TCHP Education Consortium

Issues in Infection Control

Introduction/Purpose Statement

We are constantly waging a silent war against attack, invasion, and infection. Every day, we fight bacteria, viruses, fungi, and other pathogens that would cause disease. The purpose of this home study program is to take you through the normal defenses of the body, how infection occurs, and a brief synopsis of three of the most prevalent infectious disease conditions today.

Target Audience

This home study was designed for nurses with no familiarity with issues in infection control; however, all health care professionals are invited to complete this packet.

Content Objectives

1. Describe the normal defenses of the human body against disease.
2. Describe risk behaviors for HIV transmission.
3. Describe populations at risk for infection or colonization with resistant organisms.
4. Describe infection control strategies designed to prevent infection.

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Planning Committee/Editors

Linda Checky, BSN, RN, MBA, Assistant Program Manager for TCHP Education Consortium.

Lynn Duane, MSN, RN, Program Manager for TCHP Education Consortium.

Author

Karen Poor, RN, MN, Former Program Manager at the TCHP Education Consortium

Content Expert

Dede Ouren, RN, Manager, Infection Control Department, Regions Hospital.

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Please see the last page of the packet before the post-test for information on submitting your post-test and evaluation for contact hours.

Our Body's Defense

The Epithelium

The Skin

The outer layer of skin is constantly exfoliated, which prevents bacteria and chemicals from penetrating. The normal flora of the skin aid in its defense by splitting the lipids of the epidermis into unsaturated fats, which prevents other bacteria from growing on the skin surface. Sebaceous glands and mammary glands produce secretions that kill bacteria, including secretory IgA, which may prevent the attachment of pathogens.

The Respiratory System

The epithelium of the respiratory system (nose, sinuses, larynx, and trachea) contains cilia and mucous glands. The cilia and mucus act together to trap foreign particles and move them up to be either coughed or sneezed out. The bones of the nose turbinate (swirl) the air so that dust, microorganisms, and foreign particles adhere to the mucus in the nose, rather than traveling down the trachea. Finally, alveolar macrophages phagocytize foreign material and microorganisms.

The Gastrointestinal System

Saliva contains water, lysozyme, mucus, secretory IgA, enzymes, and cells. These substances create a fluid flow which makes it difficult for chemicals and microorganisms to attach to the epithelium. The gastric mucosa secrets hydrochloric acid, gastric juice, and mucus, which act in combination to destroy pathogens and flush them through the system. The normal flora of the bowel is attached to specific receptor sites, rendering them inaccessible to other pathogens. Peristaltic motility and periodic epithelial exfoliation aid in flushing foreign agents out of the system.

The Genitourinary System

In the male, the urethra is long and acts as a conduit for multiple secretions, some of which are antibacterial in nature. In the female, the urethra is shorter and serves only the urinary system. The epithelium of the urethra secrets mucous, lysozyme, secretory IgA and other antimicrobial substances.

Cellular and Chemical Defense

The bone marrow produces erythroid, myeloid, and thrombocytic cells. The bone marrow is the source of lymphocytes and macrophages. At birth, there is bone marrow activity in almost every bone. With age, marrow is replaced by fat cells until hematopoiesis is confined to the flat bones, sternum, ribs, skull, pelvis, and shoulder girdles.

All of the active defenders are white blood cells, divided into two groups: granulocytes and agranulocytes. The granulocytes (also known as polymorphonuclear leukocytes -- PMN's) include the neutrophils, eosinophils, and basophils. The agranulocytes include macrophages and lymphocytes.

Neutrophils phagocytize foreign materials, particularly bacteria. They are capable of killing bacteria and digesting the ingested materials through lysosomal hydrolytic enzymes. Neutrophils are activated minutes after microbial invasion, and normally die as a result of the phagocytosis.

Eosinophils phagocytize immune complexes (antigen+antibody) and limit the degree of inflammation. Eosinophils also secrete a protein that injures both tissues and parasites. Eosinophil counts rise with allergic reactions and parasitic infections.

Macrophages are large, long-lived white blood cells. Macrophages are important in recognizing which materials "belong" in the body, and which materials do not. Macrophages ingest foreign particles (including debris, cells, bacteria, etc...) after recognizing the particle as being a "non-self" material. The macrophage cannot "kill" a bacterium, but processes it for lymphocyte destruction. The macrophage releases monokines (one of which is interleukin I), which alert the lymphocytes to an antigen.

Mechanisms of Defense

Inflammation

Inflammation is the first step of the defense. Inflammation prepares the injured area for the defenses to arrive through a vascular response, and helps to destroy pathogens.

Phagocytosis

Phagocytosis is the process of engulfing and isolating foreign material and microorganisms by neutrophils, eosinophils, and macrophages.

Pyrogen

Pyrogen is a substance that is produced by the neutrophils and macrophages in response to inflammation. This substance causes fever, which inhibits bacterial multiplication and changes enzyme activities that are temperature dependent.

Interferon

This substance was first recognized for its activity in protecting a host cell from viral infections. Interferon has since been studied for its activity against some microorganisms and its ability to inhibit division of both normal and malignant cells.

Acquired Host Defenses

Immunity is an active defense that is acquired by the host. It is provided by the lymphocytes by either antibody production through B-cell lymphocytes or cellular immunity through T-cell lymphocytes.

Manufacturers

Lymph nodes serve as proliferation sites for lymphocytes when stimulated by antigens. They produce both lymphocytes and monocytes.

The thymus is a site of hematopoiesis and a maturation site for T-lymphocytes in the fetus and infant. The T cells go to the thymus for DNA programming and then to go the lymph nodes and lymph tissue. The thymus degenerates and is non-functional after childhood.

The spleen stores the majority of lymphocytes and macrophages, and is important in antibody synthesis and other defense mechanisms.

T-Lymphocytes

T-Lymphocytes (T-cells) provide **cell mediated immunity.** The T cells work with macrophages to process an antigen, and then work with the B-cells to stimulate antibody production. T-lymphocytes comprise 80% of all circulating lymphocytes. There are four types of T-cells:

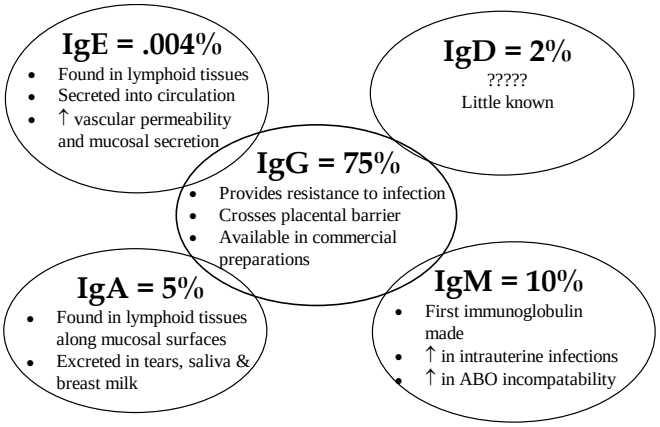
- **Helper T-cells** assist B-cells with antibody production.
- **Killer T-cells** kill with lymphokines and are capable of attacking cancer cells.
- **Suppressor T-cells** control lymphocyte production.
- **Memory T-cells** remember antigens to which the body has been exposed and assumes helper and killer functions when they are re-encountered.

B-Lymphocytes

B-lymphocytes provide **humoral immunity**. When the body is exposed to an antigen, the B-cells are alerted by the macrophages. The B-cells, acting with the T-cells, change into plasma cells and produce antibodies. These antibodies are specific to the antigen and circulate freely in the blood and tissue spaces.

Antibodies (immunoglobulins) are protein molecules possessing a unique sequence of amino acids (peptide chains) that permit highly specific interactions with antigens.

The antibody will go to the antigen to link an IgG and IgM to the antigen, which increases phagocytosis, or may interact with the antigen to cause clumping (e.g. transfusion reaction). To amplify the immune response, antibodies also stimulate the release of vasoactive IgE, certain chemicals (histamine, SRS-A, and ECF-A), and the complement cascade.



When the Defenses Fail

Immunosuppression: When an immune response cannot be formed.

Immunodeficiency: When the immune response to antigens is compromised causing phagocytosis and/or production of antibodies to be dysfunctional.

What are the causes of immunosuppression and deficiency?

Primary immunosuppression can be congenital; a result of taking immunosuppressive drugs (e.g.; chemotherapy or immuno-suppressive agents post organ transplant); or caused by the human immunodeficiency virus (HIV), which leads to acquired immunodeficiency syndrome (AIDS).

Immunodeficiency may also be a secondary effect of other processes. ***Phagocytosis*** is abnormal or decreased in burns, anesthesia, alcoholic cirrhosis, corticosteroid use, diabetes, Hodgkin's disease, and malnutrition. ***B-cell function*** is diminished with burns, corticosteroid use, myeloma, and nephrotic syndrome. ***T-cell function*** is diminished with acute viral infection, aging, anesthesia, burns, hepatitis, corticosteroid use, Hodgkin's disease, malnutrition, tuberculosis, and uremia.

Organisms That Cause Infection

An antigen is any foreign substance that enters the body. Examples of antigens include:

- Microorganisms: bacteria, virus; spirochetes, rickettsia, chlamydia, fungi
- "Non-self" tissues or cells: transplanted organs or tissues, non-matched blood transfusion
- Foreign proteins or polysaccharides: endotoxins or exotoxins made by bacteria

Bacteria

Bacteria are small, one celled organisms which autonomously replicate outside a host cell. All bacterial organisms have a rigid outer wall that is made up of a unique polymer called peptidoglycan. Not all bacteria are "bad guys" in the immunologically intact host; some provide essential functions as part of the normal flora.

The structure of the outer wall determines the shape of the bacteria, for example:

- Spherical bacteria = cocci (a chain = streptococci; a cluster = staphylococci)
- Helical bacteria = spirilla
- Elongated bacteria = bacilli

Viruses

Viruses are very, very small microorganisms that need to live inside a host cell. They reproduce (replicate) by using the biochemical machinery inside the host cell. Viruses penetrate a susceptible host cell and either cause the death of the cell during replication, or insert their own DNA or RNA genome into the cell, altering the host cell function.

Spirochetes

Spirochetes are actually bacteria, but have such different forms and mechanisms that they are typically placed in a separate class. Spirochetes are responsible for infections such as Lyme disease and syphilis.

Rickettsia and Chlamydia

These organisms are both made up of bacterial and viral traits. They need to live inside a host cell; but are able to reproduce without using the cell's machinery. Examples of diseases caused by these organisms are Rocky Mountain spotted fever, epidemic typhus, and genital infections.

Fungi

Fungi come in two forms: molds and yeasts. Though normally quite harmless and part of the normal human flora, fungi can become pathogenic when the host immune system has been affected. Common diseases include athlete's foot, thrush, and vaginal yeast infections. Aspergillus pneumonia, another fungal infection, has a high mortality rate.

How They Cause Infection

Toxins

Endotoxins are complex molecules in the bacterial cell wall that trigger regulatory responses in the host, such as clotting, bleeding, inflammation, hypotension and fever. Endotoxins are released when the cell dies and is lysed.

Exotoxins are proteins that are released by the bacterial cell during growth. These exotoxins can inactive a host cell, or may modify cells to cause major dysfunction. Botulism is one example of a bacterial exotoxin action, where the exotoxin interferes with neurotransmitters, causing paralysis and death.

Adherence

Microorganisms may or may not require certain sites or cells on which to attach. In order to adhere to their chosen spot, microorganisms have developed: (1) highly specific "*ligands*," which are substances that attach to the cell receptor site, (2) hairlike structures called *pili* or *fimbriae*, or (3) in the case of viruses, *hemagglutinins* which bind to upper respiratory tract cells. After initial adherence, many bacteria secrete "slime" or mucus that helps anchor them to the cell.

Evasive factors

Microorganisms have a variety of mechanisms that enable them to stay alive past all host defenses. These mechanisms include:

- **Excretion of extracellular polysaccharides** (capsules, slime, mucous layers) which decrease the ability of the neutrophils and macrophages to phagocytize the causative organism
- **Excretion of leukocidins** which kill WBC's
- The ability to **survive and reproduce inside the phagocytic cells**
- Excretion of **surface proteins which bind IgM or IgA**
- The ability to **alter their own surface antigens** to avoid detection by the active defenders

How does a pathogen invade the body?

Penetration: Microbes can invade through any break in the skin or mucous membranes. For example:

- **Accidental injury** -- burns, trauma, abrasions
- **Medical procedures** -- surgery, IV access, invasive cardiac procedures
- **Inoculation** -- insect or animal bites, IV drug use, rubbing mucous membranes

Direct contact: Invasion through intact mucous membranes. Examples include sexually transmitted diseases, mother to infant transmission during birth, and contaminated medical equipment.

Ingestion: Bacteria, viruses, and parasites can invade through the GI tract via ingestion by the host. Examples include cholera, dysentery, and hepatitis A.

Inhalation: Although the respiratory system has a very efficient filtering system, organisms that cause pneumonia, meningitis, chicken pox, measles, and tuberculosis can invade a healthy individual.

Focus on Tuberculosis

What causes tuberculosis?

Tuberculosis is a disease which is caused by the *Mycobacterium tuberculosis*, a bacillus which is spread by airborne droplets that contain *M. tuberculosis* particles.

The majority (85%) of sites for tuberculosis disease are in the lung. Other potential sites include the pleura, central nervous system, lymphatic system, genitourinary system, and bones/joints. "Miliary" tuberculosis is the term used when the tuberculosis is disseminated throughout many body systems.

The good news:
TB rates are decreasing!

- 2002: 15, 075 new cases
- 2003: 14, 874 new cases
- 2004: 14, 511 new cases

In Minnesota:
TB rates are also decreasing[1]

- 2002: 237 new cases
- 2003: 214 new cases
- 2004: 199 new cases
- 2005: 199 new cases

I had a positive Mantoux test (also known as PPD for Purified Protein Derivative)-- does that mean I have tuberculosis?

Being infected with tuberculosis does not necessary mean that you have tuberculosis as a disease. In most (90%) people, exposure to tuberculosis will not cause tuberculosis as a disease. Exposure to tuberculosis will cause an activation of the immune system. The immune system response halts the spread of tuberculosis within 2-10 weeks of the exposure. The immune system response causes a positive skin test (Mantoux) reaction.

Occasionally, the immune system is unable to mount a response because the host is ***anergic***. Anergy is defined as a decreased or absent delayed-type hypersensitivity reaction. Individuals with HIV, measles, Hodgkin's disease, sarcoidosis, or who are taking immunosuppressive drugs may be anergic. In these individuals, two controls (such as candida and mumps) are usually placed at the same time as the TB skin test.

EVERYONE SHOULD RESPOND TO ONE OF THE CONTROLS.
If all three tests are negative, the patient is anergic.

TB disease will develop within 1 year in approximately 5% of all people infected with tuberculosis. In another 5%, the disease will occur at a later time in their lives, when their immune system is challenged by another disease or condition.

Who is at risk for getting TB disease?[2]

Some people are 3-100 times more likely to develop the TB disease after exposure. They include people with:

- An HIV infection
- A history of substance abuse
- Diabetes mellitus
- Silicosis
- Been on prolonged corticosteroid or other immunosuppressive therapy
- Cancer of the head or neck
- Hematologic and reticuloendothelial diseases
- End stage renal disease
- Had an intestinal bypass or gastrectomy
- Chronic malabsorption syndromes
- A low body weight

Certain groups of people are more at risk to get TB: who?[3]

- People who are in close contact to persons with infectious TB
- Foreign born persons from TB prevalent areas (Asia, Africa, Latin America)
- Medically underserved, low income populations
- The elderly
- Residents of long term care facilities, including prisons and nursing homes
- Persons who inject drugs
- Persons who are occupationally exposed to infectious TB

How is TB diagnosed?[4]

There are four main assessments that together can diagnose TB:

1) Medical history:

- a productive cough > 3 weeks
- chest pain
- hemoptysis
- fever
- chills
- night sweats
- tiredness
- anorexia/weight loss

2) Tuberculin skin test:

- there is normally positive skin reactivity 2-10 weeks after exposure
- the skin test reaction is measured in millimeters (not as positive or negative); no reactivity should be documented as "0 mm"
- the average person exposed to TB may have a reaction of > 10 mm
- an immunosuppressed patient may have a positive reaction with < 10 mm

3) Chest Radiography:

- the most common sites for lesions are in the apical or posterior segments of the upper lobe or the superior aspect of the lower lobe

4) Laboratory (Bacteriologic Evidence):

- collection of the first sputum sample to test for acid-fast bacilli (AFB) should be completed within 24 hours of admission/first visit; the series of three should be collected in the morning on three consecutive days

How is TB classified?[5]

The CDC has developed a classification system for looking at the pathogenesis of TB:

Class	*Type*	*Description*
0	No TB exposure Not infected	• No history of exposure • Negative reaction to skin test
1	TB exposure No evidence of infection	• History of exposure • Negative reaction to skin test
2	TB infection No disease	• Positive reaction to skin test • Negative bacteriologic study • No clinical or radiographic evidence
3	Current TB disease	• *M. tuberculosis* cultured or a positive skin test • Clinical or radiographic evidence of current disease
4	Previous TB disease	• History of episode(s) of TB or abnormal but stable radiographic findings • Positive skin test • Negative bacteriologic studies • No clinical or radiographic evidence of current disease
5	TB suspected	Diagnosis pending

Source: Core Curriculum on Tuberculosis (3rd ed.) (1994). U.S. Department of Health and Human Services

Can the spread of TB be prevented?

Measures that can increase drug compliance:

1. Asking the patient on routine visits if he/she is taking the medications as ordered.
2. Counting the number of pills.
3. Checking the urine for medication metabolites.
4. Checking for continued negative bacteriologic tests.
5. Directly Observed Therapy (DOT) for patients who demonstrate nonadherence to the therapy.

Besides infection control measures, the CDC has recommended that people who are at high risk for contracting TB should receive preventative therapy. These high priority candidates include persons with a positive skin test reaction, regardless of age, who: [6]

- Are known or are suspected to have HIV
- Are close contacts of persons with infectious TB
- Have a chest x-ray suggestive of previous TB
- Are injectable drug users

Persons with a positive skin test reaction who are under 35 years of age and are: [7]

- Foreign born from TB prevalent countries
- Medically underserved or are from low income populations
- Residents of long term care facilities (including prisons and nursing homes)
- Under 4 years of age

What does preventative therapy include? [8]

- Adults are given 300 mg of isoniazid (INH) daily for six months.
- Children are given 10-15 mg/kg of isoniazid daily for nine months.
- Adults with HIV are given 300 mg of isoniazid daily for 12 months.
- Rifampin is given to high priority people who are in close contact with an individual who has drug-resistant TB.

What treatment is available for TB disease?

The treatment of TB disease is multi-faceted. The first element of treatment is pharmacological intervention with a combination of drugs -- isoniazid, rifampin, pyrazinamide, ethambutol (or streptomycin). These drugs are combined to provide the most effective and wide spread coverage against the susceptible TB bacilli. The pharmacologic treatment lasts between 6 and 24 months.

The second element of treatment is education. Patients must be educated about the transmission and course of tuberculosis; the dosing of medications; the possible adverse effects of the medications; and the importance of taking the medications.

Nonadherence to the drug regimen is one of the biggest problems related to TB treatment. It is estimated that **25% of patients do not complete 12 months** of recommended therapy.

This can lead to increased numbers of drug resistant tuberculosis, already a major health hazard.

What TB controls need to be in place to be compliant with OSHA?

Administrative Controls

CDC guidelines, which are enforced by OSHA, say that all facilities need to have a plan in place for the early detection of TB. Patients who have the signs and symptoms of TB should be moved immediately away from other patients, preferably into tuberculosis isolation rooms. These patients should wear a surgical mask, and should be instructed to cover the mouth and nose while coughing or sneezing.

The person with the signs and symptoms of TB should be evaluated quickly and have the appropriate treatment started as soon as possible. All confirmed or suspected TB cases should be reported to the CDC immediately.

Education of the patient and family is vital in decreasing the transmission of TB to other people. The mode of transmission and reasons for TB isolation should be explained fully to the patient. Plans should be made early to ensure that contact investigations and discharge plans are comprehensive and will be carried out.

Visitors should be limited to household contacts and should wear surgical masks for respiratory protection. These visitors may also have TB -- causing a potential threat to staff and other patients.

Health care workers also need to have education on the basic concepts of TB transmission and pathogenesis; on infection control practices; on the signs and symptoms of TB; and the importance of participating in the employee skin testing program. Finally, each facility should have a TB screening and prevention program in place for their employees.

Engineering Controls

The primary infection control strategy related to engineering is that of an adequate ventilation system. An efficient ventilation system will decrease the concentration of infectious droplet nuclei in the air and will prevent the dissemination of droplet nuclei throughout the facility. The ventilation system should maintain negative pressure in a TB isolation room and should exhaust the air properly directly to the outside. To assist the ventilation system, the doors to a TB isolation room should remain closed except when entering or exiting a room.

UVGI = ultraviolet germicidal irradiation

HEPA = high-efficiency particulate air filtration

Rooms must be tested daily in TB isolation rooms to assure that negative pressure is being maintained. Other engineering measures, such as UVGI and HEPA filtered exhaust, may be appropriate in certain conditions as recommended by the Infection Control Department and by building engineers or consultants.

Personal Controls

Personnel need to wear respiratory protection and ensure that their work practices include shutting the doors to isolation rooms to prevent transmission.

All health care workers that may be exposed to patients with TB must be educated about respiratory protection, and fit-tested for a personal respirator. There are different types of respirators available. Two common types are the 3M Disposable N95 and the 3M Powered Air Purifying Respirator (PAPR).

Well fitting personal respirators should be worn in TB isolation rooms, in rooms where coughing procedures are done, and in the homes of infectious TB patients.

Procedures such as suctioning, ET intubation, sputum inductions, sputum collections, bronchoscopies and administration of aerosolized pentamidine treatments should be done in a TB isolation room or negative pressure procedure room and well fitting respirators must be worn by all health care workers.

Focus on HIV and AIDS

What microorganism causes HIV and AIDS?

HIV is a retrovirus which enters the body and establishes an infection in a host cell by attachment to T4 helper/inducer lymphocytes, monocytes and macrophages. The method of host cell penetration is unknown at this time.

At this point in time, researchers hypothesize that a massive, overwhelming explosion of HIV reproduction occurs with initial infection. The explosion overwhelms the immune system, causing a decrease in the appropriate immune response that protects against infection.

The initial high level of reproduction eventually slows or maintains a constant level. Billions of new HIV virons may be produced each day. A loss or degradation of the virus begins to occur. Eventually, a relatively steady state in which reproduction and loss are approximately equal occurs. This steady state of production or loss is unique to each individual.

How is the presence of HIV assessed?

HIV infection is unique to each individual. Factors influencing HIV infection include the strain of the virus acquired and the individual immune system response. When the virus is overpowering, the body succumbs to infections and symptomology that is unique to this infectious process.

Assessment of the HIV infection has been primarily based on the CD4 (or T4) helper count. This blood test is able to provide insight into the immune system damage as a result of HIV infection. The normal range of the CD4 count is 500-1,200. The lower the CD4 count, the higher the chances for becoming ill with an infection. A person with a CD4 count of less than 200 is considered at significant risk for developing HIV infections.

A test called the **HIV viral load test** has been developed which quantifies the amount of HIV virus in the blood. The test is usually ordered soon after HIV has been diagnosed.

Test results give an estimation of the level of HIV present. The HIV viral load test is reported as the number of HIV copies in a milliliter of blood.

A high viral load (between 5,000 – 10,000 copies) indicates that the virus is actively reproducing, and that the disease may progress more rapidly than if the viral load is low. The viral load can be as high as one million or more.

A low viral load (between 200 – 500 copies) indicates that HIV is not rapidly reproducing, and that the disease may progress more slowly. The prognosis is better with a lower level of HIV viral load.

If the viral load count increases, this generally indicates that the infection is worsening. When the count decreases, this indicates improvement.

The **Rapid HIV Antibody Test** will detect the antibody to HIV-1 in the blood in 5 – 30 minutes. This test is not available in all hospitals, and may be restricted to specific use (e.g. employee exposure only).

The rapid HIV-1 test may not detect HIV-1 infection in people exposed with in three months of being tested because it can take that long for antibodies to HIV-1 to be detectable. The CDC recommends confirming the results with an additional, more specific test.

Is there a classification system for AIDS?

There are three classifications of HIV and AIDS as written by the Centers for Disease Control (CDC).

Category A
The patient may:
- be asymptomatic
- have a persistent generalized lymphadenopathy
- have an acute (primary) HIV infection with accompanying illness or history of acute infection

Category B
The patient has one or more of the following infections:
- Bacillary angiomatosis
- Candidiasis (oral or vaginal)
- Cervical dysplasia
- Constitutional symptoms
- Hairy leukoplakia (oral)
- Herpes zoster
- Idiopathic thrombocytopenia purpura
- Listeriosis
- PID
- Peripheral neuropathy

Category C
The patient has one or more of the following infections:
- Candidiasis of bronchi, lungs, trachea, esophagus
- Invasive cervical cancer
- Coccidioidomycosis
- Extrapulmonary cryptococcosis
- Cytomegalovirus disease (retinitis)
- Encephalopathy
- Chronic herpes simplex ulcers
- Histoplasmosis
- Isosporiasis

The symptomology of HIV and AIDS...

It is important to note that an **HIV infection** is when a person has the virus, but has not exhibited significant symptomology. A person is said to have **AIDS** when that person has had significant dysfunction with the immune system, resulting in HIV-related symptoms and infection.

The symptomology is related to the type of infection that the individual has. Each individual has unique symptoms that may vary considerably. In the past, the most frequently seen health complaints were:

- fatigue
- low grade fevers
- night sweats
- weight loss
- mouth sores

The more common infections are **candidiasis** and **Pneumocystis carinii pneumonia (PCP).**

How does a person "get" HIV?

When using a condom to decrease the risk of transmission:
DO wear latex condoms for anal or vaginal sex
DO use water based (not oil based) lubricants
DON'T store condoms for long, because they may dry out
DO leave space at tip
DO remove condom immediately after ejaculation
DO use nonoxynol-9 (a spermicide) for added protection

Although HIV has been transmitted through blood transfusions and occupational exposure, HIV is **usually** transmitted when an uninfected person engages in risk behaviors with an infected person. The risk increases when a person is exposed to multiple partners.

The risk behaviors include:

- Sexual intercourse: vaginal or anal without condom or condom used incorrectly
- Sharing needles: work cookers, spoons, and other drug-injecting paraphernalia

- Oral sex (vaginal or penile) with a partner who has genital or oral lesions/sores, bleeding gums or menstrual blood
- Pregnancy, birth or breast feeding: transmission can occur from mother to baby.

How can a person prevent HIV transmission?

Practicing safe sex is one of the ways to minimize the chances of acquiring HIV. In safe sex, sexual partners keep their blood, semen, pre-ejaculate and vaginal secretions from entering each other's bodies.

Differing sexual behaviors carry different levels of risk depending on how likely they are to allow exposure to blood, semen, pre-ejaculate and vaginal secretions. Understanding the ***level of risk*** is important for making informed choices about how much risk is acceptable.

Safe sex should be practiced even if both partners are infected.

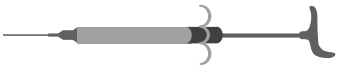
Absolutely Safe: Abstinence, dry kissing, masturbation, external water sports, massage, oral sex with condom or dental dam, rimming (mouth on anus) with dental dam, finger sex with gloves, touching, fantasy

Reasonably Safe: Wet kissing or vaginal or anal intercourse with condom.

Risky: Oral sex without barrier, masturbation on open/broken skin, rimming without barrier

High Risk: Vaginal or anal intercourse without condom, oral sex with woman during menstrual cycle, internal water sports (urination inside a body cavity), fisting (inserting fist into anus) without gloves and lubricant

What about injectable drug use?



Another risk behavior is the practice of **injectable drug use**. Factors increasing the risk of transmission of HIV (and hepatitis) include *sharing contaminated equipment*, direct sharing of the drug, **sharing drug preparation equipment**, and *sharing either equipment or drugs with an unknown person*.

Although sharing equipment or drugs with another individual is risky, there are reasons why it is done:

- sharing is a ritual embedded within the drug using subculture;
- the drug user cannot be arrested for possession of drug paraphernalia if he/she is not carrying it;
- individuals save money when they can share.

To minimize the risk of HIV transmission, IV drug users should be encouraged to abstain from drug use, or, if they are unable to abstain, to use sterile needles and syringes and to participate in needle exchange programs.

Needle exchange programs are available to distribute sterile syringes, to collect contaminated syringes, and to establish trust and rapport with injectable drug users to permit education and counseling.

As a health care worker, what are my risks for contracting HIV?

Ninety-three percent of the U.S. AIDS cases are related to human behaviors involving sexual contact or sharing needles during injectable drug use. A small percentage (< 0.01%) of the remaining reported AIDS cases are related to occupational exposure.

You are 300 times more likely to acquire hepatitis B than HIV from a blood exposure.

Though exact numbers are difficult to obtain because of poor reporting, it is estimated that there are between 500,000-800,000[9] exposures from sharps each year in health care. Of those, approximately 5,000[10] exposures may be from those who are HIV infected.

The risk of acquiring hepatitis following a percutaneous exposure from a Hepatitis B infected source is as high as 30%. The risk of acquiring HIV after the same type of exposure from an HIV infected source is approximately 0.3%. The risk of acquiring HIV following exposure with a contaminated **hollow bore needle** is higher, and may be as much as 1%.

Some occupational infections reported among nurses have been related to:

- Exposure to a terminally ill AIDS patient
- Exposure to a needle used in a blood vessel
- Exposure to a visibly bloody device
- Receiving a deep puncture
- Recapping needles
- Drawing blood
- Administering injectable medications

- Inappropriate disposal of contaminated needles

Universal Blood and Body Fluid Precautions, as recommended by the CDC, considerably reduce the chance of acquiring HIV through a patient contact.

Who is more at risk for acquiring HIV?

The good news is that the number of new AIDS cases has been dropping over the last several years (18% decline from 1996-1997 and 12% decline from 1997-1998). The bad news is that the CDC estimates that there are between 690,000 - 900,000 people living with AIDS in the U.S. - and that 200,000 don't know it.

The majority of new AIDS cases are men who have sex with men (60%) and injectable drug users (25%). HIV has hit in a disproportionately greater incidence in the black community (66%). Though heterosexual risks are lower, the rates of infection have been dramatically rising in the past several years, up to 15% for men and 75% for women.

> Recent research studies indicate that the rate of HIV infection among women is rising, from 7% in 1985 to 23% in 1999.[11]

What is involved in testing for HIV?

Testing for HIV should be a part of any and all STD assessment and testing. HIV counseling and testing involves facts, risk reduction techniques and benefits to testing. Testing is offered at most, if not all, health facilities around the country.

Testing for HIV currently involves a sample of blood that is processed for the detection of antibodies produced in response to the presence of HIV in the body. The testing typically includes the Western Blot and the ELISA antibody tests. Both tests are used to increase the validity of the results. Test results may take up to several weeks. In the near future, the use of HIV viral load may lead to a faster, and possibly more accurate, identification of HIV.

> One example of new devices to decrease exposure is the needle-less systems. IV-connection injuries have decreased 50-60%.[12]

Changes in the identification and treatment of HIV...

Dramatic changes have occurred during the past several years. The ability to measure HIV levels and using combination drug therapy with up to 11 anti-HIV medications is quickly moving this infection into the arena of a manageable, though not curable, chronic disease. Current standards of therapy include treatment with 2-4 medications for detectable HIV levels. The goal is to maintain the HIV level as low as possible for as long as possible.

As a result of the current "cocktail" therapies, many people are not progressing into the later stages of AIDS. HIV infected people are having fewer infections and are generally feeling better. This is clearly demonstrated by the dramatic turn-around in the death rate.

Current concerns are related to the possibility that HIV infected people will develop resistance to the combination therapies. In addition, the use of the multiple drug cocktail and non-compliance factors may lead to virulence and more aggressive strains of the virus.

Infection Control Considerations

Administrative Controls

Attempts to limit the spread of diseases such as HIV start with administrative controls. Policies and procedures which outline the action plan for protecting against exposure and for what to do if an exposure occurs are mandated by OSHA. Health care facilities need to have:

1. An Exposure Control Plan
2. A Post-Exposure Plan
3. Training records for three years
4. Records that document the exposure incident + 30 additional years

Administratively, health care facilities must also:

- Analyze puncture injuries and other exposures
- Watch the market for new devices that may decrease certain types of exposure incidents
- Offer the Hepatitis B vaccine annually to all employees who have not had the vaccine

Engineering Controls

Needle puncture containers, special disposal units for contaminated liquids, and cleaning procedures are among the engineering controls at many institutions. Needle-less IV systems have become predominant in the last several years, minimizing the chance for needle stick.

Personal Protection

All health care facilities now practice Universal Blood and Body Fluid Precautions (also known as the Standard Precautions). Many facilities have written the elements of Universal Precautions into the performance-based evaluation of the health care worker.

All health care workers should:

1. Anticipate the task and wear appropriate protective gear;
2. Separate solid and liquid wastes;
3. Place liquid wastes in a special container which will not be compacted;
4. Label all bags that contain contaminated equipment or laundry with a Biohazard sticker;
5. Place all disposable sharp instruments/needles into a puncture-proof container.

Focus on Antibiotic-Resistant Organisms

Every year, more than 1 million people hospitalized in the U.S. become infected with drug-resistant organisms. Despite staggering treatment costs, many die as a result of these infections. This may get worse. Organisms continue to develop greater resistance to antibiotics, while we are running out of new drugs to fight them.

Resistance to what?

Organisms are said to be "resistant" when an antibiotic which normally kills the organism fails. The resistance of organisms is to **antibiotic drugs** but not to chemical disinfectants, germicides, or antiseptics.

The Growing List of Resistance...

Enterococcus	*Escherichia coli* (E. coli)
Fungal infections	*Haemophilus influenzae*
HIV	*Neisseria gonorrhea*
Pseudomonas	Salmonella
Shigella	Staphylococcus
Tuberculosis	*Streptococcus pneumoniae*

What's the Big Deal?

Infections caused by antibiotic resistant organisms pose treatment difficulties, as the antibiotic of choice can no longer be used with effectiveness. These organisms, once established in health care facilities, are also difficult to eliminate and may become the source of nosocomial outbreaks. Finally, scientists are concerned that organisms can transfer resistance genetically to another organism that is not yet resistant.

How Can It Cost So Much?

Antibiotic resistance results in $100 million - $30 billion in excess costs for U.S. hospitals each year. Why?

Patients with infections related to resistant organisms have to stay longer in the hospital; require private isolation rooms; and have increased pharmacy, laboratory, personnel, physician, and supply costs. Developing a single new antibiotic can cost over $300 million (est.).

How Does Resistance Develop?

There are three ways that resistance to antibiotics can develop:

1. The organism has a built in resistance to an antibiotic (**intrinsic resistance**). For example, vancomycin is not used with gram-negative bacterial infections because gram-negative bacteria are not susceptible to the action of vancomycin.

2. Repeated exposure to antibiotics can cause a genetic shift in an organism, which may be transferred from other organisms (**acquired resistance**).

3. Using one drug exclusively, overusing antibiotics, and using subtherapeutic doses of antibiotics can cause an antibiotic to become resistant through a process called "**selective pressures**."

There are also contributing factors to resistance, including:

- Excessive and prolonged use of antibiotics
- Over-the-counter availability in many countries
- Prolonged survival and treatment of patients with chronic diseases
- Antibiotics in feed animals
- International travel and migration

Why won't my doctor give me antibiotics any more for a cold or flu?

The prescription of antibiotics using "bad habits" has also contributed to the development of resistance:

1. Prescribing antibiotics before the culture results are available
2. Failing to review and change therapy when culture results are obtained
3. Using the "Big Guns" (broad spectrum combination antibiotics) instead of using antibiotics specifically designed to "kill" the bacteria
4. Using antibiotics for surgical prophylaxis without good indications
5. Continuing therapy long after appropriate

What happens to these organisms?

The resistant organisms may be eliminated by the host, or they may continue to increase in numbers. The organisms may also be spread to a new host, resulting in either colonization or infection.

Vancomycin-Resistant Enterococcus (VRE)

VRE is not overtly virulent and has little pathogenic effect in the normal host. In the compromised host, however, VRE may cause:

- Urinary tract infection
- Bacteremia
- Endocarditis
- Skin and soft tissue infections
- Wound infections
- Meningitis (rarely)

People who are at risk for becoming infected or colonized with VRE are those individuals who are **critically ill** or **debilitated** with a severe underlying disease; individuals who are **immunosuppressed**; or those after **intra-abdominal** or **cardiothoracic surgery**. Other patients at risk are those who have **indwelling devices** (urinary or CV catheter); those who have had a **prolonged hospital stay**/**ICU stay**; and those who have been on **prolonged anti-microbial therapy/vancomycin therapy**.

Enterococcus is part of the normal flora of the GI tract. *Vancomycin-resistant Enterococcus* (VRE) is a gram-positive cocci which has developed a resistance to vancomycin and most other antibiotics. Areas which act as reservoirs for VRE include the female reproductive tract, the male perineal or meatal area, wounds/decubitus ulcers, and even the nose. VRE is transmitted through direct contact. VRE may survive on both gloved and ungloved fingertips for at least 60 minutes, and persists on the diaphragmatic surface of a stethoscope for 30 minutes. This bacterium can survive on environmental surfaces for 5-7 days.

In Europe, colonization with VRE in the community setting is much more common than in the U.S. Researchers believe that the subtherapeutic use of an antibiotic called "avoparcin" in food-producing animals may cause human colonization. This drug is not approved for use in the U.S. [13]

Methicillin-Resistant Staphylococcus

Staphylococcus, as a species, are gram positive cocci which appear in clusters/groups. There are three species which cause the majority of human disease*: S. aureus, S. epidermidis, S. saprophyticus*. *Staphylococcus aureas* that becomes resistant to the antibiotic methicillin is referred to as MRSA. One reservoir for MRSA is the anterior nares. Health care workers, diabetics, hemodialysis patients, and IV drug users all may carry MRSA, and may transmit it through direct contact with hands.

Populations at risk for developing MRSA colonization or infection are those patients who have had a prolonged hospitalization, who have stayed in an ICU or Burn Unit, or who have received multiple or broad spectrum drugs.

There are some strains of Staphylococcus that are also developing resistance to vancomycin -- the anti-biotic being used to treat MRSA infections.[14]

MRSA can infect nearly anywhere in the body, causing any one of the following problems:

- Localized skin infections with or without a rash
- Bloodstream infections
- Vertebral osteomyelitis
- Endocarditis
- Pneumonia
- Surgical site/wound infections

Acute Care Infection Control Considerations

Administrative Controls

Physicians, nurses, and other health care workers need to be educated about resistant organisms and strategies to prevent their spread. Physicians in particular need to be educated about using antibiotics appropriately:

1. All necessary specimens for appropriate cultures should be obtained before therapy if possible.
2. The initial drug therapy should be specific to the organism causing the infection.
3. Although a few days of broad spectrum antibiotics is acceptable, a final adjustment is necessary.

Institutions need to continuously monitor for the presence of resistant organisms through laboratory surveillance and develop protocols for culturing suspected resistant organisms, and for discontinuing isolation.

Patients should be placed in contact isolation with a private room with handwashing and toilet facilities. Cohorting patients with like resistant organisms may be acceptable. These patients should have their chart or computer file flagged to alert all personnel about isolation and contamination precautions. Education is very important for both the patient and family members. Family members should be instructed on the importance of isolation and monitored to ensure that there are no breaks in the isolation procedures.

Personal Controls

All personnel should wear clean (non-sterile) gloves when:

- entering a patients room and touching environmental surfaces
- having direct contact with the patient
- working with equipment that has been in the patient room or used by the patient.

Patients who have ileostomies, colostomies, incontinence problems with stool in an uncontained manner, or have drainage/secretions/excretions have a potential to heavily contaminate the environment. A gown should be worn if contact with the patient is likely. Gloves should be changed between patients and when moving to different sites on the same patient; personal protective equipment should be removed before leaving the patient room. Good handwashing practices with antimicrobial soap are essential. All equipment should be cleaned and disinfected. If possible, non-critical items should be dedicated to that patient.

Engineering Controls

- Use good housekeeping practices.
- Treat laundry and trash using Standard Precautions/Universal Blood and Body Fluid Precautions.
- There are no special requirements for dishes.
- Think about the 4 C's for patient assessment: Is the patient -- **C**lean, **C**lothed, **C**ontinent, **C**ompliant?

Ambulatory Care Infection Control Considerations

Many of the precautions listed in the acute care infection control section also apply to ambulatory care areas, such as clinics, same day surgeries, etc...

Patients who are either colonized or infected with an antibiotic-resistant organism, **and who have uncontained secretions**, should only be in the waiting room for a limited time, and should be given a separate room in which to be seen.

Good handwashing should be done before and after each patient contact. Equipment and rooms should be cleaned appropriately after the patient has been discharged.

Long Term Care Infection Control Considerations

Communication between facilities and staff in the long term care facility is vital to prevent the spread of antibiotic resistant organisms. Patients who are either colonized or infected with an antibiotic-resistant organism, **and who have uncontained secretions**, should have a private room; an individual bathroom is recommended. The environment and equipment should be cleaned and disinfected on a routine basis. Non-essential items should be dedicated to the resident with an antibiotic resistant organism.

Personnel should wash their hands routinely with antimicrobial soap, and should wear personal protective equipment as appropriate (gloves, gowns, masks). Staff should think about the 4 C's: Is the patient -- **C**lean, **C**lothed, **C**ontinent, **C**ompliant?

Home Care Infection Control Considerations

Finally, health care workers in the health care environment should wear gloves for direct patient contact, and a gown or other covering when there is an increased risk of soiling. Handwashing and drying with paper towels (versus family towels) is not only important for the health care worker to practice, but also important to teach. One very important point is to establish a safe working surface for any "clean" procedures.

Summary

In the beginning of this program, you learned about what the natural defenses of the body were, and how of the invasive procedures and interventions that we do in health care can bypass those defenses. You took a tour through the workings of pathogens, and spent some time learning about tuberculosis, HIV/AIDS, and resistant organisms. We hope that you gained some knowledge about the risks, symptoms, and treatments for these selected pathogens, but most importantly, we hope that you learned about how to prevent the transmission of the same. We hope this information will assist you in your war.

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3. Ibid, page 13.
4. Ibid, pages 25-31.
5. Ibid, page 9.
6. Ibid, page 33.
7. Ibid, page 34.
8. (1994). Core Curriculum on Tuberculosis, 3rd edition. U.S. Department of Health and Human Services and the Centers for Disease Control and Prevention: Atlanta, GA. Pages 36-37.
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13. (1997). Update: Staphylococcus aureus with reduced susceptibility to vancomycin -- United States, 1997. Morbidity and Mortality Weekly Report, 46(35): 813-815.
14. McDonald, L.C., et. al. (1997). Vancomycin-resistant enterococci outside the health-care setting: prevalence, sources and public health implications. Emerging Infectious Diseases, 3(3), 311-317.

Recommended Reading

1. APIC Text of Infection Control and Epidemiology, Volume 1.
2. APIC Text of Infection Control and Epidemiology, Volume 2 (also available on CD ROM – 2002).
3. Bennett, JV and Brachman PS. Hospital Infections. Philadelphia: Lippincott-Raven Publishers. 1998; 4th ed.
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7. Red Book: Report of the Committee on Infectious Diseases. Elk Grove Village, IL: American Academy of Pediatrics. 26th ed. (also available on CD ROM 26th ed., 2003).
8. Taber's Electronic Medical Dictionary: Cd-Rom, v. 2.0.
9. Wenzel, RP. Prevention and Control of Nosocomial Infections. Baltimore: Williams and Wilkins. 1997; 3rd ed.

Directions for Submitting Your Post Test for Contact Hours

To obtain a certificate of completion for this home study program, please complete the post-test and evaluation on the next few pages. If you are completing this home study as pre-reading for a TCHP class, please bring your post-test and evaluation to class with you for processing. The date on your certificate of completion will be the date that your home study is received. **Any materials received with a postmark after the expiration will be discarded.**

HealthEast, HCMC, & MVAMC Employees

If you are an employee of HealthEast, HCMC, & MVAMC, you may send the post-test and evaluation to TCHP for processing. Your post-test will be returned to you through your hospital. It cannot be mailed to your home.

Paid Participants

If you are not an employee of one of the TCHP hospitals, please send the post-test and evaluation to TCHP with a check for $12.00. Please make check payable to **TCHP Education Consortium** and mail to:

TCHP Education Consortium
Capitol Office Building
525 Park Street, Suite 120
St. Paul, MN 55103

Your post-test will be returned to you with the certificate of completion.

Issues in Infection Control Post- Test

Please print all information clearly and sign the verification statement:

Name_____
(please print legal name above)

Birth date (required)								
Format: 01/03/1999	**M**	**M**	**D**	**D**	**Y**	**Y**	**Y**	**Y**

For HealthEast, HCMC, or MVAMC, employees only:
Hospital _____ Unit_____

Personal verification of successful completion of this educational activity (required):
I verify that I have read this home study and have completed the post-test and evaluation.

_____
Signature

1. Which of the following patients may be more susceptible to infection?
   a) patient with an indwelling urinary catheter
   b) patient with burns
   c) patient with a tracheostomy
   d) all of the above

2. Which of the following cells **do not** defend the body against infection?
   a) erythrocytes
   b) neutrophils
   c) eosinophils
   d) macrophages

3. Do you automatically have the TB disease if you have a positive Mantoux test?
   a) Yes
   b) No

4. Which of the following people are at increased risk for developing TB disease?
   a) HIV infected people
   b) people on long-term corticosteroids
   c) end stage renal failure people
   d) all of the above

5. What percentage of people do not complete the recommended 12 months of therapy for TB?
   a) 10%
   b) 25%
   c) 50%
   d) 75%

6. You should use respiratory precautions and wear a well-fitting TB respirator when:
   a) collecting a sputum sample
   b) assisting with a bronchoscopy
   c) administering aerosolized treatments
   d) all of the above

7. Which of the following are risk behaviors for becoming infected with HIV?
   a) anal intercourse without a condom
   b) sharing needles
   c) pregnancy and vaginal delivery
   d) all of the above

8. The risk of acquiring HIV after a needle-stick increases when:
   a) the exposure is shallow
   b) the exposure is with a hollow-bore needle
   c) the exposure is through latex gloves
   d) the exposure is from a non-HIV patient

9. Infection with MRSA can cause:
   a) endocarditis
   b) skin infections
   c) pneumonia
   d) all of the above

10. Can patients with the same resistant organism be in the same room?
    a) Yes
    b) No

Expiration date: The last day that post tests will be accepted for this edition is **December 31, 2017**—your envelope must be postmarked on or before that day.

Evaluation: Issues in Infection Control

Please complete the evaluation form below by placing an "X" in the box that best fits your evaluation of this educational activity. Completion of this form is required to successfully complete the activity and be awarded contact hours.

At the end of this home study program, I am able to:	**Strongly Agree**	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
1. Describe the normal defenses of the human body against disease.					
2. Describe risk behaviors for HIV transmission.					
3. Describe populations at risk for infection or colonization with resistant organisms.					
4. Describe infection control strategies designed to prevent infection.					
5. The teaching / learning resources were effective. *If not, please comment:*					

The following were disclosed in writing prior to, or at the start of, this educational activity (please refer to the first 2 pages of the booklet).		
	Yes	**No**
6. Notice of requirements for successful completion, including purpose and objectives		
7. Conflict of interest		
8. Disclosure of relevant financial relationships and mechanism to identify and resolve conflicts of interest		
9. Sponsorship or commercial support		
10. Non-endorsement of products		
11. Off-label use		
12. Expiration Date for Awarding Contact Hours		
13. Did you, as a participant, notice any bias in this educational activity that was not previously disclosed? *If yes, please describe the nature of the bias:*		

14. How long did it take you to read this home study and complete the post test and evaluation:
_____hours and _____minutes.

15. Did you feel that the number of contact hours offered for this educational activity was appropriate for the amount of time you spent on it?
____Yes
____No, more contact hours should have been offered
____No, fewer contact hours should have been offered.

Expiration date: December 31, 2017