Chapter 23

Obstructive Lung Disease: COPD, Asthma, and Related Diseases
Objectives

- State definitions of chronic obstructive pulmonary disease (COPD), emphysema, and chronic bronchitis.

- Identify how many Americans are diagnosed with COPD and how many deaths from COPD occur each year.

- State the two major risk factors associated with the onset of COPD.
Objectives (cont.)

- Identify the common signs and symptoms associated with COPD.

- Describe a treatment plan for the patient with stable COPD and for the patient with an acute exacerbation.

- State the factors associated with the onset of asthma.

- Describe the clinical presentation typical for the patient with asthma.
Objectives (cont.)

- Identify the treatment currently available for the patient with acute asthma.

- Describe the treatment currently available for patients with bronchiectasis.
COPD: Overview and Definitions

- COPD is an inflammatory disorder characterized by not fully reversible, typically progressive, airflow obstruction.

- Composed of two major disease entities
  - Emphysema characterized by
    - Permanent enlargement of distal airspaces
    - Destruction of A/C membranes, without fibrosis
  - Chronic bronchitis characterized by
    - Chronic productive cough for at least 3 months of 2 consecutive years
    - Must exclude other causes of cough
COPD: Epidemiology

- Incidence: ~16 million Americans have COPD
  - 14 million with chronic bronchitis
  - 2 million with emphysema

- COPD is fourth leading cause of death in United States.

- Number of deaths per year has continued to rise over years paralleling (with a lag time) prior smoking trends.
Risk Factors for COPD

**Box 23-1 Causes of COPD**

- Cigarette smoking
- $\alpha_1$-Antitrypsin deficiency†
- Hypocomplementemic urticarial vasculitis
- Intravenous Ritalin abuse
- Ehlers-Danlös syndrome; Marfan syndrome
- Salla disease†
- $\alpha_1$-Antichymotrypsin deficiency†
- HIV (emphysema-like illness)

*Multiple causes (e.g., cigarette smoking and $\alpha_1$-antitrypsin deficiency may coexist in a single patient).
†Putative cause; firm evidence unavailable.
Lung Decline Tied to Smoking
COPD Risk Factors and Pathophysiology

- Cigarette smoking’s impact on COPD mortality and morbidity far outweighs all other factors combined.
- Second most common cause is AAT deficiency
  - Genetic deficiency in AAT results in early onset emphysema.
  - Preventive measures may avoid early onset COPD
    - Smoking cessation key to managing this disorder.
    - Treatment with IV augmentation therapy may prevent neutrophil elastase damage to lung tissue.
COPD Risk Factors and Pathophysiology (cont.)

- Mechanisms of airflow limitation in COPD
  - Inflammation and obstruction of small airways
    - Occurs in airways less than 2 mm in diameter
  - Loss of elasticity
    - Destruction of elastin resulting in destruction of alveolar walls
  - Active bronchospasm
    - Some element of reversibility is noted in two-thirds of COPD patients.
COPD: Signs and Symptoms

- **Common symptoms**
  - Productive cough
  - Wheezing or diminished breath sounds
  - Shortness of breath (SoB) particularly on exertion
  - Progressive dyspnea usually manifesting in 6th or 7th decade of life (AAT deficiency ~45 years of age)

- **Late signs include**
  - Barrel chest with flattened diaphragms
  - Accessory muscle usage
  - Edema from cor pulmonale
  - Changes in mental status due to $\downarrow \text{O}_2$ or $\uparrow \text{CO}_2$
Management of COPD

Establishing the diagnosis with airflow obstruction

- Separating COPD from asthma is the major challenge.

- Features that favor COPD are
  - Chronic productive cough, ↓diffusing capacity
  - Diminished vascularity on chest radiograph

- Asthma favored if the diminished FEV₁ is normalized after use of an inhaled bronchodilator.

- Once COPD established, check for AAT deficiency
Optimizing Lung Function: Stable COPD

- PRN bronchodilator for all COPD patients
  - Sympathomimetic and/or anticholinergic
  - Reversibility if postbronchodilator FEV₁ ↑12%
  - No survival benefit but often improves symptoms

- Systemic corticosteroid trial (6–29% respond)
  - If patient responds (↑FEV₁), use inhaled steroids.
  - Lung decline continues, but decreases exacerbations

- Methylxanthines decrease feeling of dyspnea.
  - Try to avoid toxicity serum levels of 8–10 µg/ml
### Optimizing Lung Function: Stable COPD (cont.)

<table>
<thead>
<tr>
<th>Therapy at Each Stage of COPD</th>
</tr>
</thead>
<tbody>
<tr>
<td>I: Mild</td>
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<tr>
<td></td>
</tr>
<tr>
<td>- FEV&lt;sub&gt;1&lt;/sub&gt;/FVC &lt; 70%</td>
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<tr>
<td>- FEV&lt;sub&gt;1&lt;/sub&gt; ≥ 80%</td>
</tr>
</tbody>
</table>

**Active reduction of risk factor(s); influenza vaccination**

**Add** short-acting bronchodilator (when needed)

**Add** regular treatment with one or more long-acting bronchodilators (when needed); **Add** rehabilitation

**Add** inhaled glucocorticosteroids if repeated exacerbations

**Add** long term oxygen if chronic respiratory failure.

**Consider** surgical treatments

Optimizing Lung Function: Acute Exacerbations

- Inhaled bronchodilators, especially $\beta_2$-agonists

- Oral antibiotics if purulent sputum is present (7–10 days)

- Short course of systemic corticosteroids

- Supplemental oxygen to keep $\text{SaO}_2 > 90\%$

- With hypercapnia (pH < 7.3), NIV is an attractive option.
  - IF it fails, then make decision on intubation and MV
COPD: Maximizing Functional Status

- Primary goal is to maximize ability to perform daily tasks.

- In addition to therapies mentioned previously
  - Comprehensive pulmonary rehabilitation is indicated for all Class II, III, and IV COPD patients.
    - Improves exercise capacity
    - Upper body strength and ventilatory function
Preventing Progression of COPD and Enhancing Survival

- Smoking cessation is first-line intervention.
  - Slows rate of FEV₁ decline to same-age nonsmokers
  - Enhanced survival rates

- Long-term oxygen therapy (LTOT)
  - Survival benefit noted with minimum 15 hours/day
  - The closer to 24 hours/day the better

- Annual influenza and pneumococcal vaccinations

- Some end-stage COPD patients may benefit from lung transplant or lung volume reduction surgery
Preventing Progression of COPD and Enhancing Survival (cont.)

### Box 23-2

**Indications for Long-Term Oxygen Therapy**

I. Continuous oxygen
   A. Resting $\text{PaO}_2$ of $\leq 55$ mm Hg
   B. Resting $\text{PaO}_2$ of 56-59 mm Hg or $\text{Sao}_2$ of 89% in the presence of any of the following:
      1. Dependent edema, suggesting congestive heart failure
      2. $P$ pulmonale on the electrocardiogram ($P$ wave $\geq 3$ mm in standard lead II, III, or aVf)
      3. Erythrocythemia (hematocrit $>56\%$)
         (a) Rembursable only with additional documentation justifying the oxygen prescription and a summary of more conservative therapy that has failed

II. Noncontinuous oxygen
   A. Oxygen flow rate and number of hours per day must be specified
      1. During exercise: $\text{PaO}_2$ of $\leq 55$ mm Hg or $\text{Sao}_2$ of $\leq 88\%$ with a low level of exertion
      2. During sleep: $\text{PaO}_2$ of $\leq 55$ mm Hg or $\text{Sao}_2$ of $\leq 88\%$ with associated complications, such as pulmonary hypertension, daytime somnolence, or cardiac arrhythmias

ASTHMA

Definition

- An inflammatory airway disease characterized by reversible airway obstruction

Incidence

- Increasing prevalence in United States since 1980
- Affects people of all ages
Asthma (cont.)

Etiology and pathogenesis

- Genetic susceptibility to allergens, RTI, occupational and environmental stimuli, etc.

- Whatever the trigger, it can produce “asthma”
  - Airway inflammation and bronchial hyperreactivity, which result in airway obstruction
  - Once above are present, asthma can be triggered by
    - Exercise, cold dry air, hyperventilation, stress, cigarette smoke, etc.

- When asthma is triggered, it causes mast cell degranulation, releasing proinflammatory substances
  - Starts the cycle of asthma.
Early and Late Asthmatic Response

- Late response is usually more severe and longer lasting.
Clinical Presentation and Diagnosis

- Diagnosis is by clinical and laboratory evaluation.
- History plays key role as patients can be entirely normal between episodes.
- Classic symptoms are episodic wheezing, SoB, cough
  - If present, send for PFTs to demonstrate reversible airways obstruction

- PFTs may be normal between exacerbations or show some degree of airway obstruction.
  - ↓FEV₁ and FEV₁/FVC ratio
Clinical Presentation and Diagnosis (cont.)

- Airway reversibility in asthma is noted just like in COPD.
  - post-bronchodilator FEV₁ ↑12% and 200 ml

- If PFTs are normal, bronchoprovocation is undertaken.
  - The most common agent used is methacholine.

- Arterial blood gases taken during an acute attack.
  - Most often show hypoxemia with hyperventilation
  - A normal PaCO₂ level is indicative of a severe attack and impending ventilatory failure.
Asthma Management

● Goals of asthma management
  - Maintain high-quality, asymptomatic life
  - No limitations on the job or during exercise
  - No medication side effects

● Stepwise approach to long-term management of asthma
  - Medication therapy is based on disease severity.
  - Control is attained when (there are)
    - Minimal to no daily symptoms or limitations
    - Infrequent exacerbations, with little or no use of $\beta_2$-agonists
    - PFTs are normal or near normal.
# Asthma Management (cont.)

<table>
<thead>
<tr>
<th>Severity*</th>
<th>Clinical Features Before Treatment†</th>
<th>PEFR or FEV₁</th>
<th>Long-Term Preventive Medications</th>
<th>Quick-Relief Medications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step 4</strong></td>
<td>Continuous symptoms</td>
<td>≤60% predicted</td>
<td>Inhaled corticosteroids</td>
<td>Inhaled β₂-agonist as needed for symptoms</td>
</tr>
<tr>
<td>Severe persistent</td>
<td>Frequent exacerbations</td>
<td>&gt;30% variability</td>
<td>800-2000 µg/day or more Long-acting bronchodilator;¹ Oral corticosteroids</td>
<td></td>
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<tr>
<td>Red zone</td>
<td>Nocturnal symptoms</td>
<td></td>
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<tr>
<td></td>
<td>Symptoms limit activity</td>
<td></td>
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<tr>
<td><strong>Step 3</strong></td>
<td>Daily symptoms</td>
<td>&gt;60%–80% predicted</td>
<td>Inhaled corticosteroids</td>
<td>Inhaled β₂-agonist as needed for symptoms, not to exceed three to four times per day</td>
</tr>
<tr>
<td>Moderate persistent</td>
<td>Exacerbations affect activity and sleep</td>
<td>&gt;30% variability</td>
<td>800-2000 µg/day or more Long-acting bronchodilator;¹ especially for nocturnal symptoms</td>
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<tr>
<td>Yellow zone</td>
<td>Nocturnal symptoms more than once per week</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Daily use of short-acting β₂-agonist</td>
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<tr>
<td><strong>Step 2</strong></td>
<td>Symptoms at least once per week but less than one time per day</td>
<td>≥80% predicted</td>
<td>Either inhaled corticosteroid, 200-500 mg/day, cromolyn, or nedocromil Long-acting bronchodilator;¹ for nocturnal symptoms</td>
<td>Inhaled β₂-agonist as needed for symptoms, not to exceed three to four times per day</td>
</tr>
<tr>
<td>Mild persistent</td>
<td>Exacerbations may affect activity or sleep</td>
<td>20%-30% variability</td>
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<td></td>
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<tr>
<td>Yellow zone</td>
<td>Nocturnal symptoms more than twice per month</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Step 1</strong></td>
<td>Intermittent symptoms less than once per week</td>
<td>≥80% predicted</td>
<td>None needed</td>
<td>Inhaled β₂-agonist needed for symptoms, but less than once per week Inhaled β₂-agonist or cromolyn before exercise or exposure to allergen</td>
</tr>
<tr>
<td>Intermittent</td>
<td>Nocturnal symptoms not more than twice per month</td>
<td>&lt;20% variability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Green zone</td>
<td>Asymptomatic with normal lung function between exacerbations</td>
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</tr>
</tbody>
</table>

Modified from Global Initiative for Asthma: Asthma management and prevention: a practical guide for public health officials and health care professionals, Bethesda, Md, 1995, National Institutes of Health, National Heart, Lung, and Blood Institute, and World Health Organization, NIH publication no. 96-3659A.

FEV₁, Forced expiratory volume in 1 second; PEFR, peak expiratory flow rate.

*Step-down: Review treatment every 3 to 6 months. If control is sustained for at least 3 months, consider a gradual stepwise reduction in treatment.

†Step-up: If control is not achieved, consider step-up, but first review patient medication technique, compliance, and environmental control.

The presence of one of the features of severity is sufficient to place a patient in that category.

¹Long-acting β₂-agonist or sustained-release theophylline.
Pharmacotherapy

Corticosteroids

- Most effective mediation in treatment of asthma
  - Reduces symptoms and mortality
- Use of inhaled steroids for long-term treatment preferred
  - Use spacer and rinse mouth to eliminate or minimize side effects
- Long-term use of oral steroids should be restricted to patients with asthma refractory to other treatment.
- Short-term oral steroid use during exacerbation reduces severity, duration, and mortality.
Pharmacotherapy (cont.)

Cromolyn (NSAID)

- Protective against allergens, cold air, exercise
- Administered prophylactically, CANNOT be used during an acute asthma attack
- Of limited use in adults
- Drug of choice for atopic children with asthma

Nedocromil (NSAID)

- Similar to cromolyn, it is 4–10 times more potent in preventing acute allergic bronchospasm.
Pharmacotherapy (cont.)

Leukotriene inhibitors
- Leukotrienes mediate inflammation and bronchospasm.
- Modestly effective to control mild to moderate asthma

Inhaled steroids remain the antiinflammatory drug of choice for the treatment of asthma.

Methyxanthines (use is controversial)
- Oral or IV use if admitted for acute asthma attack
Pharmacotherapy (cont.)

$\beta_2$-Adrenergic agonists

- Most rapid and effective bronchodilator
- Drug of choice for exercise-induced asthma and emergency relief of bronchospasm
  - Should be used PRN
- Improves symptoms not underlying inflammation
  - Regular use may worsen asthma control and increase risk of death.
Pharmacotherapy (cont.)

Anticholinergics

- Can be used as adjunct to first-line bronchodilators if there is an inadequate response
- Has an additive effect to $\beta_2$-agonists
Emergency Management of Asthma

- Early and frequent use of aerosolized $\beta_2$-agonists
  - Consider continuous therapy for severe attack

- High-dose parenteral corticosteroids

- Oxygen therapy for hypoxemia

- Antibiotics if evidence of infection

- In severe ventilatory failure, use MV with permissive hypercapnia: small $V_T$, low rate, PIP $< 50$ cm H$_2$O
Asthma and Environmental Control

• Recognized relationship between asthma and allergy
  ➢ 75–85% asthma patients react to inhaled allergens

• Environmental control is aimed at reducing exposure to allergens.
  ➢ Avoid outdoor allergens by remaining inside, windows closed, AC on
  ➢ Indoor allergens are combated by
    • Air purifiers and no pets
    • Dust mites: airtight covers on bed and pillow, no carpets in bedroom, chemical agents to kill mites
Special Considerations in Asthma Management

- **Exercise-induced asthma (EIA)**
  - Common particularly in cold weather
    - Heat loss from airways may precipitate attack
  - Prophylactic inhalation of $\beta_2$-agonists or cromolyn

- **Occupational asthma**
  - Most common form of occupational lung disease
  - Early identification and cessation of exposure are key

- **Cough-variant asthma**
  - Cough is sole complaint, amenable to $\beta_2$-agonists.
Special Considerations in Asthma Management (cont.)

- Nocturnal asthma

  - Present in two-thirds of poorly controlled asthmatics
  - May be due to diurnal decrease in airway tone or gastric reflux
  - Treatment should include:
    - Steroid treatment targeted to relieve night symptoms
    - Sustained release theophylline
    - New long-acting $\beta_2$-agonists
    - Antacids for reflux
Special Considerations in Asthma Management (cont.)

- **Aspirin sensitivity**
  - 5% of adult asthmatics will have severe, life-threatening asthma attacks after taking NSAIDs.
  - All asthmatics should avoid; suggest Tylenol use.

- **Asthma during pregnancy**
  - A third of asthmatics have worse control at this time.
  - Much higher fetal risk associated with uncontrolled asthma than that of asthma medications.
  - Theophyllines, $\beta_2$-agonists, and steroids can be used without significant risk of fetal abnormalities.
Special Considerations in Asthma Management (cont.)

- Sinusitis may cause asthma exacerbation.
  - CT of sinuses will diagnosis problem.
  - Treat: 2–3 weeks antibiotics, nasal decongestants, and nasal inhaled steroids

- Surgery
  - Asthmatics at higher risk for respiratory complications
    - Arrest during induction
    - Hypoxemia with/without hypercarbia
    - Impaired cough, atelectasis, pneumonia
  - Optimize lung function preoperatively.
  - Use steroids during procedure.
Bronchiectasis

- Abnormal, irreversible dilation of bronchi caused by chronic airway inflammation and destruction

- Presents in three major anatomical patterns
  - Cylindrical: airway is uniformly dilated
  - Varicose: irregular constrictions and dilations
  - Cystic: progressive distal, sac-like dilations
## Causes of Bronchiectasis

### Local Bronchiectasis
- Foreign body
- Benign airway tumor (e.g., adenoma)
- Bronchial compression by surrounding lymph nodes (e.g., middle lobe syndrome)

### Diffuse Bronchiectasis
- Cystic fibrosis
- Ciliary dyskinesia disorders (e.g., Kartagener’s syndrome, Young’s syndrome)
- Hypogammaglobulinemia
- $\alpha_1$-Antitrypsin deficiency
- Allergic bronchopulmonary aspergillosis
- Rheumatoid arthritis
- Serious lung infection (e.g., from whooping cough, measles, or influenza)
Bronchiectasis (cont.)

- **Clinical presentation and evaluation**
  - Hallmark is chronic production of copious amounts of purulent sputum.
  - Dyspnea is variable; depends on extent of disease.
  - Hemoptysis is frequent, though rarely severe.
  - Chest radiograph shows tram lines (airway dilation).
  - Definitive diagnosis is made with fine-cut CT.
    - Reversible airway changes consistent with bronchiectasis may follow pneumonia.
    - Wait 6–8 weeks following pneumonia resolution.
Bronchiectasis (cont.)

Mainstays of Management

- Antibiotics
  - As needed or regularly scheduled
  - Sputum cultures should guide therapy.

- Bronchopulmonary hygiene
  - Postural drainage and cough maneuvers
  - Humidification and hyperosmolar substances
  - Dry powder inhaled mannitol may be helpful.

- With massive hemoptysis may embolize artery or surgically repair