Chapter 16

The Respiratory System
What you should know

• Discuss the generalized functions of the respiratory system
• List the major organs of the respiratory system and describe the function of each
• Explain the mechanism responsible for the exchange of gases
What you should know

• Identify and discuss the mechanisms that regulate respiration
• Identify and describe the major disorders of the upper respiratory tract
• Identify and describe the major disorders of the lower respiratory tract
• Why is smoking more addictive and dangerous than when your grandparents did it 30 years ago?
• Does smoking only cause lung cancer?
• Can cancer from smoking move to other parts of the body besides the lungs?
• Are there other impacts from smoking?
Why is smoking so addictive?

What is addictive?

• 599 to 4000 ingredients depending on source

• Out of the 4000 ingredients what is the most addictive?

--nicotine (according to the DARE website, nicotine is more addictive than heroin or cocaine)
Smoking and the Heart

- Smoking lowers HDL cholesterol ("good" cholesterol), even in adolescents.
- Smoking deteriorates the elastic properties of the aorta, the largest blood vessel in the body, which increases the risk for developing blood clots.
- Smoking increases the activity of the sympathetic nervous system, putting additional stress on the system that regulates the heart and blood vessels.
- In women, smoking increases risk for cardiovascular disease because it effects hormones that cause estrogen deficiency.
- Those who smoke a pack of cigarettes a day have almost two and a half times the risk for having a stroke as nonsmokers.
Smoking and Cancer

Smoking is the cause of nearly 85 percent of all cases of lung cancer in the United States, but smoking accounts for other types of cancers as well. Because cigarettes contain so many chemicals, cancer may develop from the accumulative effects of more than one of these carcinogens.

- Tar from cigarettes causes specific DNA damage to the lungs, making it particularly difficult for cells to repair.
- Smoking and smokeless tobacco (chew) account for over 60 percent of cancers of the throat, mouth and esophagus.
- Smokers have higher rates of leukemia, and cancers of the stomach, bladder, kidney and pancreas.
- About 30 percent of cervical cancers have been attributed to smoking.
Effects of Smoking on Bones and Joints

- Smoking has many negative effects on bones and joints since it impairs formation of new bone.
- Women who smoke are at an exceptionally high risk for developing osteoporosis,
- and women smokers have a slightly increased chance of developing rheumatoid arthritis.
- Smokers are also more disposed to developing degenerative disorders and injuries in the spine.
Other Smoking-Related Disorders

- Smoking increases acid secretion, reduces prostaglandin and bicarbonate production and decreases mucosal blood flow — which can cause peptic ulcers. Smoking also delays the healing of gastric and duodenal ulcers.
- Cyanedim, a chemical found in cigarette smoke, interferes with thyroid hormone production, which can lead to thyroid disease.
- Heavy smokers are at risk for developing cataracts of the eye, and smokers also have twice the risk of nonsmokers for developing macular degeneration, an age-related eye disorder.
- Smokers look older than nonsmokers since smokers develop more and deeper wrinkles as they age.
- Women who smoke are at greater risk for infertility. Those at greatest risk are women who smoke a pack or more per day, or those who started smoking before age 18.
Structural Plan

• Basic plan of respiratory system would be similar to an inverted tree if it were hollow; leaves of the tree would be comparable to alveoli, with the microscopic sacs enclosed by networks of capillaries

• Diffusion is the mode for gas exchange that occurs in the respiratory mechanism
Gas exchange of the lung between alveolus and capillary
Respiratory Tracts

• Upper respiratory tract—nose, pharynx (throat), and larynx (Just below throat)
• Lower respiratory tract—trachea (windpipe), bronchial tree, and lungs
Respiratory Mucosa

- Mucous membrane that lines the air distribution tubes in the respiratory tree
- Mucus serves as an air purification mechanism by trapping inspired irritants such as dust, pollen
- Cilia on mucosal cells beat in only one direction, moving mucus upward to pharynx for removal
Mucus and Cilia
Nose

• Structure
  – Nasal septum separates interior of nose into two cavities
  – Mucous membrane lines nose
Nose

• Functions
  – Warms and moistens inhaled air
  – Contains sense organs of smell
Pharynx

• Structure
  – Pharynx (throat) about 12.5 cm (5 inches) long
Pharynx

• Functions
  – Passageway for food and liquids
  – Air distribution; passageway for air
  – Tonsils—masses of lymphoid tissue embedded in pharynx provide immune protection
Larynx

• Structure
  – Located just below pharynx; also referred to as the voice box
  – Several pieces of cartilage form framework
    • Thyroid cartilage (Adam’s apple) is largest
    • Epiglottis partially covers opening into larynx
  – Mucous lining
  – Vocal cords stretch across interior of larynx; space between cords is the glottis
Larynx

• Laryngeal cancer
  – Incidence increases with age and alcohol abuse
  – Occurs most often in men over age 50
  – If larynx removed, “esophageal speech” or electric artificial larynx needed for speech
Disorders of the Upper Respiratory Tract

- Upper respiratory infection (URI)
  - Rhinitis—nasal inflammation, as in a cold, influenza, or allergy
    - Infectious rhinitis—common cold
    - Allergic rhinitis—hay fever
  - Pharyngitis (sore throat)—inflammation or infection of the pharynx
Disorders of the Upper Respiratory Tract

• Upper respiratory infection
  – Laryngitis—inflammation of the larynx resulting from infection or irritation
    • Epiglottis—life threatening
    • Croup—not life threatening
Trachea

• Structure
  – Tube (windpipe) about 11 cm (4½ inches) long that extends from larynx into the thoracic cavity
  – Mucous lining
  – C-shaped rings of cartilage hold trachea open

• Function—passageway for air to move to and from lungs
• Obstruction
  – Blockage of trachea occludes the airway and if complete causes death in minutes
  – Causes more than 4000 deaths annually in the United States
  – Abdominal thrust maneuver is a lifesaving technique used to free the trachea of obstructions; also called *abdominal thrusts*
  – Tracheotomy—surgical procedure in which a tube is inserted into an incision in the trachea so that a person with a blocked airway can breathe
How to give a tracheotomy

- http://www.5min.com/Video/Tracheotomy-How-To-114222861
Bronchi, Bronchioles, and Alveoli

• Structure
  – Trachea branches into right and left bronchi
    • Right primary bronchus more vertical than left
    • Aspirated objects most often lodge in right primary bronchus or right lung
  – Each bronchus branches into smaller and smaller tubes (secondary bronchi), eventually leading to bronchioles
  – Bronchioles end in clusters of microscopic alveolar sacs, whose walls are made of alveoli
Bronchi, Bronchioles, and Alveoli

• Function
  – Bronchi and bronchioles—air distribution; passageway for air to move to and from alveoli
  – Alveoli—exchange of gases between air and blood
Bronchi, Bronchioles, and Alveoli

• Respiratory distress—relative inability to inflate the alveoli
  – Infant respiratory distress syndrome (IRDS)—leading cause of death in premature infants resulting from lack of surfactant production in alveoli
  – Adult respiratory distress syndrome (ARDS)—impairment of surfactant by inhalation of foreign substances or other conditions
Lungs and Pleura

• Structure
  – Size—large enough to fill the chest cavity, except for middle space occupied by heart and large blood vessels
  – Apex—narrow upper part of each lung, under collarbone
  – Base—broad lower part of each lung; rests on diaphragm
Lungs and Pleura

• Structure
  – Pleura—moist, smooth, slippery membrane that lines chest cavity and covers outer surface of lungs; reduces friction between the lungs and chest wall during breathing
Puncture wound to chest can cause a pneumothorax, if blood in pleura-a hemothorax.

Outside air rushes in due to disruption of chest wall and parietal pleura.

Lung air rushes out due to disruption of visceral pleura.

Normal lung

Chest wall

Pleural space

Diaphragm

Mediastinum
Mechanics of breathing

- Pulmonary ventilation includes two phases called *inspiration* (movement of air into lungs) and *expiration* (movement of air out of lungs)
- Changes in size and shape of thorax cause changes in air pressure within that cavity and in the lungs because as volume changes, pressure changes in the opposite direction
- Air moves into or out of lungs because of pressure differences (pressure gradient); air moves from high air pressure toward low air pressure
Respiration

• Inspiration
  – Active process—muscles increase volume of thorax, decreasing lung pressure, which causes air to move from atmosphere into lungs (down the pressure gradient)
  – Inspiratory muscles include diaphragm and external intercostals
Respiration

• Expiration
  – Internal intercostals and abdominal muscles—expiratory muscles used in forceful expiration
Respiration

• Exchange of gases in tissues
  – Oxyhemoglobin breaks down into oxygen and hemoglobin
  – Oxygen moves out of tissue capillary blood into tissue cells
  – Carbon dioxide moves from tissue cells into tissue capillary blood
  – Hemoglobin combines with carbon dioxide, forming carbaminohemoglobin
Blood Transportation of Gases

• **Transport of oxygen**
  – Only small amounts of oxygen can be dissolved in blood
  – Most oxygen combines with hemoglobin to form oxyhemoglobin to be carried in blood

• **Transport of carbon dioxide**
  – Dissolved carbon dioxide—10%
  – Carbaminohemoglobin—20%
  – Bicarbonate ions—70%
Types of Breathing

- Eupnea—normal breathing
- Hyperventilation—rapid, deep respirations
- Hypoventilation—slow, shallow respirations
- Dyspnea—labored or difficult respirations
- Orthopnea—dyspnea relieved by moving into an upright or sitting position
Types of Breathing

• Apnea—stopped respiration
• Cheyne-Stokes respiration (CSR)—cycles of alternating apnea and hyperventilation associated with critical conditions
• Respiratory arrest—failure to resume breathing after a period of apnea
Disorders of the Lower Respiratory Tract

• Lower respiratory infection
  – Acute bronchitis or tracheobronchitis—
inflammation of the bronchi or bronchi and trachea
  caused by infection (usually resulting from the
  spread of a URI)
  – Pneumonia—acute inflammation (infection) in
    which lung airways become blocked with thick
    exudates
    • Lobar pneumonia—affects entire lobe of lung
    • Bronchopneumonia—infection scattered along bronchial
      tree
Types of pneumonia
Tuberculosis (TB)—chronic, highly contagious lung infection characterized by tubercles in the lung; can progress to involve tissues outside the lungs and pleurae
Disorders of the Lower Respiratory Tract

• Restrictive pulmonary disorders reduce the ability of lung tissues to stretch (as during inspiration)
  – Factors inside the lungs, such as fibrosis (scarring) or inflammation, may restrict breathing
  – Factors outside the lungs, such as pain from injury or pleurisy, may restrict breathing
Disorders of the Lower Respiratory Tract

• Obstructive pulmonary disorders
  – Obstruct breathing
  – Chronic obstructive pulmonary disease (COPD) can develop from preexisting obstructive conditions
    • Chronic bronchitis—chronic inflammation of the bronchial tree
    • Emphysema—reduced surface area of lungs caused by rupture or other damage to alveoli
    • Asthma—recurring spasms of the airways accompanied by edema and mucus production
**NORMAL**

- Submucosal gland
- Smooth muscle
- Bronchiole
- Respiratory bronchiole
- Epithelium
- Alveoli

**CHRONIC BRONCHITIS**

- Enlarged submucosal gland
- Inflammation of epithelium
- Mucus accumulation
- Hyperinflation of alveoli

**ASTHMA**

- Smooth muscle constriction
- Edema of respiratory mucosa and excessive mucus production obstruct airways
- Mucus plug
- Hyperinflation of alveoli

**EMPHYSEMA**

- Enlargement and destruction of alveolar walls
- Walls of alveoli are torn and cannot be repaired. Alveoli fuse into large air spaces.
Disorders of the Lower Respiratory Tract

• Lung cancer—malignant tumor of the lungs, occasionally treatable with surgery, chemotherapy, radiation, and photodynamic therapy