intubation
Pathogenesis

- Inhalation of aerosolized infectious particles
- Aspiration of organisms
- Direct inoculation of organisms into the lower airways
- Spread of infection to the lung from adjacent structures
Pathogenesis (cont.)

- Spread of infection to the lung from the blood
- Reactivation of latent infection, usually resulting from immunosuppression
  - e.g., *Pneumocystis carinii*, reactivation tuberculosis, cytomegalovirus
Clinical Manifestations

- Patients with CAP typically have fever, cough, sputum production, pleuritic chest pain, and dyspnea.

- In the elderly, pneumonia may not cause fever or cough; it may simply present as dyspnea, confusion, worsening of CHF, or failure to thrive.
Clinical Manifestations (cont.)

- VAP traditionally presents with a new onset of fever, purulent endotracheal secretions, and a new infiltrate.

- The diagnosis of HAP can be difficult in the patient with preexisting pulmonary abnormalities on the chest radiograph.
Chest Radiograph

- The diagnosis of pneumonia is established by the presence of a new infiltrate on the chest film. However:
  - Not all outpatients require a chest radiograph.
  - A normal chest x-ray does not exclude the diagnosis of pneumonia.
    - Early pneumonia
    - Dehydration
Chest Radiograph (cont.)

- Consolidation of an entire lobe is called “lobar pneumonia."
- “Bronchopneumonia” refers to the presence of a patchy infiltrate surrounding one or more bronchi.
- Both patterns suggest a bacterial pathogen.
- Pleural effusions are common in bacterial pneumonia.
Chest Radiograph (cont.)

- Interstitial infiltrates suggest viral disease, *P. jiroveci*, or miliary tuberculosis.

- Cavitary infiltrates are seen in reactivation tuberculosis and some fungal infections.

- The chest radiograph is less helpful in the diagnosis of VAP because the patient often has other causes of pulmonary infiltrates.
Risk Factors for Mortality/Assessing the Need for Hospitalization

- Many cases of CAP can be treated on an outpatient basis.
- The challenge is to identify those patients at higher risk who need hospitalization.
Risk Factors for Mortality/Assessing the Need for Hospitalization (cont.)

- Risk of death in pneumonia is increased in:
  - Male patients
  - Hypotension
  - Tachypnea
  - Diabetes
  - Cancer
  - Neurologic disease
  - Bacteremia
  - Leukopenia
  - Multiple lobe involvement
Diagnostic Studies

Box 22-2

Recommended Tests for Adults With Community-Acquired Pneumonia Warranting Consideration of Hospitalization

- Chest radiograph
- Complete blood count
- Blood chemistries
  - Glucose
  - Serum sodium
  - Blood urea nitrogen
- Arterial blood gas
- Sputum Gram stain and culture
- Additional sputum studies as clinically indicated
  - Acid-fast stains and culture for mycobacteria
  - Potassium hydroxide examination and fungal culture
  - Stain for Pneumocystis jiroveci
  - Direct fluorescent antibody stain for Legionella spp.
- Blood cultures
- Pleural fluid analysis if sizable effusion is present
  - Cell count with differential
  - Glucose, protein, and lactate dehydrogenase
  - pH
  - Gram stain and routine aerobic and anaerobic culture
  - Acid-fast stain and culture for mycobacteria
- Additional other studies as clinically indicated
  - Legionella urinary antigen
  - Acute and convalescent sera for M. pneumoniae, Legionella spp., and C. pneumoniae
  - Fungal serologies
  - HIV test for individuals aged 15 to 54 years or for those engaging in high-risk behavior
Diagnostic Studies (cont.)

CAP

• Respiratory therapists play a key role in collecting sputum samples for microbiological examination.

• A satisfactory specimen contains >25 leukocytes and <10 squamous epithelial cells per hpf.

• The presence of acid-fast bacilli in stain sputum samples suggests tuberculosis.

• Blood cultures should be obtained in severe cases of pneumonia.
Nosocomial Pneumonias: HAP, HCAP, VAP

- Accurate diagnosis is very difficult.

**Box 22-3  Techniques for Diagnosing Nosocomial Pneumonia**

- Clinical diagnosis
- Direct visualization of the airway by bronchoscopy
- Quantitative cultures of endotracheal aspirates
- Quantitative cultures of protected brush-bronchoscopy specimens
- Quantitative cultures of non-bronchoscopic distally protected specimens
- Quantitative cultures of conventional or protected bronchoalveolar lavage (BAL) specimens, plus microscopic examination of recovered cells
- Quantitative cultures of protected specimen brush and BAL specimens, plus microscopic examination of BAL fluid cells
- Therapist-directed mini-BAL
- Transthoracic fine-needle aspiration
Therapy

- Choice of antibiotic for patient with CAP depends on:
  - Age of the patient
  - Severity of the illness
  - Risk factors for specific organisms
  - Results of initial diagnostic tests

- For hospitalized patients who are not critically ill:
  - An empirical regimen of an advanced macrolide plus a second- or third-generation cephalosporin or a beta-lactam/beta-lactamase inhibitor is recommended.
Therapy (cont.)

- Duration of therapy for CAP is generally 10 – 14 days.

- Legionnaires’ disease requires a minimum of 2 weeks

- The elderly and those with comorbidities may also require longer therapy.
Prevention

- Prevention of CAP centers around immunization.

- Immunization is indicated for individuals:
  - over age 60 years.
  - with chronic lung or heart disease.
Prevention (cont.)

**TABLE 22-10**

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Efficacy</th>
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</thead>
<tbody>
<tr>
<td>Handwashing</td>
<td>Probably effective</td>
</tr>
<tr>
<td>Isolation of patients with resistant organisms</td>
<td>Probably effective</td>
</tr>
<tr>
<td>Infection control and surveillance</td>
<td>Probably effective</td>
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<tr>
<td>Enteral feeding, rather than TPN</td>
<td>Possibly effective</td>
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<tr>
<td>Semierect position</td>
<td>Possibly effective</td>
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<tr>
<td>Sucralfate for bleeding prophylaxis</td>
<td>Possibly effective</td>
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<tr>
<td>Careful handling of respiratory therapy</td>
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<tr>
<td>equipment</td>
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<tr>
<td>Subglottic secretion aspiration</td>
<td>Possibly effective</td>
</tr>
<tr>
<td>Selective digestive decontamination</td>
<td>Unproved efficacy</td>
</tr>
<tr>
<td>Topical tracheobronchial antibiotics</td>
<td>Unproved efficacy</td>
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</tbody>
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*TPN, Total parenteral nutrition.*
Tuberculosis (TB)

- The incidence of TB steadily declined after the introduction of effective antibiotics in the 1950s.

- From 1985 to 1992, the incidence increased due to the emergence of AIDS.

- Since 1992, the incidence of TB has declined again but remains a problem for selected groups of patients (e.g., the immunocompromised, those living in crowded conditions, those with poor access to health care, etc.).
Tuberculosis (cont.)

- TB is acquired by inhalation of airborne droplets containing *M. tuberculosis*.

- Most people exposed to TB do not develop active infection as TB is controlled by an intact immune system.

- People who are positive for TB but asymptomatic are said to have “latent TB”
  - If they subsequently become debilitated it may develop into reactivation TB.
Tuberculosis (cont.)

- People who acquire infection upon initial exposure have “primary TB.”

- Primary TB is most likely to occur in HIV patients.

- Primary TB causes fevers in 70% of patients, that persists for 14 to 21 days in most cases.

- Cough is less common.
Tuberculosis (cont.)

- Chest x-ray usually shows lymphadenopathy, while an infiltrate is seen in 25% of cases.

- In those without HIV infection, reactivation disease accounts for 90% of cases.

- The most common symptoms in reactivation TB include fever, cough, night sweats, and weight loss.

- The chest radiograph shows upper lobe infiltrates in 80% to 90% of reactivation TB cases.
Extrapulmonary TB is defined as spread of the organism beyond the lung and may involve any organ.
- Most often occurs in the CNS, musculoskeletal system, GI tract, and lymph nodes.

The history is vitally important in the diagnosis of patients with TB.
- Clinician should ask about symptoms, exposure, travel, prior history of TB, risk factors, etc.
Tuberculosis (cont.)

- Patients diagnosed or suspected of having TB should be placed in respiratory isolation.

- The gold standard for the diagnosis of TB is culture isolation of the organism.
  - The culture may take 4 to 6 weeks.

- Acid-fast staining of expectorated sputum may be used in the diagnosis.

- A positive PPD skin test supports the diagnosis in the appropriate clinical setting.
A negative skin test may occur in patients with HIV who are infected with TB.

The goals of treatment are to cure the patient and prevent further transmission.

Daily observation therapy should be used.

Isoniazid, rifampin, pyrazinamide, and ethambutol are first-line antibuberculous medications.

Routine treatment should be given for 6 to 9 months.
Role of the Respiratory Therapist in Pulmonary Infections

- Collection of sputum samples as indicated
- Assist with bronchoscopy
- Administer chest physical therapy in selected cases
- Counsel patients in sputum clearance techniques such as PEP and autogenic drainage
- Model optimal infection control practices