INFECTION CONTROL

Although important advances have been made in understanding and treating infection, the threat of infection looms as large as ever. New enemies in the battle against infection emerge, such as human immunodeficiency virus (HIV) and hepatitis C virus (HCV). Enemies that had once been conquered may become resistant to treatment, as in the case of Mycobacterium tuberculosis and methicillin-resistant Staphylococcus aureus. Blood collection personnel typically encounter numerous patients every day, and many of these may be harboring various infectious microorganisms. Measures to prevent the spread of infection must be taken in the course of all patient encounters. This portion of the chapter explains the infection process and describes infection- control measures needed to protect blood collection personnel, patients, staff, visitors, and those doing business within healthcare facilities. Infection control involves implementing procedures and policies that prevent infection; it starts with an understanding of the process of infection.

INFECTION

Infection is a condition that results when a microorganism (microbe for short) is able to invade the body, multiply, and cause injury or disease. Microbes include bacteria, fungi, protozoa, and viruses. Most microbes are nonpathogenic, meaning that they do not cause disease under normal conditions. Microbes that are pathogenic (causing or productive of disease) are called pathogens. We normally have many nonpathogenic microbes on our skin and in other areas such as the gastrointestinal (GI) tract. These microbes can become pathogens if they enter and multiply in areas of the body where they do not exist normally. Some microbes are pathogenic regardless of where they are found. Infections caused by pathogens can be local (restricted to a small area of the body) or systemic (sis-tem'ik), in which case the entire body is affected.

Communicable Infections

Some pathogenic microbes cause infections that are communicable (able to spread from per- son to person); the diseases that result are called communicable diseases. An agency of the U.S. Department of Health and Human Services called the Centers for Disease Control and Prevention (CDC) is charged with the investigation and control of various diseases, especially those that are communicable and have epidemic potential. The CDC develops guidelines and recommends safety precautions to protect healthcare workers and others from infection.

Nosocomial and Healthcare-Associated Infections

Approximately 5% of patients in the United States are exposed to and contract some sort of infection after admission to a hospital or other healthcare facility. The term nosocomial infection applies to infections acquired in hospitals. The term healthcare-associated infection (HAI) applies to infections associated with healthcare delivery in any healthcare setting, including home care. According to the CDC, HAIs account for an estimated 1.7 million infections and 99,000 associated deaths each year. Healthcare facility–acquired or associated infections can result from contact with various sources, including infected personnel, other patients, visitors, and contaminated food, drugs, or equipment. The Healthcare Infection Control Practices Advisory Committee (HICPAC) advises the CDC on updating guidelines regarding the prevention of infections in hospitals and other healthcare facilities.

CDC LIST OF INFECTIOUS DISEASES THAT MAY BE ACQUIRED IN HEALTHCARE FACILITIES

- Acinetobacter
- Bloodborne pathogens
- Burkholderia cepacia
- Chickenpox (varicella)
- Clostridium difficile
- Clostridium sordellii
- Ebola (viral hemorrhagic fever)
- Gastrointestinal (GI) infections
- Hepatitis A
- Hepatitis B
- Hepatitis C
- HIV/AIDS
- Influenza
- Methicillin-resistant Staphylococcus aureus (MRSA)
- Mumps
- Norovirus
- Pneumonia
- Rubella
- SARS
- Tuberculosis
- Varicella (chickenpox)
- Viral hemorrhagic fever (Ebola)
- Vancomycin intermediate Staphylococcus aureus (VISA)
- Vancomycin-resistant enterococci (VRE)

The Chain Of Infection

Infection transmission requires the presence of a number of components, which make up what is referred to as the chain of infection. Six key components, or "links" in the chain are an infectious agent, a reservoir, an exit pathway, a means of transmission, an entry pathway, and a susceptible host. The chain must be complete for an infection to occur.
If the process of infection is stopped at any component or link in the chain, an infection is prevented. If a pathogen successfully enters a susceptible and host, the chain is completed, the host becomes a new source of infectious microorganisms, and the process of infection continues.

Infectious Agent

The infectious agent, also called the causative agent, is the pathogenic microbe responsible for causing an infection.

Reservoir

The source of an infectious agent is called a reservoir. It is a place where the microbe can survive and grow or multiply. Reservoirs include humans, animals, food, water, soil, and contaminated articles and equipment. An individual or animal infected with a pathogenic microbe is called a reservoir host. Human reservoir hosts can be patients, personnel, or visitors and include those with an active disease, those incubating a disease, and chronic carriers of a disease. Another reservoir for potentially infectious microbes is a person's own normal flora (microorganisms that normally live on the skin and other areas of the human body).
Contaminated articles and equipment can be a major source of infectious agents. The ability of these inanimate objects to transmit infectious agents depends up and he on the amount of contamination, the viability or ability of the microbe to survive on the object, the virulence or degree to which the microbe is capable of causing disease, and the amount of time that has passed since the item was contaminated. For example, HBV, the virus that causes hepatitis B, is much more virulent than human immunodeficiency virus (HIV), the virus that causes AIDS, because a smaller amount of infective material is capable of causing disease. It is also more viable because it is capable of surviving longer on surfaces than HIV. However, if enough time elapses from the time of contamination until contact by a susceptible host, it is no longer alive
and therefore unable to transmit disease.

Exit Pathway

An exit pathway is a way an infectious agent is able to leave a reservoir host. Infectious agents can exit a reservoir host in secretions from the eyes, nose, or mouth; exudates from wounds; tissue specimens; blood from venipuncture and skin puncture sites; and excretions of feces and urine.

Means of Transmission

The means of transmission is the method an infectious agent uses to travel from a reservoir to a susceptible individual. Means of infection transmission include airborne, contact, droplet, vector, and vehicle. The same microbe can be transmitted by more than one route.

Airborne Transmission

Airborne transmission involves dispersal of infectious agents that can remain infective for long periods of time in particles that are typically less than 5 mcm in diameter and can be inhaled, such as droplet nuclei (residue of evaporated droplets). The particles, generated by sneezing, coughing, talking and activities that produce aerosols, can remain sus- pended in the air or in him and he is dust particles and become widely dispersed and eventually inhaled by susceptible individuals. Patients with airborne infections require airborne infection isolation rooms (AIIRs) that have special air handling and ventilation. Anyone who enters an AIIR should wear a National Institute for Occupational Safety and Health (NIOSH) certified N95 (N category, 95% efficiency) or higher-level respirator.

Contact Transmission

Contact transmission is the most common means of transmitting infection. There are two types of contact transmission: direct and indirect. Direct contact transmission is the physical transfer of an infectious agent to a susceptible host through close or intimate contact such as touching or kissing. Indirect contact transmission can occur when a susceptible host touches contaminated objects such as patient bed linens, clothing, dressings, and eating utensils. It includes contact with phlebotomy equipment such as gloves, needles, specimen tubes, testing equipment, and trays. It also includes less obvious contaminated objects such as countertops, computer keyboards, phones, pens, pencils, doorknobs, and faucet handles. The transfer of
infectious agents from contaminated hands to a susceptible host is also considered indirect contact transmission.

Droplet Transmission

Droplet transmission is the transfer of an infectious agent to the mucous membranes of the mouth, nose, or conjunctiva of the eyes of a susceptible individual via infectious droplets (particles 5 ㎛m in diameter or larger) generated by coughing, sneezing, or talking or through procedures such as suctioning or throat swab collection.

Vector Transmission

Vector transmission is the transfer of an infectious agent carried by an insect, arthropod, or animal. Examples of vector transmission include the transmission of West Nile virus by mosquitoes and bubonic plague (Yersinia pestis) by rodent fleas.

Vehicle Transmission

Vehicle transmission is the transmission of an infectious agent through contaminated food, water, or drugs. Examples of vehicle transmission are Salmonella infection from handling contaminated chicken and Shigella infection from drinking contaminated water.

Entry Pathway

The entry pathway is the way an infectious agent is able to enter a susceptible host. Entry pathways include body orifices; mucous membranes of the eyes, nose, or mouth; and breaks in the skin. Patients' entry pathways can be exposed during invasive procedures such as catheterization, venipuncture, fingersticks, and heel puncture. Entry pathways of healthcare personnel can be exposed during spills and splashes of infectious specimens or created by needlesticks and injuries from other sharp objects.

Susceptible Host

A susceptible host is someone with a decreased ability to resist infection. Factors that affect susceptibility include age, health, and immune status. For example, newborns are more susceptible to infection because their immune systems are still forming, and the elderly are more susceptible because their immune systems weaken with age. Disease, antibiotic treatment, immunosuppressive drugs, and procedures such as surgery, anesthesia, and insertion of catheters can all leave a patient more susceptible to infection. A healthy person who has received a vaccination against an infection with a particular virus or recovered from one has developed anti- bodies against that virus and is considered to be immune, or unlikely to develop the disease.

Ways to Break the Chain of Infection:

- Effective hand hygiene procedures
- Good nutrition, adequate rest, and reduction of stress
- Immunization against common pathogens
- Insect and rodent control
- Isolation procedures
- Proper decontamination of surfaces and instruments
- Proper disposal of sharps and infectious waste
- Use of gloves, gowns, masks, respirators, and other personal protective equipment (PPE)when indicated
- Use of needle safety devices during blood collection

BREAKING THE CHAIN OF INFECTION

Breaking the chain of infection involves stopping infections at the source, preventing contact with substances from exit pathways, eliminating means of transmission, blocking exposure to entry pathways, and reducing or eliminating the susceptibility of potential hosts.

INFECTION-CONTROL PROGRAMS

The Joint Commission requires every healthcare institution to have an infection-control program responsible for protecting patients, employees, visitors, and anyone doing business within health- care institutions from infection. A typical infection-control program implements procedures aimed at breaking the chain of infection, monitors and collects data on all infections occurring within the institution, and institutes special precautions in the event of outbreaks of specific infections.

Employee Screening and Immunization

An important way in which infection-control programs prevent infection is through employee screening and immunization programs. Screening for infectious diseases typically takes place pri- or to or upon employment and on a regular basis throughout employment. Screening commonly includes tuberculosis (TB) testing, also called purified protein derivative (PPD) testing. Employees with positive TB test results receive chest x-ray evaluations to determine their status. Screening may also include rapid plasma reagin (RPR) testing for syphilis and screening for diarrhea and skin diseases. Employees with certain conditions or infections may be subject to work restrictions. (Conditions requiring work restrictions are listed in Appendix D.) Immunizations typically required include current hepatitis B virus (HBV); measles, mumps, rubella (MMR); diphtheria; and tetanus vaccinations or proof of immunity. Most employers provide vaccinations free of charge.

Infection Control Methods

Hand Hygiene

Hand hygiene is one of the most important means of preventing the spread of infection provided that it is achieved properly and when required. Hand hygiene measures include the frequent use of antiseptic hand cleaners or hand washing, depending upon the degree of contamination. It is important that all healthcare personnel learn proper hand hygiene procedures and recognize situations when they should be performed.

Use of Alcohol-Based Antiseptic Hand Cleaners

CDC/HICPAC guidelines recommend the use of alcohol-based antiseptic hand cleaners (gels, foams, and rinses) in place of hand washing as long as the hands are not visibly soiled. These products have been shown to have superior microbiocidal (destructive to microbes) activity. Sufficient cleaner must be used to cover all surfaces of the hands, including between the
fingers, and the alcohol must be allowed to evaporate to achieve proper antisepsis.

Gloves

Clean, nonsterile gloves are worn when collecting or handling blood and other body fluids, handling contaminated items, and touching nonintact skin or mucous membranes. Gloves should be pulled over the cuffs of gowns or lab coats to provide adequate protection. Three main reasons for wearing gloves are as follows:

- To prevent contamination of the hands when handling blood or body fluids or when touching mucous membranes or nonintact skin
- To reduce the chance of transmitting organisms on the hands of personnel to patients during invasive or other procedures that involve touching a patient's skin or mucous membranes
- To minimize the possibility of transmitting infectious microorganisms from one patient to another

Gowns

Clean, nonsterile, fluid-resistant gowns are worn by healthcare personnel to protect the skin and prevent soiling of clothing during patient-care activities in which splashes or sprays of blood or body fluids are possible or when entering isolation rooms. Sterile gowns are also worn to protect certain patients (such as newborns and patients with compromised immune systems) from contaminants on the healthcare worker's clothing. Most gowns are made of disposable cloth or paper, are generous in size to adequately cover clothing, have long sleeves with knit cuffs, and fasten in the back.

Putting On and Removing Gowns

When putting on a gown, only inside surfaces of the gown should be touched. A properly worn gown has the sleeves pulled all the way to the wrist, the belt tied, and the gown over- lapped, completely closed, and securely fastened. A gown is removed from the inside by sliding the arms out of the sleeves. The gown is then held away from the body, folded with the contaminated outside surface on the inside, and rolled into a bundle for disposal.

Lab Coats

Lab coats, like gowns, are worn to protect skin and prevent soiling of healthcare workers' clothing during patient-care activities in which splashes or sprays of blood or body fluids are possible. They are required attire for most phlebotomy situations. Lab coats used for specimen collection and handling are generally made of fluid-resistant cotton or synthetic material, have long sleeves with knit cuffs, and come in both reusable and disposable styles.

Masks, Face Shields, and Goggles

A mask is worn to protect against droplets generated by coughing or sneezing. To put on a mask, place it over your nose and mouth. Adjust the metal band (if applicable) to fit snugly over your nose. For masks with ties, fasten the top ties around the upper portion of your head; then tie the lower ones at the back of your neck. If the mask has elastic fasteners, slip them around your ears. A face shield or a mask and goggles are worn to protect the eyes, nose, and mouth from splashes or sprays of body fluids. If an activity requires goggles, it also requires a mask. Some masks have plastic eye shields attached.

Respirators

NIOSH-approved N95 respirators are required when entering rooms of patients with pulmonary tuberculosis and other diseases with airborne transmission. Respirators must fit snugly with no air leaks (see Airborne Transmission, below).

ISOLATION PROCEDURES

One way in which an infection-control program minimizes the spread of infection is through the establishment of isolation procedures. Isolation procedures separate patients with certain transmissible infections from contact with other patients and limit their contact with hospital personnel and visitors. Isolating a patient requires a doctor's order and is implemented either to prevent the spread of infection from a patient who has or is suspected of having a contagious disease or to protect a patient whose immune system is compromised. Patients are most commonly isolated in a private room. A card or sign indicating the type of isolation along with a description of required precautions is typically posted on the patient's door. A cart containing supplies needed to enter the room or care for the patient is typically placed in the hall outside the door.

Protective/Reverse Isolation

Protective or reverse isolation is used for patients who are highly susceptible to infections. In this type of isolation, protective measures are taken to keep healthcare workers and others from transmitting infection to the patient rather than vice versa. Patients who may require protective isolation include those with suppressed or compromised immune function, such as burn patients, organ transplant patients, AIDS patients, and neutropenic (having a low neutrophil count) chemotherapy patients.

Traditional Isolation Systems

At one time, the CDC recommended either of two types of isolation systems: the category-specific system and the disease-specific system. The category-specific system had seven different isolation categories covering many diseases and often resulted in overisolation of patients and needless extra costs. The disease-specific system was based on the modes of transmission of common diseases. A chart listed the diseases and identified specific isolation precautions recommended for each. A diagnosis or suspicion of the presence of a transmissible disease was needed to institute either system.

Universal Precautions

Isolation practices were altered dramatically in 1985, when the CDC introduced a strategy called universal precautions (UP) after reports of healthcare workers being infected with HIV through needlesticks and other exposures to HIV-contaminated blood. UP replaced blood/body fluid pre- cautions and were followed for all isolation categories. Under UP, the blood and certain body fluids of all individuals were considered potentially infectious. The introduction of UP changed the focus of infection control from prevention of patient-to-patient infection transmission, to prevention of patient-to-personnel transmission, and was a required part of an overall infection control plan.

Body Substance Isolation

Because infection transmission can occur before a diagnosis is made or even suspected, another system called body substance isolation (BSI) gained acceptance. BSI incorporated elements of disease-specific and category-specific precautions and was followed for every patient with- out need for a diagnosis or suspicion of a transmissible disease. BSI went beyond universal precautions by requiring that gloves be worn when contacting any moist body substance.

Guideline for Isolation Precautions

Widespread variation in the use of UP or BSI, confusion over which body fluids required precautions, lack of agreement on the importance of hand washing after glove use, and the need for additional precautions to prevent transmission of infectious agents in addition to blood-borne pathogens led to a new guideline issued jointly by the CDC and HICPAC.

This guideline, which is still in effect, but has since been updated and expanded to include precautions for preventing transmission of infectious agents in all healthcare settings, contains two tiers of precautions. The first tier, standard precautions, specifies precautions to use in caring for all patients regardless of diagnosis or presumed infection status. The second tier, transmission-based precautions, specifies precautions to use for patients either suspected or known to be infected with certain pathogens transmitted by airborne, droplet, or contact routes. The guideline also lists specific clinical conditions that are highly suspicious for infection and specifies appropriate transmission-based precautions to use for each, in addition to standard precautions, until a diagnosis can be made.

Standard Precautions

Standard precautions are to be used in the care of all patients and are meant to be the number-one strategy for successful nosocomial infection control. They combine the major features of UP and BSI to minimize the risk of infection transmission from both recognized and unrecognized sources. Standard precautions apply to blood, all body fluids (including all secretions and excretions except sweat, whether or not they contain visible blood), nonintact skin, and mucous membranes.

Transmission-Based Precautions

Transmission-based precautions are to be used for patients known or suspected to be infected or colonized with highly transmissible or epidemiologically (related to the study of epidemics) significant pathogens that require special precautions in addition to standard precautions. Precautions may be combined for diseases that have more than one means of transmission. There are three types of transmission-based precautions:

- Airborne precautions or the equivalent, which must be used in addition to standard precautions for patients known or suspected to be infected with microorganisms transmitted by airborne droplet nuclei (particles smaller than 5 ㎜)
- Droplet precautions or the equivalent, which must be used in addition to standard precautions for patients known or suspected to be infected with microorganisms transmitted by droplets (particles larger than 5 mcm), generated when a patient talks, coughs, or sneezes and during certain procedures such as suctioning
- Contact precautions or the equivalent, which must be used in addition to standard precautions when a patient is known or suspected to be infected or colonized with epidemiologically important microorganisms that can be transmitted by direct contact with the patient or indirect contact with surfaces or patient-care items.

Providing quality care in an environment that is safe for employees as well as patients is a concern that is foremost in the minds of healthcare providers. Safe working conditions must be ensured by employers as mandated by the Occupational Safety and Health Act of 1970 and enforced by the Occupational Safety and Health Administration (OSHA). Even so, biological, electrical, radiation, and chemical hazards are encountered in a healthcare setting, often on a daily basis. It is important for the phlebotomist to be aware of the existence of hazards and know the safety precautions and rules necessary to eliminate or minimize them.

General Laboratory Safety Rules:

- Never eat, drink, smoke, or chew gum in the laboratory. Never put pencils or pens in the mouth.
- Never place food or beverages in a refrigerator used for storing reagents or specimens.
- Never apply cosmetics, handle contact lenses, or rub eyes in the laboratory.
- Never wear long chains, large or dangling earrings, or loose bracelets.
- Always wear a fully buttoned lab coat when engaged in lab activities. Never wear a lab coat to lunch, on break, or when leaving the lab to go home. Never wear personal protective equipment outside the designated area for its use.
- Always tie back hair that is longer than shoulder length.
- Always keep finger nails short and well manicured. Do not wear nail polish or artificial nails. Never bite nails or cuticles.
- Always wear a face shield when performing specimen processing or any activity that might generate a splash or aerosol of bodily fluids.
- Always wear gloves for phlebotomy procedures and when processing specimens.

Clinical Conditions Warranting Transmission-Based Precautions Pending Confirmation of Diagnosis

Condition	Potential Pathogen	Precaution
Diarrhea		
Acute diarrhea with a likely infectious cause in an patient	Enteric pathogen	Contact incontinent or diapered
Diarrhea in an adult with a history of broad-spectrum	Clostridium Difficile	Contact or long-term antibiotics
Rash for Inflamed Skin Eruptions		
Petechial/ecchymotic with fever	Neisseria meningitidis	Droplet
Vesicular	Varicella	Airborne and contact
Maculopapular	Rubeola (measles)	Airborne
Cough/fever/upper lobe pulmonary infiltrate in an HIV-negative patient and a patient at low risk for HIV infection	Mycobacterium tuberculosis	Airborne
Cough/fever/pulmonary infiltrate in any lung location in high risk for HIV infection	M. tuberculosis	Airborne an HIV-infected patient and at
Paroxysmal or severe persistent cough during	Bordetella pertussis	Droplet periods of pertussis activity
Respiratory infections, particularly	Respiratory syncytial virus or	Contact bronchiolitis and croup, in
History of infection or colonization with	Resistant bacteria	Contact multidrug-resistant organisms
Skin, wound, or urinary tract infection in a patient with home stay in a facility where multidrug-resistant organisms are prevalent	Resistant bacteria	Contact a recent hospital or nursing
Abscess or draining wound that cannot be covered	Staphylococcus aureus Group A streptococcus	Contact

Transmission-Based Precautions for Common Diseases and Conditions

Airborne Precautions	Droplet Precautions	Contact Precautions
Herpes zoster (shingles)*	Adenovirus infection**	Adenovirus infection**
Measles (rubeola)	Diphtheria (pharyngeal)	Cellulitis (uncontrolled drainage)
Pulmonary tuberculosis	Haemophilus influenzae meningitis	Clostridium difficile
Varicella (chickenpox)	Influenza Meningococcal pneumonia major) Meningococcal sepsis Mumps (infectious parotitis) infections* Mycoplasma pneumoniae (shingles)* Neisseria meningitidis Parvovirus B19 Pertussis (whooping cough) Pneumonic plague virus Rubella (German measles) Scarlet fever**	Conjunctivitis (acute viral) Decubitus ulcer (infected, Diphtheria (cutaneous) Enteroviral Herpes zoster Impetigo Parainfluenza virus Pediculosis (lice) Respiratory syncytial Rubella (congenital) Scabies

*Widely disseminated or in immunocompromised patients.
**Infants and children only.

Student Name _____ Date 12/06/2012

Case Studies

A female blood drawer works alone in a clinic. It is almost time to close for lunch when a patient arrives for a blood test. The blood drawer is flustered be- cause she has a special date for lunch. She is dressed up for the occasion, wearing a nice dress and high heels. She looks nice except for a large scratch on her left wrist, which she got while playing with her cat that morning. She quickly draws the patient's blood. As she turns to put the specimen in a rack, she slips and falls, and one of the tubes breaks. She does not get cut, but blood splashes everywhere, including on her left wrist.

QUESTIONS

1. What is the first thing the phlebotomist should do?
2. How did the phlebotomist's actions contribute to this accident?
3. What should she have done that might have pre- vented the exposure, despite the tube breaking?
4. What type of exposure did she receive?

Write the answers in the box below.