Diseases Acquired Through the Respiratory System

More human diseases are acquired by respiratory transmission than by any other method. It is an extremely efficient mode of transmission. Respiratory system infections are among the most common and among the most damaging type of infection. One person exhaling infected mucus droplets can transmit a respiratory pathogen to every susceptible person in the immediate environment. Pathogens are transmitted directly from one person to another in droplets of respiratory secretions that are expelled by talking, laughing, coughing, or sneezing.

Airborne transmission can also occur when microorganisms survive for prolonged periods of time and are inhaled. These microorganisms can withstand prolonged drying and remain viable in dust and reenter the air.

Microorganisms can also be transmitted by inanimate objects called fomites, especially viruses that cause the common cold. When an uninfected person comes into contact with the fomite and then rubs their nose or eyes, the cold virus is transmitted.

Some pathogens that enter the body by way of the respiratory system can infect other parts of the body or produce exotoxins that circulate in the bloodstream and affect other parts of the body.

The respiratory system is divided into two regions:

1. **Upper respiratory system or tract** - It consists of the nasal cavity, pharynx (throat), and the structures associated with them, such as the tonsils, sinuses, middle ear, and eustachian (auditory) tubes.

2. **Lower respiratory system or tract** - It consists of the larynx (voice box), trachea (windpipe), bronchi, bronchioles, and alveoli (air sacs).

The respiratory system has many defenses against the microorganisms that enter the body in inhaled air. In the upper respiratory system air is filtered by coarse hairs (vibriassae) in the nose which remove large dust particles. The lining of the upper respiratory tract consists of mucosal membranes which contain cilia. Mucus secreted by the membranes traps dust and microorganisms. Cilia move the mucus and trapped microorganisms toward the mouth for elimination or to the pharynx where it is swallowed and digested in the stomach. Tonsils located in the pharynx and oral cavity trap and destroy microorganisms. In spite of its defenses, the upper respiratory tract is a warm, moist, nutrient-rich environment containing many normal flora including streptococcal species, Lactobacillus, and some gram-negative bacteria such as Moraxella catarrhalis.
The lower respiratory system, except for a few bacteria that may be found in the trachea, is normally sterile. Ciliated mucosal membranes move mucus and trapped particles upward from the bronchi to the throat. If microorganisms reach the lungs, phagocytic cells in the alveoli, called alveolar macrophages, ingest and destroy them. IgA antibodies also protect the mucosal membranes.

Respiratory System Diseases

Infections in and around the upper respiratory tract include:

1. pharyngitis - inflammation of the mucosal membrane of the throat (sore throat) frequently caused by a virus or the bacteria Streptococcus pyogenes.

2. laryngitis - infection of the larynx which affects the ability to speak and often is accompanied with the loss of voice. It is usually caused by the bacteria Haemophilus influenzae, Streptococcus pyogenes or Streptococcus pneumoniae.

3. tonsillitis - inflammation and infection of the tonsils usually caused by viruses and Streptococcus pyogenes.

4. sinusitis - inflammation of the mucosal membranes of the sinuses accompanied by a thick, heavy mucus, blocking of drainage, pressure, and severe pain. It is frequently caused by the bacteria Haemophilus influenzae and Streptococcus pneumoniae.

5. epiglottitis - inflammation of the epiglottis and is the most threatening infection. It develops rapidly and can result in death in a few hours. It is caused by the Haemophilus influenzae.

6. otitis media - infection of the middle ear usually caused by Streptococcus pneumoniae, Haemophilus influenzae, Moraxella catarrhalis, and Staphylococcus aureus.

7. bronchitis - inflammation of the bronchi and bronchioles resulting in thick mucus. It is usually caused by Streptococcus pneumoniae, Haemophilus influenzae, Streptococcus pyogenes and Mycoplasma pneumoniae.
Upper Respiratory Tract

Bacteria and viruses are the most common agents of infection of the upper respiratory tract.

Bacterial Diseases

Bacteria are the most virulent of the upper respiratory pathogens, but most of the infections they cause can be either prevented or effectively treated.

Streptococcal pharyngitis (strep throat)

a. causative agent: *Streptococcus pyogenes*  
A group A beta-hemolytic streptococcus (a clear halo forms around the colonies on blood agar where blood cells have been lysed).

b. method of transmission: Infection is usually transmitted from person (infected or a carrier) to person by respiratory droplets, but contaminated food, particularly unpasteurized milk, can also spread the disease.

c. symptoms: severely sore throat, fever, chills, headache, but coughing and nasal discharge do not occur. The adenoids and lymph nodes of the neck swell, and the tonsils develop white, pus-filled lesions.

d. prevention: personal hygiene, such as hand-washing after contact with an infected person, and control of food and milk handlers.

e. treatment: penicillin and its derivatives. It is usually a self-limiting illness and most people recover within a few days without treatment.

When *S. pyogenes* produces streptococcal pyrogenic toxin, the resulting infection is *scarlet fever*. The toxin causes a pinkish-red skin rash and a high fever. The tongue has a spotted, strawberry-like appearance and then loses its upper membrane and becomes very red and enlarged. As the disease runs its course, the affected skin frequently peels off.

Rheumatic fever may also occur after an infection. Inflammation occurs in many organs, joints, skin, and brain. Permanent and life-threatening damage occurs to the heart valves.
Viral Diseases

1. Coryza (common cold)

   a. causative agent: about 200 different viruses including, rhinoviruses (most common), parainfluenza virus, coronaviruses, and adenoviruses.

   b. method of transmission: Spread by fomites and by hand-to-hand contact, and other close contact with infected persons. Secondarily it is transmitted by respiratory droplets.

   c. symptoms: sneezing, rhinorrhea (production of excess nasal mucus), nasal congestion, malaise, and sometimes sore throat, and headache. Fever is rare or very low-grade.

   d. prevention: frequent hand washing and disinfecting fomites.

   e. treatment: Because colds are caused by viruses, antibiotics are of no use. Symptoms may be alleviated by over-the-counter remedies. Recovery usually takes a week.

2. Parainfluenza (croup)

   a. causative agent: paramyxoviruses

   b. method of transmission: spread by direct contact or large respiratory droplets.

   c. symptoms: nasal inflammation, pharyngitis, bronchitis, croup (inflammation of the larynx and epiglottis resulting in a high-pitched barking cough), and sometimes pneumonia.

   d. prevention: viruses are inactivated by drying, increased temperatures, and most disinfectants, so they do not remain long on surfaces or in the environment.

   e. treatment: Antibiotics are of no use. Recovery is usually within a few days.
Lower Respiratory Tract

The lower respiratory tract can be infected by many of the same bacteria and viruses that infect the upper respiratory tract. In addition fungal and protozoan infections can also occur.

Bacterial Diseases

1. Pertussis (whooping cough)
   a. causative agent: Bordetella pertussis
   b. method of transmission: inhalation of respiratory droplets.
   c. symptoms: catarrhal stage - fever, sneezing, vomiting, and a mild, dry, persistent cough. Paroxysmal (intensifying) stage - mucus and masses of bacteria fill the air passages and immobilize the cilia after one to two weeks. Strong, sticky, ropelike strings of mucus in the airway causing violent, intense coughing. Straining to draw in air causes a "whooping" sound. Coughing sieges occur several times a day and may cause hemorrhage, rib fractures, or convulsions. Vomiting following a coughing siege leads to dehydration, nutritional deficiency, and electrolyte imbalance. Convalescent stage - one to six weeks duration or longer with mild coughing.
   d. prevention: vaccination with DPT series at two months of age.
   e. treatment: erythromycin.

2. Pneumococcus pneumonia (classic pneumonia)

Classical pneumonia accounts for 90% of all cases of pneumonia and it produces lobar pneumonia. It is the only infectious disease in the top ten causes of death in the United States.

a. causative agent: Streptococcus pneumoniae

b. methods of transmission: Inhalation of respiratory droplets that have been exhaled by someone nearby and by carriers that have had contact with people with the disease.

c. symptoms: Inflammation of the bronchi and alveoli of the lungs with fluid accumulation and fever. Fibrin deposits solidify and cause consolidation or blockage of the air spaces. Pleurisy (inflammation of the pleural membrane) causes painful breathing. After a few days of mild upper respiratory symptoms,
violent chills and fever (up to 106°) occur. Chest pain, cough, and sputum containing blood, mucus, and pus follow.

d. **prevention:** Highly susceptible people and anyone over 65 years of age or suffering from a chronic illness or immune deficiency, should be immunized with the vaccine Pneumovax. Avoidance of contact with infected persons and their secretions.

e. **treatment:** penicillin, although a few resistant strains have been reported.

Other bacteria occasionally cause the same symptoms as *Streptococcus pneumoniae*. They include: *Haemophilus influenzae*, *Klebsiella pneumoniae*, *Staphylococcus aureus*, and *Streptococcus pyogenes*.

3. **Mycoplasmal pneumonia**

   It is so different from pneumococcal pneumonia it is called primary atypical pneumonia (PAP) or walking pneumonia.

   a. **causative agent:** *Mycoplasma pneumoniae*

   b. **method of transmission:** It usually grows in the trachea and is spread by respiratory droplets. Only about 10% of infections develop into pneumonia.

   c. **symptoms:** It usually comes on gradually, is mild, produces few definite signs and symptoms, and shows a diffuse patchy pattern rather than dense consolidation of an entire lobe. Headache, low fever, and persistent dry cough. It is rarely fatal.

   d. **prevention:** Avoidance of contact with infected persons and their secretions.

   e. **treatment:** tetracycline and erythromycin

4. **Chlamydial pneumonia**

   a. **causative agent:** *Chlamydia pneumoniae*

   b. **method of transmission:** Transmitted from person to person, probably by respiratory secretions and droplets.

   c. **symptoms:** Resembles mycoplasmal pneumonia.

   d. **prevention:** Avoidance of contact with infected persons and their secretions.

   e. **treatment:** tetracycline
5. Tuberculosis

a. causative agent: Mycobacterium tuberculosis

b. method of transmission: It is acquired by inhalation of respiratory secretions and droplets or particles of dry sputum containing the microorganism. Young children and elderly are particularly at risk.

c. symptoms: Once inhaled, they multiply very slowly inside white blood cells which have phagocytized them. Inflammation occurs and fluid accumulates in the alveoli of the lungs producing pneumonia-like symptoms. A chronic cough producing thick rust-colored (from blood) sputum, fatigue, chest pain, weight loss, and high fever results. Lesions sometimes heal, but more often they produce massive tissue necrosis or solidify to become chronic granulomas or tubercles which consist of white blood cells, the microorganism, and fibrous tissue. The central portion of the tubercle undergoes destruction, giving it a cheesy, or caseous, appearance. Tubercles can keep viable microorganisms walled off for decades and when the immune system becomes impaired by age or other infections, the tubercles open and the infection is reactivated. The microorganisms may also spread to other body tissues and organs such as bone, liver, kidney, and meninges and is called miliary tuberculosis because the small lesions that form resemble millet (grain) seeds.

d. prevention: Early detection using the tuberculin skin test and screening of school and day care workers, and nursing home workers for TB. Vaccination with attenuated microorganisms in the vaccine BCG (bacille Calmette Guerin) has had limited use for high-risk individuals, such as health care workers regularly exposed to TB patients and people specializing in pulmonary disease.

e. treatment: isoniazid and rifampin for 1 to 2 years. Sometimes both are used with the addition of pyrazinamide.

6. Legionnaires' Disease (Legionellosis)

a. causative agent: Legionella pneumophilia

b. method of transmission: It is transmitted when microorganisms growing in soil or water become airborne and enter the lungs as aerosols. Person-to-person transmission has not been documented. Air conditioners, ornamental fountains, produce sprayers in the grocery store, humidifiers, and vaporizers can spread the disease.
c. symptoms: After an incubation period of 2-10 days, weakness, high fever, chills, headache, diarrhea, vomiting, fluid in the lungs, chest and abdominal pain occur. Less frequently, profuse sweating and mental disorders occur. Death may occur due to shock and kidney failure. A nonpneumonia form produces flu-like symptoms without infiltration of the lungs. Elderly, especially those with another serious illness or a weakened immune system, are most often affected. Smokers and alcoholics are particularly susceptible.

d. prevention: Maintaining adequate chlorine levels in all potable water sources, cooling towers, and other reservoirs of water, periodic cleaning of the surfaces in air conditioners, humidifiers, and other similar equipment aid in the prevention of transmission.

e. treatment: erythromycin, penicillin, and rifampin.

7. Psittacosis or Ornithosis

It is called psittacosis because it was first discovered in parrots. Since it has been associated with parakeets, ducks, turkeys, chickens, and other wild and domestic birds, a more appropriate term is ornithosis.

a. causative agent: Chlamydia psittaci

b. method of transmission: Inhalation of microorganisms in bird droppings, and occasionally infected persons can transmit it to other people in respiratory droplets.

c. symptoms: Headache, fever, chills and a cough. If it progresses to a persistent high fever, mental confusion, and marked shortness of breath, it can be life-threatening.

d. prevention: Antibiotics are supplemented in bird feed and antibiotic treatment is given to imported parrots.

e. treatment: tetracycline and erythromycin.

8. Q fever (query because the infectious agent was unknown)

a. causative agent: Coxiella burnetii (a rickettsia)

b. method of transmission: It survives for long periods outside cells and can be transmitted aerially as well as by ticks, feces, unpasteurized milk, and inhalation of aerosol droplets from infected domestic animals such as cattle and sheep.
c. symptoms: Cough, chills, fever, headache, malaise, severe sweats (similar to primary atypical pneumonia, mycoplasmal pneumonia, and psittacosis). Severe cases may cause endocarditis (inflammation of the endocardium of the heart).

d. prevention: Vaccine for workers with occupational exposure.

e. treatment: tetracycline or fluoroquinolone

Viral Diseases

1. Influenza (flu)

a. causative agent: orthomyxoviruses

These RNA viruses have an envelope surface antigen hemagglutinin (causes agglutination of red blood cells when mixed with viruses) that is responsible for their infectivity. Some also have an enzyme, neuraminidase, which allows them to penetrate the mucosal membranes of the respiratory epithelium. Three major influenza serotypes are recognized by the antigens on their protein coats: types A, B, and C. Influenza viruses have a tendency to undergo antigenic variations, or mutations that affect viral antigens. One type of variation is an antigenic drift which results from mutations in genes that code for hemagglutinin and neuraminidase. Such mutations change the part of the antigen molecule that stimulates the production of specific antibodies. An antigenic shift may also occur when two different viruses infect the same cell and exchange parts of their RNA. The viral strains that result have significantly different antigens from previously known strains.

b. method of transmission: The viruses enter the body through inhalation of virus-containing droplets or indirect contact with infectious respiratory secretions.

c. symptoms: Fever, chills, headache, cough, sore throat, nasal discharge and general muscle aches.

d. prevention: Annual flu vaccine for high-risk persons such as the chronically ill and the elderly.

e. treatment: Amantadine (antiviral vaccine), given shortly after symptoms appear, will reduce severity and duration.
2. **Respiratory Syncytial Virus (RSV)**
   a. **causative agent:** paramyxovirus
   b. **method of transmission:** Direct contact with fomites contaminated with respiratory secretions, hand contact, and respiratory droplets. It is highly contagious and spreads rapidly among family members. It is the most common cause of fatal lower respiratory infection in young children and infants. Viruses are released for weeks to months after infection, and reinfection is common.
   c. **symptoms:** Begins with a 3 to 4 day fever as the virus infects the respiratory tract. Infected respiratory tissues develop syncytia, large, abnormal cells with multiple nuclei. Wheezing, hyperventilation, hyperinflation, and infiltration of the lungs with fluid follows. It can cause viral pneumonia. Older children and adults suffer only from coldlike symptoms.
   d. **prevention:** Reduce an infant's exposure to crowds and other sources of infection. Isolation of infectious infants and young children. Almost everyone has been infected by the virus by the age of 4 years.
   e. **treatment:** There is no vaccine. Ribavirin shortens the duration.

3. **Hantavirus Pulmonary Syndrome**
   a. **causative agent:** Hantavirus
   b. **method of transmission:** The virus is shed in the urine, feces, and saliva of rodents. Infection occurs when dried secretions become airborne and are inhaled.
   c. **symptoms:** Mild symptoms resembling a severe cold or flu, followed by fluid leaking from the lung capillaries which fills the lungs with fluid. Kidney abnormalities may also occur. The flooding of the lungs with blood plasma is a type of internal hemorrhaging and the person literally drowns.
   d. **prevention:** Avoid exposure to rodent contaminated areas, both indoors and outdoors.
   e. **treatment:** Treatment of symptoms and putting the person on a respirator.
Fungal Diseases

Fungal infections are quite common and rarely cause serious illness unless the immune system is suppressed.

1. Histoplasmosis
   a. causative agent: Histoplasmosis capsulatum
   b. method of transmission: The fungus thrives in droppings of birds and bats and transmission is by the inhalation of airborne spores.
   c. symptoms: Flulike symptoms unless a large number of spores are inhaled which causes a pulmonary infection resembling pneumonia. Immunosuppressed people may develop a chronic respiratory illness similar to tuberculosis or it may spread to other organs.
   d. prevention: Avoidance of caves inhabited by bats and chicken houses where air is laden with spores.
   e. treatment: Amphotericin B, itraconazole, or ketoconazole.

3. Cryptococcus
   a. causative agent: Filobasidiella neoformans (yeast)
   b. method of transmission: Birds, especially pigeons, carry the fungi on their feet and beak and it thrives on bird feces. Transmission is by airborne yeast cells.
   c. symptoms: Mild symptoms of respiratory infection and it may spread to the meninges and invade brain tissues in immunosuppressed individuals. It is increasing in incidence in AIDS patients.
   d. prevention: Reducing the pigeon population and decontaminating droppings with alkali.
   e. treatment: Flucytosine combined with amphotericin B.

4. Aspergillosis
   a. causative agent: Aspergillus fumigatus and other species.
   b. method of transmission: Inhalation of spores from compost piles, soil, wood chips, and rotting vegetation.
c. symptoms: Allergic asthmatic response or invasive infection of the lungs. Fungal balls (aspergilloma) of mycelium in the lungs can obstruct gas exchange and cause asphyxiation.

d. prevention: Avoid inhalation of a large quantity of spores.

e. treatment: Amphotericin B and surgical removal of the fungal balls.

Protozoan Diseases

Pneumocystis pneumonia

There is uncertainty as to whether this is a protozoan or fungal organism.

a. causative agent: Pneumocystis carinii

b. method of transmission: Unknown, however, it is found in the lungs of many people. Between 75 to 90% of healthy children under the age of 4 years show evidence of past infection. This suggests that it is inhaled during infancy or childhood without causing disease. It may then become reactivated when the immune system becomes suppressed.

c. symptoms: Fever, cough, alveolar walls become thickened which causes the epithelium to rupture. The microorganism and a foamy substance from the cells accumulates in the alveoli, resulting in a foamy sputum. It is the most common cause of death in AIDS patients.

d. prevention: Unknown. AIDS patients are given trimethoprim-sulfamethoxazole.

e. treatment: trimethoprim-sulfamethoxazole or pentamine isethionate.