Hospital Biosecurity

chapter 1

Leslie Hiber, CVT, BS

Learning Objectives

- Describe the life cycle patterns of pathogens.
- List and describe the three main routes of transmission.
- List and describe ways to prevent disease in a patient.
- Describe the biosecurity steps that should be taken prior to patient arrival and on arrival.
- List and describe types of barrier precautions.
- Outline the steps of putting on and taking off the personal protective equipment when entering/exiting mini-isolation and isolation areas.
- List categories of products used for good hand hygiene, and describe how to perform hand washing.
- Compare and contrast disinfection and sterilization in preventing nosocomial infection.
- Describe the role of the infection control team and the function of the veterinary technician on this team.

Clinical Case Problem 1.1

An 8-year-old quarter horse mare is presented to the clinic with colic-type clinical signs. The owner reports no history of infectious diseases and has no history of traveling. The patient is treated medically and is hospitalized overnight in the main clinical area. The following day she begins having diarrhea and a fever. What steps would you take in order to protect the other patients and staff? What type of communication needs to be dispersed and to whom? How would you follow up with cleaning?

See Clinical Case Resolution 1.1 at the end of this chapter.

KEY TERMS

Active surveillance
Aerosol transmission
Antibiotic stewardship
Antiseptics
Asymptomatic carrier
Biosecurity
Direct contact transmission
Disinfection
Hazard identification
Incubation period
Indirect contact transmission
Multidrug-resistant organism (MDRO)
Nosocomial
Passive surveillance
Personal protective equipment (PPE)
Risk communication
Risk management
Risk perception
Sterilization
Vector-borne transmission
Zoonotic diseases

Large Animal Medicine for Veterinary Technicians, First Edition. Edited by Laura Lien, Sue Loly, and Sheryl Ferguson.

Companion website: www.wiley.com/go/lienvettech

Introduction

Biosecurity is security from exposure to harmful biological agents. It is emerging as a hot topic in veterinary hospitals and clinics throughout the world. As more diseases and superbugs are being discovered due to new technology, clients and communities are becoming more aware of what protocols are in place to ensure that their animals are safe while under the care of a veterinary care team. As a valuable member of this team, veterinary technicians need to understand the basics of disease transmission and how to protect the patients while in the clinic. Veterinary technicians are also evolving to become the leaders of the biosecurity team, and are referred to as the infection control team. They are often in communication with all members of the veterinary care team and fully understand the day-to-day operation of the hospital/clinic. It is the mission of this team to protect all staff, clients, and patients that enter the hospital/clinic.

TECHNICIAN TIP 1.1: In order to protect the patients when visiting the clinic, the veterinary technician should understand the basics of disease transmission.

Cycle of Infection

A pathogen has a very specific purpose in its life cycle, that is, to infect as many hosts as possible in order to maintain the disease in a population. In order to complete this task the pathogen must

- find a portal of exit from the current host;
- find a method of transmission;
- find a portal of entry into a host;
- seek a susceptible host; and
- multiply within the host (the reservoir).

The likelihood of a pathogen's success depends on a variety of factors: the pathogen, the environment, and the host.

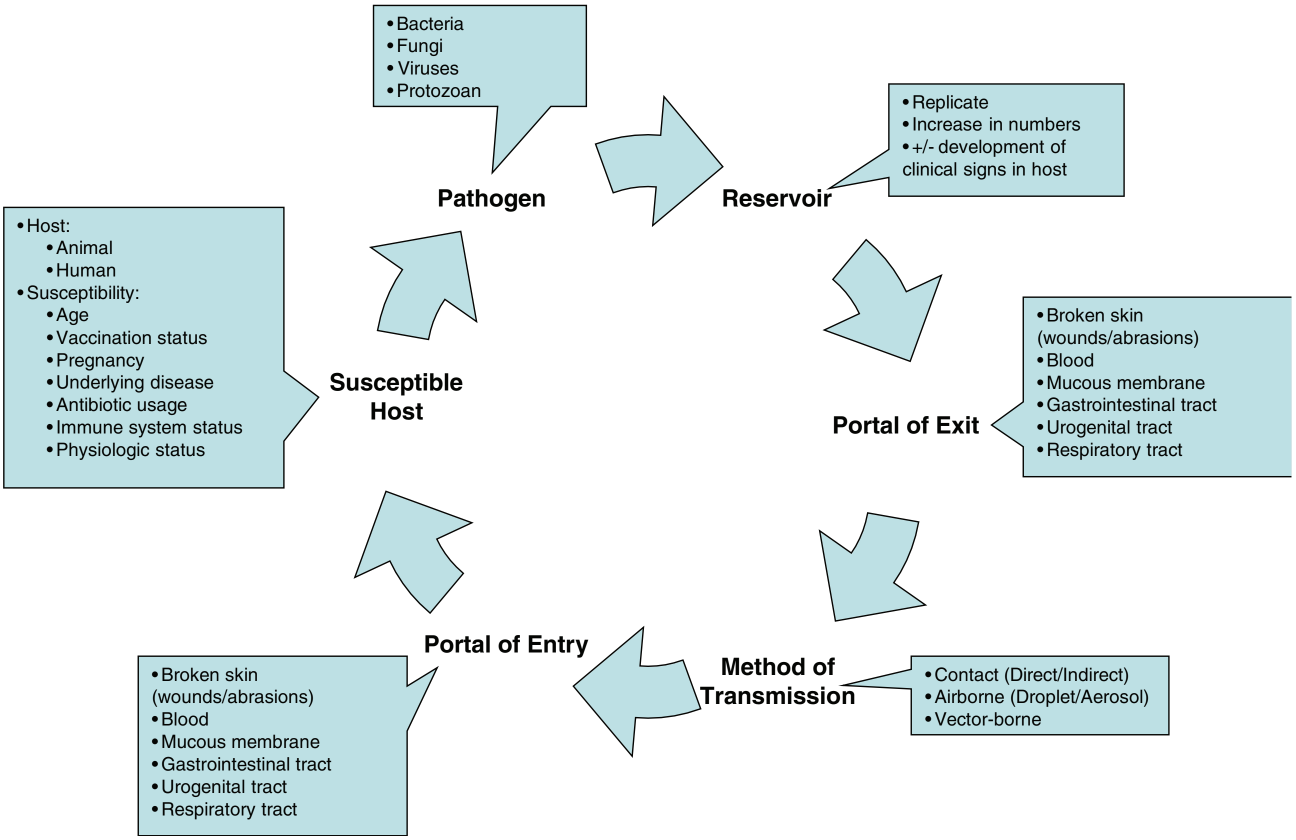

Figure 1.1 Cycle of Infection: Each component of the cycle must be present in sequential order for an infection to occur. At any point the cycle can be broken, decreasing the risk of disease transmission and infection.

For the pathogen to infect other susceptible hosts it must first leave the host that has been serving as the reservoir. The portals of exit from the host can include: gastrointestinal tract, urogenital tract, respiratory tract, blood, broken skin (wounds/abrasions), and mucous membranes. Some hosts may be an accidental host in that the pathogen does not have a strong specificity to that species. This may cause clinical disease in the patient but it will not be able to exit the host. Accidental hosts are often referred to as a "dead-end" host for the pathogen because it is unable to replicate enough to exit the host. The more routes that a pathogen is able to utilize to exit the animal, the more successful it will be in finding a new host to start the infection process.

TECHNICIAN TIP 1.2: A pathogen must first leave the reservoir host before it can infect another host.

If a pathogen is able to successfully leave the host it must move to another host. Contact, airborne, and vector-borne are the three main routes of transmission. These routes are discussed in further detail later on in the chapter. Environmental conditions and hardiness of the pathogen must be ideal for the pathogen to survive long enough to find the next host. Those pathogens that cannot withstand adverse environmental conditions must find a susceptible host in a short period of time or else it will die. Pathogens will succeed if there are a number of vulnerable hosts living closely together. Transmission may also occur if cleaning and hand hygiene is not adequate. Pathogens that are resistant to adverse environmental conditions can survive for years and cannot be eradicated unless appropriate disinfectants are used.

TECHNICIAN TIP 1.3: The three main routes of transmission of a pathogen are contact, airborne, and vector-borne.

Once the pathogen is successful in finding a method of transmission, it must find a portal of entry into a host. Entry points are the same as exit portals out of a host (mucous membranes, abrasions/wounds [broken skin], blood, respiratory tract, urogenital tract, and/or gastrointestinal tract). More sites available to a pathogen increases the chances that it will progress to the next stage in the infection process.

The infection process into a new host is only successful if the host is susceptible to infection. Susceptibility of the animal can include, but is not limited to, age, vaccination status, pregnancy, underlying disease, immune system status, antibiotic usage, and/or physiological status. Those patients that are being exposed to any immune-suppressant medications (i.e., radiation therapy, chemotherapy, steroids) are at a higher risk of infection.

TECHNICIAN TIP 1.4: Age, vaccination status, pregnancy, underlying disease, immune system status, antibiotic usage, and/or physiologic status are all factors that come into play regarding the susceptibility of an animal to a pathogen.

Some pathogens can only infect one species of animal, while others can infect many. This is known as species specificity. The more diverse numbers of species that the pathogen is able to infect, the greater the chance that the pathogen has to survive. This is especially true when dealing with smaller populations of animals in a given area. It is important to know if the pathogen is zoonotic so that people working with infected animals can take proper precautions to protect themselves from disease.

TECHNICIAN TIP 1.5: Some pathogens may infect a single species while others can infect many.

TECHNICIAN TIP 1.6: It is important that the veterinary technician use proper precautions to protect themselves when working with animals that have a zoonotic disease to keep from becoming infected.

During the final phase the pathogen will stay in the reservoir host to try to replicate and increase in numbers to eventually exit the host to start the chain of infection all over again. As the organism replicates and increases in the population it will often cause a disease response in the host, which will begin to exhibit clinical signs of infection.

The time period between exposure to an infectious agent and the appearance of the first clinical signs is called the incubation period. This time period can vary significantly from one pathogen to another. If the host has a good immune response to the pathogen (either due to health status and/or vaccination against the pathogen) then the pathogen can be destroyed before causing any harm. A pathogen contains virulence factors or properties that enable it to establish itself on or within a host and enhance its potential to cause disease. The virulence factor plus immune status of the host will determine how clinically ill the patient will become.

Not all hosts present clinical signs of disease once infected. Some may be asymptomatic carriers or subclinical and may shed the pathogen without any apparent knowledge that they are infected. If you picture an iceberg, the part one can see from the surface depicts the clinical or obvious infections. Underneath the surface the iceberg is an even larger mass and depicts the subclinical or colonized patients. This is why it is extremely important to take standard precautions to prevent exposure or movement of the potential pathogen.

Transmission

Routes of transmission can occur via three main pathways: contact (direct/indirect), airborne (droplet/aerosol), and vector-borne transmission. Interrupting the transmission of a pathogen from the reservoir to the susceptible host is an important component of eliminating nosocomial infections.

Contact Transmission

Contact transmission is the most common route and is divided into either direct or indirect contact. Direct animal-to-animal transmission can occur through a variety of different behaviors including, but not limited to, biting, touching, and grooming. The best way to break this cycle of transmission is by preventing patient-to-patient interaction.

> **TECHNICIAN TIP 1.7:** An important component of eliminating nosocomial infections is interrupting the transmission of a pathogen from the reservoir to the susceptible host.

Indirect Transmission

Indirect transmission occurs by contact with a contaminated piece of equipment, surface, or objects called fomites. High touch/patient contact areas, surgical instruments, fluid pumps, grooming aids, and endoscopes are just a few examples of contaminated areas/equipment that are commonly found to be responsible for indirect transmission of pathogens. Performing good hand hygiene and environmental decontamination are extremely important ways to prevent transmission via indirect contact.

> **TECHNICIAN TIP 1.8:** To prevent transmission via indirect contact, good hand hygiene and environmental decontamination are extremely important.

Good hand hygiene should be performed before touching other objects such as clipboards, pens, and other pieces of equipment. Washing with soap and water and utilizing hand sanitizer are two methods of hand hygiene. Washing with soap and water is the preferred method as it eliminates all types of pathogens including non-enveloped viruses and parasites, in which hand sanitizer has no effectiveness. More information on hand hygiene is discussed later in the chapter. There are often times when hand hygiene cannot be performed directly after working with a patient. This is very common in barns and on farms where no sink is readily available. Antibacterial hand wipes followed by the use of hand sanitizer is a great alternative in

Figure 1.2 Antibacterial hand wipes are a great alternative when sinks are not available.

Figure 1.3 Foam hand sanitizer.

these types of environments. If good hand hygiene is not completed then these surfaces can cause indirect transmission.

> **TECHNICIAN TIP 1.9:** The preferred method of hand hygiene is to wash with soap and water.

> **TECHNICIAN TIP 1.10:** A great alternative for environments where sinks are not readily available is the use of antibacterial hand wipes along with hand sanitizer.

Disinfectant wipes are great for quick decontamination of high touch surfaces. Fluid pumps, stethoscopes, pens, thermometers, sink handles, and keyboards are a short list of the items that should be decontaminated after every patient/room use. It is important to have a protocol that identifies how to thoroughly clean items that are not easily cleaned. Items such as halters and ropes (porous items) should be soaked in disinfectant solution and left to dry after patient discharge.

Figure 1.4 A dunk tank setup used for soaking porous equipment after the patient leaves. Items are hung to dry.

> **TECHNICIAN TIP 1.11:** For quick decontamination of high touch surfaces it is recommended to use disinfectant wipes.

Airborne transmission occurs when a pathogen in droplet or aerosol form travels through the air to find a host. Droplets are usually projected less than three feet (due to size and weight), and can be deposited on mucous membranes (i.e., conjunctiva, nasal, mucosa, oral cavity) and open wounds of the susceptible host. When droplets are 5 μm or less in size they can be classified as aerosols. The smaller the droplet size the farther it may be able to travel via air currents, therefore increasing the area of contamination. The risk of transmitting a pathogen by air also increases with proximity to the initial source and the duration of exposure. The length of time pathogens remain infectious in the droplet or aerosol form depends on the following factors:

- physiochemical properties of each individual pathogen (particularly environmental stability);
- concentration of infectious particles;
- air currents; and
- temperature and humidity.

The best way to decrease the likelihood of droplet transmission is to make sure that high-risk patients are kept at least three to six feet away from other patients, and that stall cleaning also includes the area outside of the stall. For pathogens that produce smaller droplet sizes patients should have an isolated stall with its own ventilation system. See Strict Isolation for further details.

TECHNICIAN TIP 1.12: The best way to decrease the risk of droplet transmission includes keeping high-risk patients at least three to six feet away.

Figure 1.5 An isolation stall with its own ventilation system.

Vector-borne Transmission

Vector-borne transmission utilizes a vector such as mosquitos, fleas, ticks, and rodents in order to transmit the pathogen. These carriers transmit the pathogen either via biting the host (mosquitoes) or by transporting the pathogen to an area that a susceptible host will be present (cockroaches). If the facility is able to provide good pest control then the risk of vector-borne transmission decreases. The type of vector will vary geographically. Regardless of the vector it is important that these offenders be identified and eliminated.

Preventing Disease Occurrence in the Host

There are a number of options available to prevent disease occurrence in the host. Vaccinations, prevention of malnutrition in the host, prevention of poor environmental conditions, and good antibiotic stewardship are all ways to stop a host from being susceptible to infection. Vaccinations provide protection by stimulating the immune system in the host. Vaccines are made from dead or inactive organisms that are unable to cause disease. This specific organism, when introduced into an animal, causes the immune system to produce antibodies against the specific antigen in the vaccine. When that specific live pathogen finds a portal of entry into a previously vaccinated host, the host is then able to fight off the pathogen before the pathogen is able to reproduce and cause a disease response.

TECHNICIAN TIP 1.13: Factors that can stop the host from being susceptible to infection include vaccinations, prevention of malnutrition in the host, prevention of poor environmental conditions, and good antibiotics.

Each clinic/hospital should establish an immunization protocol, based on species seen and types of problematic diseases. A patient's vaccination status is a vital component of the history that should be taken at admission to the clinic/hospital. This information will help in deciding patient placement in the hospital and will also help the clinician when ruling out diseases.

TECHNICIAN TIP 1.14: Upon admission to the hospital/clinic, it is vital to get the patient's vaccination status when taking the history.

Malnutrition and vitamin deficiencies in a host can lead to an increased susceptibility to infection. Ensuring that animals are receiving the right nutrients and in correct amounts are easy ways to increase host resistance.

> **TECHNICIAN TIP 1.15:** Ensuring that animals are getting appropriate nutrition and adequate food supply are easy ways to increase host resistance.

Poor environmental conditions for the host are often an ideal environment for pathogens to thrive. Stalls should be kept clean and disinfected periodically. Food and hay should be inspected for mold, and obvious reservoirs for pathogens (i.e., standing water, rodents, and insect pests) should be eliminated. Removing pathogen reservoirs will decrease the likelihood that pathogens are either shed in the environment or directly transmitted to the host.

> **TECHNICIAN TIP 1.16:** Stalls should be kept clean by removing feces often and disinfecting periodically.

Good antibiotic stewardship is another way to prevent disease occurrence in the patient. Antibiotic stewardship follows four basic factors:

- give the right antibiotic;
- at the right dose;
- at the right time;
- for the right duration.

The prevalence of antibiotic resistance commonly increases in proportion to the frequency of use. The goal of antibiotic administration is to achieve optimal clinical outcomes while minimizing adverse effects in the patient and limiting the selection for antimicrobial resistant strains. Ideally, a culture of the infected area or suspected area should be taken prior to administration of any antibiotics. If a culture cannot be obtained, then antibiotics should be chosen dependent on the type of organism suspected of causing the infection. Gram stains can provide some help in narrowing down the type of bacteria present. Based on the Gram stain, a narrow spectrum low-level antibiotic should be given until culture results are available. Antibiotics should never be prescribed randomly. Antibiotics may also be given as a prophylactic prior to surgery. Surgical procedures disrupt the skin's normal defensive barrier and can become an easy entry point for pathogens if the sterile surgical field is broken. An antibiotic for this purpose should be safe and provide adequate coverage for broad spectrum contaminants that might be found in the environment. For an antibiotic to be effective it needs to be administered to the patient within 60 minutes of cut time to provide therapeutic levels at the time of the first surgical incision. If surgery time is longer than one to two times the half-life of the drug then additional doses should be given during the surgery. If infection control protocols are followed throughout the prep and surgical procedure then post-op antibiotics may not be needed.

Figure 1.6 Gram stains are used to narrow down types of bacteria.

> **TECHNICIAN TIP 1.17:** Antibiotic stewardship includes: giving the right antibiotics, at the right dose, at the right time, and for the right duration.

> **TECHNICIAN TIP 1.18:** Antibiotics should be administered to the patient within 60 minutes of cut time to provide therapeutic levels at the time of first surgical incision.

Patient Placement in the Hospital

Prescreening Patients

Patient screening should begin before the patient reaches the hospital. Knowing the patient's clinical signs before he or she comes into the hospital will give the clinic/hospital staff a general idea of what to expect before arrival. A stall can be prepared in the correct location and appropriate PPE can be arranged. Patient placement ultimately depends upon the type of infection, the ability to provide appropriate care, and appropriate staffing.

> **TECHNICIAN TIP 1.19:** Reviewing the patient's clinical signs before they enter the clinic/hospital gives the staff a general idea of what to expect before arrival so they can be prepared.

Prescreening questions should include, but are not limited to:

- travel history including any fairs or shows recently attended;
- any clinical signs including fever, nasal discharge, open sores, coughing, and diarrhea;
- other members of the herd having similar clinical signs; and
- history of infectious disease in the patient or on the farm/homestead.

At arrival a brief physical exam should be completed before entry into the hospital. This can occur in the trailer or outside. The physical exam should include noting any open sores, nasal discharge, diarrhea, coughing, and other infectious clinical signs.

Figure 1.7 Equine entrance separate from other species is ideal.

Figure 1.8 Bovine entrance is separate from other species.

Species Separation

When placing patients in the hospital they should be separated according to species, reason for admission, and desired contact precautions. Correct patient placement is necessary to control disease transmission.

> **TECHNICIAN TIP 1.20:** Correct placement of the patient within the hospital or clinic is necessary to control disease transmission.

All species should be separated within the clinical setting. In an ideal situation each species would have separate buildings/barns. Most clinics/hospitals do not have that luxury so species need to be separated by hallways or other physical barriers. Separation needs to occur because each species may shed infectious organisms in varying amounts, length of time, and based on different stressors. For example, bovine patients shed *Salmonella* (in feces) and often without clinical signs. Environmental contamination can occur easily with salmonellosis, creating a higher potential of transmission to other species and patients. Housing of species together can also cause stress to some animals, such as llamas with horses. Stress can cause a prolonged healing time and can often increase shedding of infectious pathogens.

Within the different areas of the hospital/clinic setting each species should be separated based on their risk level of spreading or acquiring infectious diseases. Patients undergoing orthopedic surgery generally have a lower potential of shedding infectious organisms but have a higher risk of acquiring them. In an equine facility it has been shown that colic patients tend to have a higher risk of shedding *Salmonella*. Orthopedic and colic patients should ideally be placed in different areas of the hospital/clinic or separated by physical or virtual barriers.

> **TECHNICIAN TIP 1.21:** It has been shown that colic patients tend to have a higher risk of shedding *Salmonella* within an equine hospital.

Barrier Precautions

Once the risk level of spreading or acquiring infectious diseases is determined, then barrier precautions can be assigned depending on the patient's risk level. In the large animal setting, four different levels of precautions are:

- standard
- contact
- mini-isolation
- strict isolation

Reevaluate the risk level of the patient on a daily basis, as it can change dependent on the patient's clinical status. If the risk level increases, then the barrier precautions should reflect that change. It is important to note that with all levels of precautions, hospital personnel should be wearing clean outerwear and, if working with horses, all hooves need to be picked prior to transporting them outside of the stall environment.

> **TECHNICIAN TIP 1.22:** Daily evaluation of the patient is important as the risk level of the patient can change on a daily basis.

Figure 1.9 Mini-isolation stall.

Figure 1.10 Strict isolation stall.

Standard Precautions

The basic precautions are called standard precautions. Standard precautions include good hand hygiene before and after handling the patient. Standard precautions should be used with all patients, even if they appear to be healthy, as they can be asymptomatic carriers.

Contact Precautions

Contact precautions are the next level in the precaution recommendations. Contact precautions include good hand hygiene before and after patient contact, wearing of gloves while handling the patient, and the addition of a footbath at the front of the stall. Gloves add an additional barrier between the personnel and the patient, which can decrease the risk of disease transmission. It is important to remember that gloves are not an adjunct for good hand hygiene and that hand hygiene still needs to be performed after gloves are removed. The same pair of gloves should not be used on more than one patient and gloves should be switched if moving from a dirty to a clean area of the patient. For example, personnel should not handle a catheter after touching an open wound. Whenever possible, clean procedures should be performed before procedures in dirty areas of the patient.

Mini-isolation Precautions

Mini-isolations should be used only in cases where transferring a patient to a strict isolation facility/stall cannot be done safely or patient care would be compromised. Mini-isolations are not to be used for the sole purpose of staff convenience.

TECHNICIAN TIP 1.23: Mini-isolations are not to be used for the sole purpose of convenience to staff.

Mini-isolation includes the previous steps plus a perimeter barrier, gowns/coveralls, boot covers, multiple footbaths, and with or without face shield. A barrier should extend far enough out from the front of the stall so that there is adequate room for personnel as well as necessary equipment and supplies. A stall should also be left vacant on either side of the infectious patient. A footbath should be placed at the entrance to the barrier and also at the front of the stall door. The area on the outside of the barrier chains is considered the clean area. The space between the chains and the stall front is considered the semi-clean area. All items used with the patient should be kept neatly in this area and should not be removed unless they are completely disinfected or sent for sterilization. This includes, but is not limited to, stethoscopes, thermometers, hoof picks, manure shovels, bins, and so forth. All personal items should be left in a neutral non-clinical area. The inside stall area is considered the dirty area and all PPE needs to be used anytime personnel enter this space. Proper gowning will be discussed later on in the chapter. It is also important to remember good hand hygiene before and after patient contact even though additional PPE is being utilized. Movement of patients out of the mini-isolation area should be restricted to necessary procedures only. Limiting traffic of infectious patients in a hospital/clinic reduces the possibility of environmental contamination.

Strict Isolation Precautions

The fourth and final type of precaution is known as strict isolation precautions. This includes all of the previous items discussed in the mini-isolation step, but adds an additional space factor. All strict isolation patients should be placed in an area that has a separate ventilation system and has no communication to other stalls or patients. Isolation facilities are often located in a completely separate barn or clinic. Isolation patients are those that are considered extremely infectious and require the highest barrier precautions and personal protective equipment available (i.e., Equine Herpesvirus Myeloencephalopathy, Strangles, *Salmonella*, etc.). The isolation area is set up similar to that of the mini-isolation area, except facility walls and doors will be in place rather than chains as a barrier to ensure that there is no risk of aerosol transmission to the outside

Figure 1.11 A strict isolation building.

area. As mentioned in the previous section, no items should be removed from the isolation area unless they are thoroughly disinfected or placed in a clean bag to be transported for sterilization.

Patient placement will ultimately depend on the type of infection, the ability to provide appropriate care, and appropriate staffing.

Proper Gowning Techniques

Proper dressing and undressing of personnel entering/exiting the isolation (and mini-isolation) areas need to occur in a specific order to prevent contamination to clothing and equipment/items in the area. Note that institutions may have slightly different orders dependent on protocols, preferences, or facilities. Any refrigerated medications or disposable items should be brought to the changing area before putting on PPE. While in the clean area gloves, boots, and coveralls are donned. The staff member may now enter the semi-clean area after stepping into and through the first footbath. A second pair of gloves and a facemask (if needed) can be put on at this time. Gather the items needed for the patient and cross through the second footbath to enter the dirty area. It is helpful to have another staff member on the clean side to be the runner if additional items are needed or to record findings in the patient's record.

To exit the dirty area, the first stage is to step into and through the footbath at the stall front and enter the semi-clean area. The first item to be removed is the facemask (if used) and then the first layer of gloves that had direct patient contact. If the inner gloves are also soiled, discard them and replace them with a clean pair before going onto the next step. The next item to be removed is the coveralls and the boots. First take both arms out of the coveralls, being careful to only touch the clean side (inside). Again, only touching the clean side of the coveralls, carefully balance on one foot and remove the first leg from the coveralls along with the boot from that leg as well. Step that foot into the foot-bath and then balance on this foot in order to remove the leg and boot from the other foot. Step into the foot-bath, now with both feet in the footbath, and discard the coveralls and boots. Step into the clean area and finally remove the last pair of gloves. It is important to remember to perform good hand hygiene before going to the next patient or documenting anything on the treatment sheet. The process of gowning and de-gowning can be a little tricky and will take some practice to become efficient at the process.

Figure 1.13 Exiting isolation step one: Remove soiled gloves and replace.

Figure 1.12 Full PPE on a technician who is ready to enter isolation.

Figure 1.14 Exiting isolation step two: Remove gown with clean gloves by pulling your hands through, touching only the clean inside of the gown.

Figure 1.15 Continue taking off the isolation suit being sure to touch only the inside of the gown.

Figure 1.16 Move the isolation suit down to the boots.

Figure 1.17 Remove the suit and one boot.

Figure 1.18 With one boot loose, step into the footbath.

Figure 1.19 Continue ungowning by removing the second boot.

Figure 1.20 Place second loose foot into the footbath.

Figure 1.21 Dispose of contaminated suit.

Figure 1.22 Dispose of gloves.

Figure 1.23 Use hand sanitizer after taking off PPE.

Hand Hygiene

As mentioned earlier, hand hygiene is the number one way to prevent transmission of disease with environmental decontamination coming in as a close second. Performing both of these tasks correctly and timely will dramatically decrease the risk of contamination to patients and personnel.

Hand hygiene can be completed with the use of soap and water and/or alcohol-based hand sanitizer. It should be done before and after patient contact, after using the restrooms, before and after eating, when entering and leaving the hospital/clinic, and many other times during the day. See Figures 1.24 to 1.29 for a proper hand washing technique.

Figure 1.24 Wet hands.

Figure 1.25 Add soap.

Figure 1.26 Wash for 20 seconds.

Figure 1.27 Rinse.

Figure 1.28 Dry.

Figure 1.29 Turn off water with paper towel.

Soap and water is always the best option for hand decontamination and should always be done in place of sanitizer if the hands are visibly soiled. Some hand soaps may contain an antiseptic. Antiseptics are antimicrobial substances that are applied to the skin or mucous membranes to reduce the number of microbial flora. In addition to hand soaps, antiseptics can also be found in surgical scrubs that are used to prepare a surgeon's hands and to prepare the skin of patients for sterile procedures.

Figure 1.30 Surgical hand scrub.

Hand Sanitizer

Hand sanitizer is an alternative to soap and water only if hands are not visibly dirty, as it is deactivated by organic material. It is common in barns and large animal hospitals/clinics to have a large amount of organic material in the environment and on the patient; therefore in this situation it is better to have access to hand washing stations rather than simply using hand sanitizer. Hand sanitizer should contain at least 70–90% alcohol content to be considered appropriate for a hospital environment and should contain some type of emollients and moisturizers to keep hands from drying out. Before purchasing a sanitizer, it is important to ensure that staff will utilize the product. If personnel do not like the product due to fragrance, too much alcohol smell, foam versus gel, and so forth, they will not use it. Lack of personnel compliance will render this ineffective. Note that hand sanitizers kill most pathogens but not all of them. It will not kill parasites or non-enveloped viruses, including *Norovirus*, which is a common human virus causing gastroenteritis.

> **TECHNICIAN TIP 1.24:** An alternative to soap and water is hand sanitizer, but only if hands are not visibly dirty.

The last component to good hand hygiene is maintaining hand health and skin integrity. Dry and cracked skin provides pathogens an entryway to infect personnel. Hand lotion should be used frequently to maintain skin health.

Disinfection and Sterilization

Disinfection and sterilization are two extremely important concepts that aid in interrupting the cycle of infection. When performed properly, environmental surfaces and equipment can be safe and free of pathogens.

Disinfection

Disinfection is a process that eliminates many or all pathogenic microorganisms on inanimate objects. All cleaners/disinfectants are composed of chemicals that fall into different categories of effectiveness. For each category there are different kill times, levels of effectiveness, and types of pathogens they affect. Table 1.1 illustrates chemical types and their properties. Each clinic/hospital should have a low-level or intermediate-level disinfectant (kills most types of bacteria and viruses but it will not kill bacterial spores) and a high-level disinfectant (kills all microorganisms except for some bacterial spores). All personnel need to be trained when to use each chemical and the safety precautions needed when using them.

> **TECHNICIAN TIP 1.25:** The process of disinfection is the elimination of many or all pathogenic microorganisms on inanimate objects.

Table 1.1 Characteristics of Selected Disinfectants

FOR MORE INFORMATION, SEE THE 'DISINFECTION 101' DOCUMENT AT www.cfsph.iastate.edu

Disinfectant Category	**Alcohols**	**Aldehydes**	**Biguanides**	**Halogens: Hypochlorites**	**Halogens: Iodine Compounds**	**Oxidizing Agents**	**Phenols**	**Quaternary Ammonium Compounds (QAC)**
Sample Trade Names	Ethyl alcohol Isopropyl alcohol	Formaldehyde Glutaraldehyde	Chlorhexidine Nolvasan® Virosan®	Bleach	Betadyne® Providone®	Hydrogen peroxide Peracetic acid Virkon S® Oxy-Sept 333®	One-Stroke Environ® Pheno-Tek II® Tek-Trol®	Roccal® DiQuat® D-256®
Mechanism of Action	• Precipitates proteins • Denatures lipids	• Denatures proteins • Alkylates nucleic acids	• Alters membrane permeability	• Denatures proteins	• Denatures proteins	• Denature proteins and lipids	• Denatures proteins • Alters cell wall permeability	• Denatures proteins • Binds phospholipids of cell membrane
Advantages	• Fast acting • Leaves no residue	• Broad spectrum	• Broad spectrum	• Broad spectrum • Short contact time • Inexpensive	• Stable in storage • Relatively safe	• Broad spectrum	• Good efficacy with organic material • Non-corrosive • Stable in storage	• Stable in storage • Non-irritating to skin • Effective at high temperatures and high pH (9-10)
Disadvantages	• Rapid evaporation • Flammable	• Carcinogenic • Mucous membranes and tissue irritation • Only use in well ventilated areas	• Only functions in limited pH range (5-7) • Toxic to fish (environmental concern)	• Inactivated by sunlight • Requires frequent application • Corrodes metals • Mucous membrane and tissue irritation	• Inactivated by QACs • Requires frequent application • Corrosive • Stains clothes and treated surfaces	• Damaging to some metals	• Can cause skin and eye irritation	

Precautions	Flammable	Carcinogenic		Never mix with acids; toxic chlorine gas will be released			May be toxic to animals, especially cats and pigs	
Vegetative Bacteria	Effective	Effective	Effective	Effective	Effective	Effective	Effective	YES—Gram Positive Limited—Gram Negative
Mycobacteria	Effective	Effective	Variable	Effective	Limited	Effective	Variable	Variable
Enveloped Viruses	Effective	Effective	Limited	Effective	Effective	Effective	Effective	Variable
Non-enveloped Viruses	Variable	Effective	Limited	Effective	Limited	Effective	Variable	Not Effective
Spores	Not Effective	Effective	Not Effective	Variable	Limited	Variable	Not Effective	Not Effective
Fungi	Effective	Effective	Limited	Effective	Effective	Variable	Variable	Variable
Efficacy with Organic Matter	Reduced	Reduced	?	Rapidly reduced	Rapidly reduced	Variable	Effective	Inactivated
Efficacy with Hard Water	?	Reduced	?	Effective	?	?	Effective	Inactivated
Efficacy with Soap/Detergents	?	Reduced	Inactivated	Inactivated	Effective	?	Effective	Inactivated

? Information not found

DISCLAIMER: The use of trade names does not in any way signify endorsement of a particular product.

For additional product names, please consult the most recent Compendium of Veterinary Products.

REFERENCES: Linton AH, Hugo WB, Russel AD. Disinfection in Veterinary and Farm Practice. 1987. Blackwell Scientific Publications; Oxford, England; Quinn PJ, Markey BK. Disinfection and Disease Prevention in Veterinary Medicine, In: Block SS, ed., Disinfection, Sterilization and Preservation. 5th edition. 2001. Lippincott, Williams and Wilkins: Philadelphia.

It is critical that chemicals are diluted correctly. Over-diluting chemicals will render them ineffective, while under-diluting them will not make the cleaners/disinfectants more powerful. Using higher concentrations of chemicals is hazardous to personnel, causes more wear and tear on surfaces or equipment, and is not cost-efficient. Resistance can develop in some pathogens when certain disinfectants are misused over long periods of time.

TECHNICIAN TIP 1.26: The misuse of disinfectants may develop resistance in some pathogens.

For the chemical/disinfectant to be completely effective, the organic material must first be removed. All surfaces should be cleaned of shavings, manure, and visible dirt. Once the object/surface is visibly clean, the disinfectant of choice should be applied and left to sit on these surfaces for a minimum of 10 minutes (or as recommended by the manufacturer). Spray/rinse with water and let dry. If the area was heavily soiled, repeat the process to ensure that all pathogens are eliminated.

Figure 1.31 A stall being disinfected that was first stripped of all organic material.

Figure 1.32 Foam gun used to apply disinfectant solution to a stall.

Figure 1.33 Scrub brushes can help remove soiled areas on stall surfaces.

Sterilization

For items that need a higher level of disinfection for sterile procedures, sterilization is utilized post-cleaning. Sterilization is a process that destroys or eliminates all forms of microbial life via physical or chemical methods. Steam under pressure, ethylene oxide gas, hydrogen peroxide gas plasma, and liquid chemicals are the main types of sterilization utilized in hospitals/clinics.

Deciding which option to use is primarily dependent on the type and composition of the equipment itself and the manufacturer's specifications. Regardless of the method utilized, all items must be thoroughly cleaned and all gross material must be removed from the surface in order for the process to be effective.

> **TECHNICIAN TIP 1.27:** Thorough cleaning and removing of all organic material from surfaces before disinfecting or sterilizing must be performed in order for the process to be effective.

Steam Sterilization

Steam sterilization requires four conditions to be met in order to be effective:

- type of steam
- pressure
- temperature
- time

To kill all pathogens, spores, and heat resistant organisms, the steam inside of the autoclave must contain a relative humidity of 97–99%. The pressure of the steam must be forceful enough to penetrate wrapped items to quickly kill microorganisms. The two common steam-sterilizing temperatures are 121°C (250°F) and 132°C (270°F). Temperature correlates with time in that the length of time at the predetermined temperature must be maintained for a minimal time to kill microorganisms. Recognized minimum exposure periods for sterilization of wrapped supplies are 30 minutes at 121°C (250°F) or 4 minutes at 132°C (270°C). It is important to remember steam sterilization is only safe for items that are heat and moisture resistant. A low temperature sterilization alternative may be used for heat or moisture sensitive equipment.

> **TECHNICIAN TIP 1.28:** Equipment must be heat and moisture resistant for steam sterilization.

Gas Sterilization

Gas sterilization utilizes ethylene oxide (EtO) to provide low temperature sterilization. The four essential parameters are:

- gas concentration (450 to 1200 mg/l)
- temperature (37 to 63°C)
- relative humidity (40 to 80%) (water molecules carry EtO to reactive sites)
- exposure time (1 to 6 hours)

After the cycle is complete, the items must undergo an aeration period to remove any residual ethylene oxide that was absorbed by the items.

Gas Plasma Sterilization

Hydrogen peroxide gas plasma is a fairly new sterilization practice that has only been marketed in the United States since 1993. It is safer than ethylene oxide while sterilizing items that are heat or moisture sensitive. A hydrogen peroxide vapor solution is released into the sterilization chamber at a concentration of 6 mg/l. Microorganisms are initially inactivated by the hydrogen peroxide before a microbicidal substance is applied to the items in the chamber. An electrical field is created by a radio frequency that is applied to the chamber creating gas plasma. Free radicals are generated in the gas plasma that are capable of interacting with essential cell components disrupting the metabolism of the microorganism. The hydrogen peroxide plus the gas plasma create a deadly combination for microorganisms. This method is safer for handling items immediately post cycle. The process operates in the range of 37–44°C and has a cycle time of 75 minutes.

Hospital Management

Every veterinary clinic or hospital should have an infection control program in place to ensure that nosocomial infections are caught quickly and that infection control guidelines are in place and followed. Infection control programs will differ between facilities dependent on the size of the clinic/hospital, number of personnel, risk of nosocomial infections in the practice, amount of funding available, personnel available to dedicate themselves to the program, and overall willingness of administration and personnel to put forth effort to build and maintain a program.

> **TECHNICIAN TIP 1.29:** In order to ensure that nosocomial infections are caught quickly and that infection control guidelines are in place and followed, a veterinary clinic or hospital should have an infection control program in place.

Key components of an infectious disease program include:

- Determining which diseases are to be controlled and understanding the ecology of these diseases.
- Grouping animals based on their infection status.
- Maintaining hygiene of the facility, personnel, and patients.
- Monitoring the occurrence of infectious disease.
- Instituting an immunization program for patients and staff.
- Optimizing the overall health of the animals by minimizing stressors, optimizing nutritional status, optimizing specific immunity through vaccination, and minimizing treatments that may make the animal more susceptible to disease.

Infection Control Programs

Leadership is a key component of a successful infection control program. Historically, most programs have been chaired by a clinician. However, times are changing in that veterinary technicians are becoming vital parts and leaders of the infection control programs of their clinics/hospitals. It is not only more cost-effective for the clinic to give this responsibility to a technician, but it also gives the program a different insight as technicians generally have a better idea of what is actually occurring in the clinic in regards to infection control. Technicians are key personnel for direct patient care, cleaning (including sterilization and laundry), and oversight of patient placement.

> **TECHNICIAN TIP 1.30:** A key component of a successful infection control program is leadership.

A good infection control program begins with an infection control committee that consists of essential personnel in the hospital. Which personnel are deemed essential will differ from clinic to clinic. However, it should include a range of people including technicians, clinicians, clinical pathology personnel, hospital epidemiologist, administrators, and cleaning personnel.

The committee should have clearly defined goals and objectives that are based on ways to protect patients, hospital personnel, owners, and the community. Goals and objectives should be in writing and reviewed annually. The committee needs to be involved in policy development and in the review of standard operating procedures. This can range from having simple policies and procedures to organizing routine surveillance programs. Regardless of the complexity of the program, protocols and procedures should be adjusted and tweaked to ensure that it is a good fit for the clinic and the personnel that need to follow these policies. If people do not support or understand the reasoning behind the protocols, they will not follow them and the goals of the committee will therefore not be met.

> **TECHNICIAN TIP 1.31:** If people do not support or understand the reasoning behind the protocols they will not follow them, and the goals of an infection control committee may not be met.

The committee should complete a risk analysis of key areas of concern. The steps in the analysis include determining risk perception, hazard identification, risk management, and risk communication.

Risk perception would be the real or perceived risks for infectious or zoonotic disease. This may be based on what has historically caused problems in the hospital/clinic and community, on what has affected other hospitals, and on what the media and medical journals are portraying as potential risks. It is important to remember that all the potential risks that might occur cannot be predicted. However, by having a strong foundation in place, the magnitude of the outcomes of an outbreak can be significantly reduced.

Hazard identification involves identifying what infectious and zoonotic diseases are most likely to affect the hospital. There are some diseases that all hospitals/clinics should be concerned about such as salmonellosis, strangles, and equine herpes virus, however, large animal risks will vary by geographic location. Pathogens endemic to the area should be identified, measures to control and prevent them should be taken, and personnel should be educated about them. All exposures or outbreaks carry varying degrees of risk in regards to disease in animals and/or humans. This does not take into account lost revenue, decrease in client confidence, public image, and staff morale. The committee must decide which diseases are the most detrimental to its patients, to its staff, and to the hospital.

> **TECHNICIAN TIP 1.32:** *Salmonella*, strangles, and equine herpes virus are diseases that all hospitals and clinics should be concerned about.

Risk management is the process of identifying, selecting, and implementing measures that can be applied to reduce the level of risk. Managing risks centers on enforcing or changing protocols or procedures to improve hospital infection control. This includes looking at ways to improve hygiene (both hand and environmental), promote better barrier precautions, and implement better training and education for all staff and clients. Surveillance is an important piece of risk management and will be discussed later on in the chapter.

Risk communication is the final piece in risk analysis and involves ensuring that all personnel understand, support, and adopt the protocols and procedures developed to improve hospital infection control. A training program that includes the reasons behind the protocols will help to persuade the staff that these measures are important and are a vital component of patient care.

Technicians are essential in the creation of the training program and in how it is presented to all staff. A training program will not be effective if staff cannot apply it directly to the work that they will be performing. Generally veterinary technicians know the ins and outs of the clinic/hospital and are able to adapt the training and deliver it in a manner that staff can relate to (i.e., visual or hands-on based training). Training should include basics, such as how to perform proper hand hygiene and environmental decontamination, but should be specific enough so that all staff executes all tasks in the same manner leaving no room for self-interpretation. Never assume that personnel know how to wash their hands or clean out a stall properly. Training needs to be documented and repeated annually.

> **TECHNICIAN TIP 1.33:** Veterinary technicians are essential in the creation of a training program and in how it is presented to all staff.

Once training is complete, posters and signs are easy ways to provide staff a constant reminder on how to complete tasks or to alert them to precautions that need to be taken. Signs should be simple and concise. They should also be big enough and strategically placed so that personnel are likely to notice and read them.

Figure 1.34 Signage should be strategically placed so that personnel are likely to read them.

Figure 1.35 Signs should be simple and concise.

Communication is essential. Keeping open lines of communication between all clinicians, technicians, and cleaning staff is one of the most important jobs of the infection control technician. Being the central "go to" person is important so that ideas, comments, and complaints are not lost and can be pieced together and brought forward to the infection control committee. If something is not working then it needs to be changed. As long as the basics remain consistent, the program can be molded to meet the needs of the hospital.

Surveillance

Surveillance is an important part of any clinic's infection control program and is a key responsibility of an infection control technician. This may include monitoring of organisms, environmental hygiene, surgery site infection rates, and other factors deemed important by the infection control team as necessary. Surveillance is either passive or active. Either type can be used alone or in combination dependent on the pathogen, program, and available money.

Passive Surveillance

Passive surveillance is the easier of the two types and is often adequate for most clinics/hospitals. Passive surveillance involves gathering, organizing, and analyzing data that is already present. To ensure that nosocomial events are not occurring within the patient population, the infection control technician would gather culture reports on a routine basis and watch for common organisms or patterns. The frequency of reports should be determined, whether daily, weekly, or monthly, and followed consistently. If this is performed often and by one individual then nosocomial events can be identified before an outbreak occurs. The gathering of all the culture data can also be analyzed to look for changes in disease patterns and to calculate infection rates of specific procedures, such as postoperative surgical site infections.

Active Surveillance

Active surveillance is more time-consuming and expensive than passive surveillance; however, it produces high quality data that is extremely useful for larger clinics/hospitals. It also may be more beneficial in detecting potential events earlier. Active surveillance can involve collecting environmental samples or contacting owners to identify potential surgery site infections.

Obtaining environmental or patient samples can be very beneficial only if there are protocols in place that lay out exactly what is to be done if there is a positive sample result. If a positive environmental sample is found, the written protocols should determine what areas need to be deep cleaned, what further cultures need to be taken, if patients located in the area need to be sampled, and what needs to be communicated to hospital staff, clinicians, and possibly clients. If a positive patient sample is cultured, the next steps should be determined in regards to: the patients (move to isolation, put in mini-isolation, or enforce personal protective equipment); the environment (what type of cleaning needs to be completed); and other patients around the positive patient. Communication is again critical in this scenario to ensure that all personnel are aware of what was found, why contact precautions may or may not have changed, and what exactly needs to be communicated to clients or others outside of the clinic/hospital environment.

Whichever type of surveillance or combination the infection control team decides to utilize, the infection control technician is vital to identifying trends and notifying infection control personnel (the hospital director, clinicians, staff, and cleaning crew) to unusual events.

Multidrug Resistant Organisms, Methicillin Resistant *Staphylococcus* sp., and Zoonotic Diseases

Multidrug Resistant Organisms (MDRO)

Multidrug resistant organisms (MDRO), methicillin resistant *Staphylococcus aureus* (MRSA), zoonotic, and other infectious diseases that affect different regions are often motive for veterinary personnel to create infection control programs. It is extremely important to become familiar with the organisms that are found in the local area.

One area of particular concern is MDROs. These are organisms resistant to three or more antibiotics. These organisms are important as they limit the antibiotics that can be given and often require more expensive ones or some other course of treatment.

Methicillin Resistant Staphylococcus aureus *(MRSA)*

Staphyloccocus sp. are gram-positive organisms that are considered normal flora and generally do not cause disease. Staph organisms can cause disease when the bacteria are found in abnormal locations and can precipitate tissue inflammation and pathogenic changes. These organisms can be multidrug resistant and/or methicillin resistant. MRS organisms are mediated by the production of an altered penicillin-binding protein (PBP), which confers resistance to all beta-lactam antimicrobials. Methicillin is an antibiotic drug of the penicillin family that was used as a marker for resistance to all beta-lactam antimicrobials and also Carbepenems. The drug companies have since phased out this drug, and oxacillin has taken the place as the new marker for this type of resistance. Methicillin resistant staph species are usually not considered a zoonotic agent unless dealing with methicillin resistant *Staphylococcus aureus* (MRSA).

MRSA is a concern in human hospitals and recently has become important in veterinary medicine. As in humans, equine infections with MRSA can be subclinical (colonized), which can put other patients and hospital staff at risk. The most common site for colonization in equines is in the nasal passage. Colonization is transient in most adult horses, and MRSA colonization is eliminated in most horses within weeks (some longer than others and a small percentage have lifetime colonization), provided that measures are taken to prevent reinfection from other horses or people.

To treat or not to treat for colonization is dependent on a variety of factors, including traveling and housing situations. It is important to note that MRSA develops resistance rapidly, which may leave few treatment options for persistent or reinfected patients, therefore antimicrobial treatment needs to be limited to those patients that are a key component in the method of transmission.

MRSA surveillance and protocols should be tailored to the degree of risk that is seen in that area. Regions that have a higher prevalence of MRSA tend to take a more active surveillance protocol. This may include a protocol in which all horses admitted are screened and swabbed for MRSA (via the nasal passage), then swabbed routinely during their hospitalization. If a positive MRSA isolate is cultured at arrival, then the MRSA infection is more likely to be community acquired (picked up outside of the hospital environment). If after being hospitalized for more than 72 hours one can speculate this to be a hospital acquired infection. A more passive approach to surveillance is often instituted in regions with a low occurrence of MRSA. At a minimum, all hospitals and clinics should ensure that all *Staphylococcus aureus* pathogens are tested for oxacillin resistance.

> **TECHNICIAN TIP 1.34:** MRSA surveillance and protocols should be tailored to the degree of risk that is seen in that area.

Strict isolation precautions need to be enforced for all MRSA positive cases. Cleaning should occur as soon as the positive result is revealed, paying close attention to buckets, hay nets, and other objects/surfaces with which the nose of the horse or affected area had the most contact. It is possible that clinic personnel can become colonized or, if immunocompromised, can become ill. The decision to test human personnel for MRSA colonization is a decision to be made by the infection control team. It is a key component in events where there is evidence that links human transmission with nosocomial events. Personnel that are colonized or have been diagnosed with an active MRSA infection should be seen by a physician to prevent transmission to other staff and patients.

Zoonotic Diseases

Zoonotic diseases are diseases that are communicable from animals to humans. Acquiring an infectious pathogen is a risk that all personnel face daily as a result of working with sick animals. Immunocompromised personnel should not work with known zoonotic patients and should take extra precautions to ensure that they are keeping themselves safe and healthy. These individuals require additional PPE while working with patients and should consult with a human physician in regards to what these extra precautions may be. Hospital administration and the infection control team have a responsibility to protect their employees. Vaccinations are also available to protect staff from specific diseases. Records of immunizations should be recorded and monitored to ensure that all personnel are current. Rabies and tetanus are two significant diseases that staff members should be protected against with vaccination regardless of the species that they are working with. Initial prophylactic rabies immunization should be administered before working with patients. A titer every two years thereafter is drawn to ensure that antibody levels in the blood are still adequate for protection. If levels fall below the required titer (less than 1:5 as determined via the rapid fluorescent foci inhibition test method) then a booster shot is recommended. A tetanus immunization should be administered and updated every 10 years. Influenza vaccinations are also important for those staff working with poultry and swine to protect their patients.

TECHNICIAN TIP 1.35: Diseases that are communicable from animals to humans are zoonotic diseases.

TECHNICIAN TIP 1.36: Staff members should be protected against rabies and tetanus regardless of the species that they are working with.

Transmissions of zoonotic diseases are preventable. Education and knowledge of zoonotic diseases that affect your local area is essential to the protection of staff and patients. Please see the “Diseases” chapter for specific disease information.

Many zoonotic diseases are reportable (i.e., rabies). Reportable diseases also include diseases that can have an effect on a large population of animals in the affected area (i.e., Equine Infectious Anemia). A list of reportable diseases should be available and easily accessible to all hospital staff, and required reporting procedures should be included in the infection control protocols. Contact your state department of health for more information on what diseases are reportable in your state.

Summary

The mission of the biosecurity (infection control) team is to protect all staff, clients, and patients that enter the hospital/clinic. The chain of infection and ways to break this chain are important concepts that all hospital staff should be educated about and trained in. Leadership is a key component of a successful infection control program. Veterinary technicians are evolving into this leadership role and are key to keeping the lines of communication open, to ensuring that protocols and procedures are being followed, and to looking for continual ways to improve and enhance biosecurity.

References

Bender, J. (2004). Horses and the risk of zoonotic infections. In Turner, A., Bain, F., & Weese, J. (Eds.), *Veterinary Clinics of North America: Equine Practice*. Volume 20 (Number 3). Philadelphia, PA: Elsevier Inc.

Caveney, L. & Jones, B. (Eds.). (2012). *Veterinary Infection Prevention and Control*. Oxford, UK: John Wiley & Sons, Inc.

Greene, C., (Ed.). (2006). *Infectious Diseases of the Dog and Cat*. St. Louis, MO: Elselvier Inc.

Ikram, M. & Hill, E. (1991). *Microbiology for Veterinary Technicians*. St. Louis, MO: American Veterinary Publications, Inc.

National Association of State Public Health Veterinarians (NASPHV). (2010). Compendium of Veterinary Standard Precautions for Zoonotic Disease Prevention in Veterinary Personnel. *JAVMA, 237*(12), 1403–1422.

Rutala, W. & Weber, D. (2007). An overview of disinfection and sterilization in health care facilities. In Rutala, W.A. (Ed.), *Disinfection, Sterilization and Antisepsis*. Washington, DC: Association for Professionals in Infection Control and Epidemiology.

Rutala, W., Weber, D., & Healthcare Infection Control Practices Advisory Committee (HICPAC). (2008). Guidelines for Disinfection and Sterilization in Healthcare Facilities, 2008. Atlanta, GA: Centers for Disease Control and Prevention. Retrieved from www.cdc.gov

Santschi, E. (2006). Prevention of postoperative infections in horses. In Southwood, L. (Ed.), *Veterinary Clinics of North America: Equine Practice*. Volume 22 (Number 3). Philadelphia, PA: Elsevier Inc.

Spickler, A. (2011) *Methicillin Resistant Staphylococcus aureus*. Retrieved from Iowa State University, Center for Food Security & Public Health Web site: http://www.cfsph.iastate.edu/DiseaseInfo/factsheets.php

Steneroden, K. (2005). *Stationary Veterinary Clinic Biological Risk Management*. Ames, IA: Center for Food Security and Public Health.

Traub-Dargatz, J., Dargatz, D., Morley, P., & Dunowska, M. (2004). An overview of infection control strategies for equine facilities, with an emphasis on veterinary hospitals. In Turner, A., Bain, F., & Weese, J. (Eds.), *Veterinary Clinics of North America: Equine Practice*. Volume 20 (Number 3) (pp. 507–520). Philadelphia, PA: Elsevier Inc.

Weber, D. & Rutala, W. (2007). Use of germicides in the home and healthcare setting: Is there a relationship between germicide use and antibiotic resistance? In Rutala, W. (Ed.), *Disinfection, Sterilization and Antisepsis* (pp. 248–271). Washington, DC: Association for Professionals in Infection Control and Epidemiology.

Weese, J. (2004). Barrier precautions, isolation protocols, and personal hygiene in veterinary hospitals. In Turner, A. S., Bain, F. T., Weese, J. S. (Eds.), *Veterinary Clinics of North America: Equine Practice*. Volume 20 (Number 3) (pp. 543–559). Philadelphia, PA: Elsevier Inc.

Weese, J. (2004). Methicillin-resistant *Staphylococcus aureus* in horses and horse personnel. In Turner, A. S., Bain, F. T., Weese, J. S. (Eds.), *Veterinary Clinics of North America: Equine Practice*. Volume 20 (Number 3) (pp. 601–613). Philadelphia, PA: Elsevier Inc.

Yang, J. (2013). *Virulence Factors of Pathogenic Bacteria*. Retrieved from http://www.mgc.ac.cn/VFs/main.htm

Clinical Case Resolution 1.1

Salmonella would be a suspect pathogen in this case; therefore, it would require isolation to prevent spreading to other patients and to the staff. The patient needs to be transported to a separate isolation stall. If one is not available, move the patient to a stall that is away from all other patients and follow the steps for mini-isolation; however, moving the patient into full isolation is the best option. During transport be sure to disinfect the path the horse has taken to the new stall, as well as those of all members of the veterinary care team, including cleaning crew, staff working in the area, and clinicians of the other patients housed in the same area. The hospital infection control (IC) team needs to be notified and needs to decide on what to tell the owners of the patients housed in the same area, if they are notified at all. The IC team should also determine if those patients need to have further monitoring (i.e., twice daily temperatures) to watch for any signs of possible *Salmonella* infection.

All areas that the infectious patient visited need to be thoroughly cleaned and disinfected. This includes any treatment areas as well as the hallways and the stall area. It is not a bad idea to block off the stall and/or the treatment area (if it was heavily used or soiled) until the fecal cultures have returned to normal. If there is a positive *Salmonella* result, environmental cultures should be taken (focusing on high touch surfaces, walls, and the floor) to ensure that the areas were cleaned properly and there is no apparent risk of contamination left when a new patient is admitted.

Activities

Multiple choice questions

(Answers can be found in the back of the book.)

1. Factors that account for how clinically ill a patient may become include:
A) immune status of the pathogen
B) route of transmission
C) virulence of the pathogen
D) portal of entry for transmission

2. What host factor will not effect disease prevention?
A) vaccinations
B) mode of transmission
C) malnutrition in the host
D) good antibiotic stewardship

3. Good antibiotic stewardship refers to which of the following:
A) give antibiotics to mitigate infections before potential exposure.
B) give the right antibiotics, at the right dose, at the right time, and for the right duration.
C) antibiotics prescribed randomly during periods of potential exposure.
D) give heavy dose antibiotics for extended periods of time.

4. Which of the following is not considered a portal of exit for pathogens?
A) gastrointestinal tract
B) urogenital tract
C) mucous membranes
D) central nervous system

5. Patients in the hospital should be separated according to which factor?
A) their risk level of spreading or acquiring infectious diseases
B) clinical symptoms that are present at time of admission
C) species and breed specifications
D) color and size

6. Which of the following precautions should be used for hospitalizing a patient with EHV-1?
A) standard precautions
B) contact precautions
C) mini-isolation precautions
D) strict isolation precautions

7. What is the number one way to prevent transmission of disease?
A) antibiotic therapy
B) environmental decontamination
C) hand hygiene
D) elimination of fomites

8. In order for steam sterilization to be effective the following conditions must be met:
A) type of chemical used and time
B) type of steam, pressure, temperature, and time
C) type of packaging items are wrapped in
D) gas concentration, relative humidity, and exposure time

9. In order to kill all pathogens, spores, and heat resistant organisms, the steam inside of the autoclave must contain a relative humidity of:
A) 50–60%
B) 60–80%
C) 80–90%
D) 97–99%

10. Which of the following is not true of Methicillin resistant *Staphylococcus aureus* (MRSA)?
A) gram positive
B) normal flora
C) multidrug resistant
D) species specific

Test your learning

1. Describe three things that factor into a pathogen's success.
2. Describe what a dead-end host is and its effect.
3. Describe the three common routes of disease transmission.
4. Describe the difference between disinfection and sterilization.
5. List the key components of an infectious disease program.

Answers can be found in the back of the book.

Extra review questions, case studies, and a breed ID image bank can be found online at www.wiley.com/go/lienvettech.