Nervous System

The nervous system regulates the rate and depth of respiration by the respiratory center in the medulla oblongata, the pneumotaxic center in the pons, and the apneustic center in the reticular formation. The respiratory center is stimulated primarily by increased CO_2 in the fluids of the center. (However, excessive CO_2 depresses the respiratory center.) When the center is stimulated, the rate and depth of breathing are increased, and excessive CO_2 is exhaled. A lesser stimulus to the respiratory center is decreased oxygen in arterial blood.

The nervous system also operates several reflexes important to respiration. The cough reflex is especially important because it helps protect the lungs from foreign particles, air pollutants, bacteria, and other potentially harmful substances. A cough occurs when nerve endings in the respiratory tract mucosa are stimulated by dryness, pressure, cold, irritant fumes, and excessive secretions.

Musculoskeletal System

The musculoskeletal system participates in chest expansion and contraction. Normally, the diaphragm and external intercostal muscles expand the chest cavity and are called muscles of inspiration. The abdominal and internal intercostal muscles are the muscles of expiration.

SUMMARY

Overall, normal respiration requires:

1. Atmospheric air containing at least 21% O_2.
2. Adequate ventilation. Ventilation, in turn, requires patent airways, expansion and contraction of the chest, expansion and contraction of the lungs, and maintenance of a normal range of intrapulmonic and intrapleural pressures.
3. Adequate diffusion of O_2 and CO_2 through the alveolar–capillary membrane. Factors influencing diffusion include the thickness and surface area of the membrane and pressure differences between gases on each side of the membrane.
4. Adequate perfusion or circulation of blood and sufficient hemoglobin to carry needed O_2.

In addition, normal breathing occurs 16 to 20 times per minute and is quiet, rhythmic, and effortless. Approximately 500 mL of air is inspired and expired with a normal breath (tidal volume); deep breaths or "sighs" occur 6 to 10 times per hour to ventilate more alveoli. Fever, exercise, pain, and emotions such as anger increase respirations. Sleep or rest and various medications, such as antianxiety drugs, sedatives, and opioid analgesics, slow respiration.

DISORDERS OF THE RESPIRATORY SYSTEM

The respiratory system is subject to many disorders that interfere with respiration and other lung functions. These disorders may be caused by agents that reach the system through inhaled air or through the bloodstream and include respiratory tract infections, allergic disorders, inflammatory disorders, and conditions that obstruct airflow (eg, excessive respiratory tract secretions, asthma, and other chronic obstructive pulmonary diseases). Injury to the lungs by various disorders (eg, anaphylaxis, asthma, mechanical stimulation such as hyperventilation, pulmonary thromboembolism, pulmonary edema, acute respiratory distress syndrome) is associated with the release of histamine and other biologically active chemical mediators from the lungs. These mediators often cause inflammation and constriction of the airways.

The ciliated epithelial cells of the larger airways, the type I epithelial cells of the alveoli, and the capillary endothelial cells of the alveolar area are especially susceptible to injury. Once injured, cellular functions are impaired (eg, decreased mucociliary clearance). Common signs and symptoms of respiratory disorders include cough, increased secretions, mucosal congestion, and bronchospasm. Severe disorders or inadequate treatment may lead to cell necrosis or respiratory failure.

DRUG THERAPY

In general, drug therapy is more effective in relieving respiratory symptoms than in curing the underlying disorders that cause the symptoms. Major drug groups used to treat respiratory symptoms are bronchodilating and anti-inflammatory agents (see Chap. 47), antihistamines (see Chap. 48), and nasal decongestants, antitussives, and cold remedies (see Chap. 49).

Review and Application Exercises

1. What is the main function of the respiratory system?
2. Where does the exchange of oxygen and carbon dioxide occur?
3. List factors that stimulate rate and depth of respiration.
4. List factors that depress rate and depth of respiration.
5. What are common signs and symptoms of respiratory disorders for which drug therapy is often used?

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