



CLINICAL FOCUS

Disorders of the Respiratory System

BRONCHI AND LUNGS

Bronchitis (brong-kt'is) is an inflammation of the bronchi caused by irritants, such as cigarette smoke, air pollution, or infections. The inflammation results in swelling of the mucous membrane lining the bronchi, increased mucus production, and decreased movement of mucus by cilia. Consequently, the diameter of the bronchi is decreased, and ventilation is impaired. Bronchitis can progress to emphysema.

Emphysema (em-fi-ze'mà) results in the destruction of the alveolar walls. Many smokers have both bronchitis and emphysema, which are often referred to as **chronic obstructive pulmonary disease (COPD)**. Chronic inflammation of the bronchioles, usually caused by cigarette smoke or air pollution, probably initiates emphysema. Narrowing of the bronchioles restricts air movement, and air tends to be retained in the lungs. Coughing to remove accumulated mucus increases pressure in the alveoli, resulting in the rupture and destruction of alveolar walls. Loss of alveolar walls has two important consequences. The respiratory membrane has a decreased surface area, which decreases gas exchange, and loss of elastic fibers decreases the lung's ability to recoil and expel air. Symptoms of emphysema include shortness of breath and enlargement of the thoracic cavity. Treatment involves removing the sources of irritants (e.g., stopping smoking), promoting the removal of bronchial secretions, using bronchodilators, retraining people to breathe so that expiration of air is maximized, and using antibiotics to prevent infections. The progress of emphysema can be slowed, but no cure exists.

Adult respiratory distress syndrome (ARDS) is caused by damage to the respiratory

membrane. The damage stimulates an inflammatory response, which further damages the respiratory membrane. Water, ions, and proteins leave the blood and enter alveoli. Surfactant in the alveoli is reduced as surfactant-producing cells are damaged and surfactant present in the alveoli is diluted. The fluid-filled alveoli reduce gas exchange and make it more difficult for the lungs to expand. ARDS usually develops rapidly following an injurious event, such as an infection, inhalation of smoke from a fire, inhalation of toxic fumes, trauma, aspiration of gastric content associated with gastric reflux, or circulatory shock. Even with oxygen inhalation therapy, the mortality rate is high.

Asthma (az'mà) is a disease characterized by abnormally increased constriction of the bronchi and bronchioles in response to various stimuli, resulting in a narrowing of the air passageways and decreased ventilation efficiency. Symptoms include rapid, shallow breathing; wheezing; coughing; and shortness of breath. In contrast to many other respiratory disorders, however, the symptoms of asthma typically reverse either spontaneously or with therapy. The prevalence of asthma in the United States is from 3%–6% of the population. In approximately half the cases, the symptoms appear before age 10, and twice as many boys as girls develop asthma.

The exact cause or causes of asthma are unknown, but asthma and allergies are more common in some families. Multiple genes contribute to a person's susceptibility to asthma; genes on chromosomes 5, 6, 11, 12 and 14 have all been linked to asthma. Although no definitive pathologic feature or diagnostic test for asthma has yet been discovered, three important

features of the disease are chronic airway inflammation, airway hyperreactivity, and airflow obstruction. The inflammatory response results in tissue damage, edema, and mucus buildup, which can block airflow through the bronchi and bronchioles. Airway hyperreactivity results in greatly increased contraction of the smooth muscle in the bronchi and bronchioles in response to a stimulus. As a result of airway hyperreactivity, the diameter of the airway decreases, and resistance to airflow increases. The effects of inflammation and airway hyperreactivity combine to cause airflow obstruction.

Many cases of asthma appear to be associated with a chronic inflammatory response. The number of immune cells in the bronchi and bronchioles, including mast cells, eosinophils, neutrophils, macrophages, and lymphocytes, increases. Inflammation appears to be linked to airway hyperreactivity by some chemical mediators released by immune cells (e.g., leukotrienes, prostaglandins, and interleukins), which increase the airway's sensitivity to stimulation and cause smooth muscle contraction.

The stimuli that prompt airflow obstruction in asthma vary from one individual to another. Some asthmatics have reactions to particular allergens, which are foreign substances that evoke an inappropriate immune system response (see chapter 22). Examples include inhaled pollen, animal dander, and dust mites. On the other hand, inhaled substances, such as chemicals in the workplace or cigarette smoke, can provoke an asthma attack in some people without stimulating an allergic reaction. Ingested substances, such as aspirin or nonsteroidal anti-inflammatory compounds, such as

ibuprofen (i-boo'-pro'-fen), can also stimulate an asthma attack. Acetaminophen (as-et-a-mē'no-fen; Tylenol), which does not stimulate an asthma attack, can be substituted for aspirin.

Other stimuli, such as strenuous exercise, especially in cold weather, can precipitate an asthma attack. Such episodes often can be avoided by using a bronchodilator drug prior to exercise. Viral infections, emotional upset, stress, and even reflux of stomach acid into the esophagus are also known to elicit an asthma attack.

Treatment of asthma involves avoiding the causative stimulus and administering drug therapy. Steroids and mast cell-stabilizing agents, which prevent the release of chemical mediators from mast cells, are used to reduce airway inflammation. Theophylline (the-of'i-len, the-of'i-lin) and β -adrenergic agents (see chapter 16) are commonly used to stimulate bronchiolar dilation. Treatment is generally effective in controlling asthma, although in rare cases death by asphyxiation occurs. Death can be prevented with early and intensive therapy.

Pulmonary fibrosis is the replacement of lung tissue with fibrous connective tissue, thereby making the lungs less elastic and breathing more difficult. Exposure to asbestos, silica (silicosis), or coal dust is the most common cause.

Lung, or bronchiogenic, cancer arises from the epithelium of the respiratory tract. Cancers arising from tissues other than respiratory epithelium are not called lung cancer, even though they occur in the lungs. Lung cancer is the most common cause of cancer death in males and females in the United States, and most cases occur in smokers or those exposed to secondhand smoke. Because of the rich lymph and blood supply in the lungs, cancer in the lung can readily spread to other parts of the lung or body. In addition, the disease is often advanced before symptoms become severe enough for the victim to seek medical aid.

Typical symptoms include coughing, sputum production, and blockage of the airways. Treatments include removal of part or all of the lung, chemotherapy, and radiation. Promising new, early detection tests are being explored. These include blood tests for a lung cancer-specific protein and sputum DNA tests that detect genetic abnormalities.

NERVOUS SYSTEM

Sudden infant death syndrome (SIDS), or crib death, is the most frequent cause of the death of infants between 2 weeks and 1 year of age. Death results when the infant stops breathing during sleep. Although the cause of SIDS remains controversial, evidence exists that damage to the respiratory center during development is a factor. No treatment has yet been found, but at-risk babies can be placed on a monitor that sounds an alarm if the baby stops breathing.

Paralysis of the respiratory muscles can result from spinal cord damage in the cervical or thoracic region. The damage interrupts the nerve tracts that transmit action potentials to the muscles of respiration. Transection of the spinal cord can result from trauma, such as having an automobile accident or diving into water that is too shallow. Another cause of paralysis is poliomyelitis, a viral infection that damages neurons of the respiratory center or motor neurons that stimulate the muscles of respiration. Anesthetics and central nervous system depressants can also depress the function of the respiratory center if they are taken or administered in large enough doses.

INFECTIOUS DISEASES OF THE RESPIRATORY SYSTEM

Strep throat is caused by a streptococcal bacteria (*Streptococcus pyogenes*) and is characterized by inflammation of the pharynx and by fever.

Frequently, inflammation of the tonsils and middle ear is involved. Without a throat analysis, the infection cannot be distinguished from viral causes of pharyngeal inflammation. Current techniques allow rapid diagnosis, within minutes to hours, and antibiotics are an effective treatment.

Laryngitis (lar-in-'ji'tis) is an inflammation of the larynx, especially the vocal folds. Bacterial or viral infections can move from the upper respiratory tract to cause laryngitis.

The **common cold** is the result of a viral infection. Symptoms include sneezing, excessive nasal secretions, and congestion.

Flu (influenza) is a viral infection of the respiratory system and does not affect the digestive system, as is commonly assumed. Flu is characterized by chills, fever, headache, and muscular aches, in addition to coldlike symptoms.

Pneumonia (noo-mō'ne-ā) is a general term that refers to many infections of the lung. Most pneumonias are caused by bacteria, but some result from viral, fungal, or protozoan infections. Symptoms include fever, difficulty breathing, and chest pain. Inflammation of the lungs results in the accumulation of fluid within alveoli (pulmonary edema) and poor inflation of the lungs with air.

Other respiratory system infections include the bacterial infections **diphtheria** (dif-the're-ā), **whooping cough** (pertussis; per-tūs'is), and **tuberculosis** (tū-ber'kū-lō'sis) and the fungal infections **histoplasmosis** (his'to-plaz-mō'sis) and **coccidioidomycosis** (kok-sid-ē-oy'dō-mī-kō'sis). Vaccines against diphtheria and whooping cough are part of the normal vaccination procedure for children in the United States.