Stationary Veterinary Clinic Biological Risk Management

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Introduction

In order to provide the best care for animal patients, it is the responsibility of veterinary practices to minimize the risks associated with the spread of infectious and zoonotic diseases. Establishment of a Biological Risk Management (BRM) program with practical approaches designed for individual facilities can help identify the potential risks within a clinic before they become problems.

This document is intended to increase your awareness of the biological risks associated with a veterinary hospital as well as the potential consequences of disease introduction. While the introduction of disease can be accidental or incidental, developing a BRM plan can help to both prevent disease entry into your clinic as well as spread within. This document will also provide information on how to conduct an assessment of your veterinary practice with measures to help identify and reduce risks in your practice.

Importance of BRM to Veterinary Practitioners

The implementation of BRM protocols are a practical precaution for any veterinary practice. A well designed plan will:

- **Optimize patient care by reducing the threat of infectious and nosocomial disease.** Infectious disease outbreaks can and do happen. Nosocomial infections as well as zoonotic disease transmission are occurring in veterinary practices and their reporting is on the rise.
- **Help reduce the risk and spread of zoonotic disease among staff and clients**. This is especially relevant to high risk groups (e.g.. immunocompromised, pregnant, children, elderly). A recent study found that one in five veterinary technicians in small animal practice contracted a zoonotic infection. The rate increased with the number of years spent in practice. While the infections were usually of a less serious nature, staff education on zoonotic disease may have saved practice owners time and money.
- **Promote public health and develop skills and knowledge of infectious disease control among staff members**. Focusing on preventive medicine will empower you to make safer and wiser choices for yourself and your staff. It will also help to maximize the public and environmental health of the community.
- **Reduce the risk of liability and financial loss due to disease outbreaks**. Prevention is generally less costly than treatment. One of the greatest initial costs in developing a BRM plan is time. It takes time to assess a practice, draw up a plan, and educate staff and clients. These costs can be borne over time. In comparison, the potential costs of treatment in an outbreak are monetary and immediate: the cost of disinfectants, antibiotics, vaccinations, and closing business for a period of time. A small investment of time for prevention can outweigh the economical impact of an incident. Protecting your financial investment and your future assets from liability is worthwhile insurance.
- **Prepare for foreign animal diseases and the emergence of novel pathogens**. Establishing and following a BRM plan will help manage the threat of disease entry

and spread. With a BRM plan in place and staff educated about infection control, diseases will have a more difficult time gaining entry and spreading through your practice.

- **Reduce the risk of antimicrobial resistance**. Antibiotic resistance is a growing issue, not only with regard to livestock and human medicine, but with companion animals as well. Judicious use of antimicrobials to preserve their effectiveness in veterinary and human medicine is encouraged. When you control infection through biological risk management you ultimately control antibiotic use.

Veterinarians are well trained in zoonotic and infectious diseases, but have varying comfort levels with their knowledge of these diseases and ways to minimize risk or implement procedures for prevention.

The development of a BRM plan is a process of analyzing risk. The steps involved in this risk analysis include risk perception, hazard identification, risk management and risk communication.

Risk Perception

Risk perception can be defined as what individuals believe about real and potential risks. In the case of BRM, this would be the real or perceived risks for infectious or zoonotic diseases. Risk perception may pose the greatest obstacle to improvement in BRM. Perceptions are influenced by what the practice owner(s) and staff have encountered in the past, what they have read in the paper, journals, and magazines or found on the internet. It may also be influenced by what they have heard on television, at local veterinary meetings, or from other veterinarians, as well as what they have learned in their formal training. Each of these means of obtaining information carries their own biases and influences one's perception of risk.

It must be remembered that the risk of disease cannot be totally eliminated, but its effect and consequences can be reduced. It is difficult to measure and prove the benefit of unseen events, such as avoiding an infectious disease outbreak. Scientific evidence is mounting in favor of increased infection control measures in veterinary hospitals. This will help overcome negative perceptions of risk.

Hazard Identification

An important step in the process of BRM is the identification of the diseases most likely to affect a veterinary hospital. Veterinarians and their staff are generally aware of the common infectious and zoonotic diseases seen in their practice and have knowledge of other pathogens endemic in their area. Some diseases may have a widespread geographic distribution and should be included as potential hazards on every veterinary clinic's list.

Additionally, infectious diseases that could potentially affect a geographic region but are not yet endemic should be considered. For instance, the vector for heartworm disease is present in western Washington, but heartworm disease is not prevalent. Others disease hazards may be limited by the geographical distribution of vectors or environmental situations. However, vigilance for the "zebras", in the form of emerging and foreign animal disease, or bioterrorism, and agroterrorism agents is important. The enormous impact of West Nile Virus (WNV) on the

equine and human population is a potent example of an emerging infectious disease that has now become established in the United States.

Risk Assessment

Assessing risk is evaluating the likelihood of disease introduction along with the estimation of its potential consequences. Risk assessment must be a non-biased evaluation of a veterinary practice to evaluate its strengths and weaknesses. It is helpful to begin risk assessment by focusing on the routes of transmission: aerosol, oral, direct contact, fomites and vectors. Disease spread by any of these means can be influenced by many factors including the disease agent involved, the speed and accuracy of a diagnosis, timely use of proper patient isolation, and appropriate cleaning and disinfection.

Assessing risk based on route of transmission provides a more complete and holistic approach and avoids emphasizing the importance of specific disease(s). The only references made to specific diseases, syndromes or infectious agents in this material are for illustrative purposes only, and there are no specific recommendations provided as to vaccination, treatment or testing procedures. This focus will make the information applicable to a variety of audiences and remain relevant even as scientific advances improve our understanding of diseases. In general, by focusing on transmission routes, provisions to control several different diseases can be accomplished at one time.

The assessment of potential risks as well as their consequences will help guide practice owners and staff towards a biological risk management program that is proactive, practical and tailored to the individual hospital.

Consequences of Disease Spread in Veterinary Clinics

An important aspect of biological risk assessment is considering the potential consequences of infectious disease exposure and spread in a veterinary practice. These interrelated consequences range from the very tangible - disease or death in animals, disease or death in humans, and lost revenue, to the less tangible - losses of “good will”, client confidence, public image and staff morale.

Disease or death in animals

Facts and figures on disease outbreak or spread from individual veterinary practices are limited, but growing. In 2002, an outbreak of highly virulent feline calicivirus (FCV) with high mortality was documented in three different veterinary clinics and an animal rescue organization in Southern California. Healthy, adult, vaccinated cats were primarily affected with the disease which was spread by client and technician traffic between the veterinary practices. In all, 54 cats were infected with a 40% mortality rate.

Reports from veterinary teaching hospitals can provide tremendous insight into the tangible and intangible consequences of infectious disease outbreak. A good example is the outbreak of *Salmonella infantis* at Colorado’s Veterinary Teaching hospital in 1996. More recently, a multi-drug resistant strain of *Salmonella* became responsible for the closure of the University of Pennsylvania’s New Bolton Center in May 2004. The hospital closed for approximately 12 weeks, while a lengthy decontamination process was undertaken. The entire hospital complex was

sandblasted, disinfected and repainted. Dirt floors were removed and replaced with concrete and a new drainage system was installed. One percent of the hospital caseload was infected and *Salmonella* was isolated from 16 fatal horse cases. There were no reported human cases from this outbreak.

According to a 2001 study done at a Swiss university companion animal and equine veterinary hospital, nosocomial infections similar to those seen in human hospitals were present and were considered emerging in veterinary medicine. Until recently, little attention has been paid to the prevention of nosocomial infections in veterinary medicine. Some situations in veterinary clinics are similar to those found in human hospitals, such as the widespread use of antibiotics, complex treatments, and prolonged hospitalization of critically ill patients. The development of emergency medicine and the appearance of large intensive care units in veterinary clinics may also increase the potential risk of nosocomial diseases.

Disease or death in humans

Over the last decade, the occurrence of new (e.g., monkeypox) and emerging (e.g., West Nile virus and hantavirus) diseases have occurred. While one of our responsibilities lies in the protection and care of animal clients, veterinarians are also responsible for the effect animal diseases can have on the public, particularly from zoonotic diseases.

Consider the following example:

In the spring of 2003, a rare viral disease never before seen in the Western Hemisphere was diagnosed in the Midwestern United States. Monkeypox, traditionally seen in Africa, produces a rash similar to smallpox with a case fatality rate of 1-10%. During this outbreak, rodents and small mammals imported to be sold as pets in the United States, exposed and infected prairie dogs, which in turn infected a total of 71 humans who had contact with them.

Public health strategies to control this outbreak included an FDA-CDC joint order that banned importation and prohibited movement of the suspect animal species. State measures were also put in place including restricted intrastate animal shipment and trade, quarantines, and animal euthanasia. These strategies were effective in reducing exposure of humans to the infected animals. Additional measures included pre- and post-exposure vaccination of potentially exposed persons with the smallpox vaccine.

According to the CDC, recent emerging zoonotic disease outbreaks in the U.S., such as monkeypox, highlight the need to better protect the veterinary community by educating them about personal protective measures. In the monkeypox outbreak, over 25% of confirmed and probable human cases were veterinarians or members of their staff. During the outbreak “a lack of universally accepted infection control and personal protection guidelines within the veterinary community hampered the delivery of effective prevention messages to this vulnerable population.”

Outbreaks of zoonotic disease appear to be on the rise in veterinary practices. In 1999, the CDC received reports from three state health departments of outbreaks of multidrug-resistant *Salmonella* serotype *typhimurium* infections in employees and clients of small animal veterinary clinics and an animal shelter. During a two month period in 2003, the New York State Department of Health identified seven human infections with *Salmonella* serotype *typhimuium* which had an apparent link to a veterinary clinic. These outbreaks demonstrate that small

animals shed *Salmonella* and that small animal facilities can serve as foci of transmission for *Salmonella* to other animals and humans.

Pregnant clients or staff members may also be at greater risk of the consequences from a zoonotic disease such as toxoplasmosis, cat scratch fever, psittacosis or brucellosis. Having current knowledge and information for vulnerable clients or staff will provide them with resources to make informed decisions and avoid potential risks.

The health of a family pet can affect the health of its family, especially when it comes to children. Informing clients about the risk of zoonotic disease transmission is an element of a proper standard of care and failure to provide warnings may be a source of liability. Lawsuits have been brought against veterinarians as a result of children suffering vision loss from canine roundworm infestation. Parasite control measures recommended by veterinary practices should be in accordance with the Centers for Disease Control and Prevention (CDC) guidelines.

Human death is a highly unlikely, but nevertheless tragic, consequence of zoonotic disease transmission. Allegations of malpractice leading to human illness, death or injury can be quite expensive to defend and the settlements or awards costly. Taking the example of animal bites, there were 2,300 workers compensation insurance claims for cat bites alone from 1999-2001, representing nearly 2 million dollars in losses. While most cat bites are resolved with a doctor's visit and antibiotics, some can require extensive treatment and cause permanent disabilities. According to the AVMA PLIT, frequent bites can lead to significant loss of productivity for a clinic, damage employee morale, and also have significant impact on workers compensation premiums and a practice's ability to obtain workers compensation insurance.

For the years 1992-1994, there were 246 zoonotic disease related worker's compensation claims filed with AVMA PLIT, amounting to approximately $500,000. The claims were primarily from rabies exposure, dermatitis and plague, with the average zoonotic disease insurance claim amounting to $2,000 in direct costs. While not as easily calculated, indirect costs also need to be considered. When an employee is out of work, other employee's workloads increase. This can lead to fatigue, decreased productivity and mental strain. Temporary employees are often less efficient because they are not as familiar with procedures.

Lost revenue

Outbreaks of infectious disease in veterinary facilities may lead to liability or financial losses. For example, the 1996 outbreak of *Salmonella infantis* at CSU's Veterinary Teaching Hospital affected 59 animals (primarily equine), three of which died. Following a temporary hospital closure, lost revenue amounted to $300,000 with an additional $250,000 needed for facility renovation.

The economic costs of closing down business for a day/week/month to decontaminate are something each practice owner will have to consider individually. Being largely a service based industry, down time means lost revenue that may be difficult to recover. Time taken away from servicing clients and generating income is instead devoted to purchasing supplies and clean up equipment, which will increase non-billable expenses.

Intangible losses

These are the social and psychological effects on veterinarians, staff and community members when disease outbreaks occur. It includes the loss of opportunity, loss of competition, and

reputation as well as community morale. Loss of client confidence, good will and public image can lead directly to economic losses as clients and staff alike potentially turn elsewhere for services and expertise. Fear of disease exposure may also keep customers away.

This document illustrates the best available "standard operating procedures" for a wide range of management practices. Each veterinarian should perform a thorough assessment to identify opportunities for improvement. Then the management suggestions should be considered as to which ones are most practical, applicable, and economically viable. Most recommendations can be implemented independent of others. This will result in customization of the BRM program for each veterinary practice based upon his/her preferences, resources, and perception of risk. Some suggestions may not be feasible for a given facility or veterinarian; recognizing what is optimum helps establish long term goals.

Risk Management

Risk management is the process of identifying, selecting and implementing measures that can be applied to reduce the level of risk. Consideration of various options will need to be explored and assessed for feasibility and efficacy.

Risk management plans can include three areas: general practices to improve hygiene, general practices to improve hospital infection control, and management changes aimed at the routes of transmission.

General practices to improve hygiene

Hygiene practices and protocols followed by a particular hospital include hand washing policies, uniforms and barrier protection (personal protective equipment or PPE), handling of infectious waste, and cleaning and disinfection. Most veterinary practices will benefit from improved and updated general hygiene practices. Adherence to standard precautions is the foundation of infectious disease prevention and will help reduce transmission of most infectious/zoonotic diseases. Within this section, special attention is paid to zoonotic disease and immune compromised individuals, a vulnerable population. Signage should be posted in restrooms, treatment rooms and hospital wards to remind staff of practices to protect themselves and others. General hygiene practices, termed "Standard Precautions" include the following:

- Hand washing is, and will remain, the most important measure to reduce the risk of transmitting infectious organisms. When and how hands are washed is important. Hand washing signs and stations should be located in areas where animal contact occurs.
- Barrier protection (personal protective equipment or PPE) in the form of gloves, masks, protective clothing and respirators used appropriately can reduce the potential disease risk further. Barrier protection must be appropriate for the type of procedure being performed. It must be available and, if not disposable, properly washed and stored in such a way to prevent environmental contamination.
- Limiting the number of individuals that come into contact with potentially infectious animals will obviously limit potential spread of disease. In isolation areas, only designated persons should handle animals and their wastes.

- Infectious waste must be disposed of appropriately. Waste should be bagged in the area where it was generated and placed in an additional bag once outside of the infected area. Storage of infectious waste until removal by sanitation services must be secure.
- Proper cleaning and disinfection of contaminated environments is essential. Any basic disinfection protocol should include the following steps:
  - Assess the affected areas to be cleaned and treated.
  - Remove all grossly visible debris. The presence of gross contamination will inactivate most disinfectants.
  - Wash (sanitize) the affected areas with water and detergent or soap.
  - Thoroughly rinse the cleaned area to remove any detergent residue. Note: Some disinfectants may be inactivated by detergents; therefore, it is very important to rinse well after washing the area.
  - Allow the area to dry completely.
  - Select and apply an effective disinfectant.
  - Allow the proper contact time. This may vary depending on the disinfectant selected. Consult the product label.
  - Thoroughly rinse away any residual disinfectant.
  - Leave the area free for animals for a sufficient amount of time (per disinfectant label).
  - Evaluate the effectiveness of the disinfection action plan.

See the Disinfection 101 document for more complete information on cleaning and disinfection. Also see the detailed handout regarding Standard Precautions for Veterinary Clinics available on the website.

Zoonotic Disease and Immune Compromised Persons

Studies show that veterinarians are the most knowledgeable and expected providers of information on zoonotic disease. Studies also show that immune compromised individuals are not offered adequate information about zoonoses prevention, either from their physicians or veterinarians and may not be as comfortable discussing their immune status with their veterinarian. Physicians and veterinarians alike must share in the responsibility of educating individuals and communities about zoonotic disease.

No one knows better than veterinarians the positive benefit that pet companionship offers to individuals. The bond between humans and animals has long been recognized to offer substantial emotional and physical health benefits. Likewise, veterinarians realize the potential health risks associated with zoonotic transmission of infectious diseases. With over 250 potential zoonoses, educating clients and staff on practices that protect from zoonotic disease is an important professional task.

The overall risk of contracting a zoonotic disease from pets is low and most experts agree that the benefits of animal companionship outweigh the risks. While the possibility of exposure and

transmission of zoonotic diseases from animals to people cannot be totally eliminated, it can be minimized. By providing immune compromised clients with correct and up to date zoonotic information, we can encourage them to keep their pets healthy and choose new pets wisely.

Immune compromised clients and staff may include: children under the age of 5, pregnant women, and the elderly. While the most profound immune suppression is caused by HIV/AIDS, other diseases and conditions that can compromise the immune system include bone marrow or organ transplants, radiation, chemotherapy or chronic corticosteroid therapy, chronic renal failure, or implanted medical devices. Persons with diabetes, alcoholism with liver cirrhosis, malnutrition or autoimmune diseases, splenectomy patients, and those on long-term hemodialysis also have compromised immune systems. It is important to note that some of these conditions or diseases may have a social stigma, making it difficult for a client to share their personal health information. This again makes it vital for veterinarians to educate all their clients about zoonotic diseases.

Education can be accomplished through:

- Making clients aware that information is available to them if they or family members are immune compromised
  - Through clinic and/or exam room signage, clinic newsletter, or outreach to local community organizations.
- Making clients aware that immune status can be affected by many conditions.
- Speaking with immune compromised clients regarding pet guidelines and recommendations.
- Providing a handout/brochure on pet ownership and zoonoses information with web links to further information.
- Making immune compromised clients aware that:
  - They should seek veterinary care early in the course of their animals illness.
  - Routine annual preventative veterinary visits are essential.
  - Diligent preventative veterinary care may be more expensive.

There are several excellent sources of information on zoonotic disease and recommendations for immune compromised individuals. These guidelines and information may be printed, copied and kept for distribution to staff and clients for education on zoonoses.

- The Center for Disease Control and Prevention.
  - **The CDC Healthy Pets, Healthy People website** has information on zoonoses that can be accessed at http://www.cdc.gov/healthypets . Their printable client handout on general zooonses prevention can be accessed at: http://www.cdc.gov/healthypets/pdf/petscript_general.pdf See Pet Scription CDC handout.
  - **The CDC's Division of HIV/AIDS Prevention** publishes information on precautions, testing, common questions and misconceptions and web links for more information. Their printable brochure on prevention of infection from pets in HIV/AIDS patients can be accessed at www.cdc.gov/hiv/pubs/brochure/oi_pets.htm.

- Pets are Wonderful Support (PAWS).
    - This non-profit organization helps to improve the quality of life for persons with HIV. They publish information targeted towards immune compromised individuals and their pets. In conjunction with the Humane Society of the United States (HSUS), PAWS has developed educational materials that include the *Safe Pet Guidelines*, which are applicable to any immune compromised or high-risk individual. These guidelines include information on the animal's diet, veterinary care, grooming and flea control, cats, litter box guidelines, birds, rodents, horses, adopting a new pet, pets to avoid, and links to more information that can be accessed on the internet.
    - General information is available at www.pawssf.org.
    - *Safe Pet Guidelines* is available online at http://www.pawssf.org/graphics/education/safe_pet_guidelines.pdf . See Safe Pet Guidelines PAWS handout.
- Infectious Diseases of the Dog and Cat (Greene C. 1998 W.B. Saunders Company).
    - This text is an excellent source of information for veterinarians. Chapter 99: Immunocompromised People and Pets, contains guidelines for reducing zoonotic risks for immunocompromised persons. It also contains a table of resources for pet owners infected with HIV, and disease information on common zoonotic pathogens.
- The Merck Veterinary Manual (8th edition Whitehouse Station, NJ, 1998).
    - This manual contains a chapter on zoonoses, including large animal species and wildlife. The Merck Veterinary Manual is also available on-line at www.merckvetmanual.com.

General Practices to Improve Hospital Infection Control

The layout of a hospital and flow of patients, client education practices and staff training can all have a great effect on the potential for infectious disease introduction and spread within a veterinary clinic. Thoughtful input, common sense and creative ideas will be necessary to address the unusual situations within individual practices. There is no "one size fits all" for biological risk management plans. Individual practices will have unique issues that cannot be generalized.

Hospital layout/organization and flow

How patients move through the hospital (i.e. from parking area to reception, exam room, treatment room, hospital ward/kennel, isolation, necropsy) is an important consideration with regards to tracking and monitoring potential disease spread. Facility design may not be easily changed, but protocols that attempt to avoid contact between animals can be implemented. Cages, runs and stalls may be permanent unmovable fixtures but rearrangement of patient and staff traffic flow may reduce transmission risk. Food storage and delivery methods may affect disease transmission. Food delivery can perhaps be changed to preclude delivery persons from traveling through patient areas. If animal boarding is offered at the veterinary hospital, protocols (vaccination requirements as well as infection control guidelines, isolation from the patient population) must be in place to protect them from potential infectious disease.

Client education varies considerably among veterinary practices. There should be a set policy or protocol designating who is responsible for providing client education regarding zoonotic diseases (i.e. the veterinarian or staff members). Information such as medical treatments given to pets, recommended diagnostic tests, treatment the owner has declined, and counsel given to clients should all be documented in the medical records. Veterinarians may consider using client consent forms for the purpose of documenting that the client was informed of the zoonotic disease risks involved in a certain situation.

Client education efforts must consider that individuals need repeated exposure to a new concept to effectively understand it and commit it to memory. Multiple learning approaches will also need to be used because people learn in different ways. Some clients may respond well to written handouts while others need to hear the information, see a diagram, participate or actually do something with regard to the learning objective. Having clients repeat information back to the veterinarian or technician will help verify the level of understanding.

Other opportunities for client education include clinic newsletter articles, community newsletters or newspapers, brochures, hospital bulletin boards, or infectious/zoonotic disease articles posted on veterinary hospital websites.

Staff training on biological risk management is essential, as is a written hospital infection control policy that can be referred to by staff at any time. Staff should have an understanding of why each policy is important, with regard to infectious/zoonotic disease management, to be motivated to implement the plan. Improvements require the leadership making prevention a priority and integrating infection control practices into everyday practice. Preparation of written infection control policies will serve as a resource for staff and new employees. The teaching and integrating of infection control practices is a continuous process. According to the CDC, years of experience in a human healthcare setting is a negative predictor of adherence to infection control practices. Improving adherence needs a multifaceted approach that incorporates continuous assessment of both the individual and the work environment. While protocols for infectious disease control need to be firmly established and consistently practiced, the rules should not interfere when an animal's life is in jeopardy. For this reason, policies regarding when, how and who will "bend the rules" needs to be established. With regard to zoonotic diseases, we will also need to consider the immune status and rabies vaccination status of staff, as well as their consistent use of barrier protection.

In this next section, we will look at methods to improve hospital infection control based on the specific routes of transmission.

Management Aimed at Routes of Transmission

Disease transmission occurs when an animal's environment is contaminated with a pathogenic organism. Many disease agents can survive for extended periods of time in the air, on surfaces and in organic material. Animals or humans can acquire pathogenic agents through inhalation, oral consumption, and direct contact, via fomites or vectors. Each of these routes will be discussed and recommended control strategies will be provided to manage disease risk. Keep in mind, however, that these are general recommendations for managing disease transmission. All disease transmission will be decreased by prompt diagnosis, proper handling or isolation of infected animals, and cleaning and disinfecting contaminated areas. More specialized management steps may be needed for specific disease control.

Aerosol Transmission

The spread of pathogens by aerosol transmission occurs when pathogenic agents contained in aerosol droplets are passed from one animal to another, or from animal-to-human. Most pathogenic agents do not survive for extended periods of time within the aerosol droplets and as a result, close proximity of infected and susceptible animals is required for disease transmission. The greater the distance between animals, the less likely transmission will occur. Aerosol transmission may occur in a veterinary hospital through close contact of animals and/or humans. Infectious agents may be freshly aerosolized (as in a sneezing cat with feline respiratory virus), may be re-aerosolized by high-pressure washing of cages, stalls or pens or on dust particles by air currents (i.e. *Mycobacterium tuberculosis* and *Histoplasma capsulatum*- Greene 1998). Temperature, relative humidity and ventilation play important roles in aerosol transmission of pathogens.

Aerosol transmission may be the most challenging route of transmission to control. Prompt handling and isolation of coughing/sneezing patients will help reduce the spread of potentially infective organisms via aerosol transmission. How animals move through the hospital will also affect aerosol transmission. Crowded reception areas with animals in close proximity will lead to greater exposure. Scheduling of clients with disease transmission in mind may decrease potential exposures. Hospital layout with regards to cage placement may help or hinder the spread of aerosolized agents. Cages directly across from one another with a narrow distance in between may be more likely to facilitate the spread of diseases such as feline respiratory viruses.

If patients are led past cages where they can come into close contact with other animals, diseases such as kennel cough (*Bordetella bronchiseptica*) may be transmitted. If large animals are housed in pens or stalls in close proximity to one another, diseases such as equine herpes virus or infectious bovine rhinotracheitis can be transmitted. While the optimum situation is to have separate facilities or separate air spaces for different groups of animals to allow for segregation based on disease status, leaving a cage or pen between animal patients may help decrease aerosol transmission of disease.

Density of animals is very important in determining pathogen spread within a veterinary hospital. This is because density influences not only the contact of susceptible with carrier animals; it also influences the airborne pathogen load. Recommendations on appropriate density of animals in a clinic will depend on a number of factors including square footage, cage space, whether there is a haul-in facility on premises for mixed and large animal practices, and the type of ventilation system. Density should be kept at the minimum acceptable level, situations that lead to congregation should be limited, and stress and excitement should be minimized.

Ventilation systems are a critical aspect of infection control. Appropriate ventilation is extremely important in reducing airborne disease transmission. Especially in large animal haul-in facilities, increased activity in a confined space can create dust and raise the respiratory rate of animals which can lead to more coughing, increased ventilatory effort and decreased efficacy of respiratory clearance mechanisms. These conditions increase not only the airborne pathogen load shed by infected animals, they also increase the amount inhaled and transported to the deep lung tissues of susceptible animals. Holding facilities for large animals brought to the clinic need to be designed to reduce aerosol spread of disease.

Proper ventilation should ensure that the animal enclosures have as little moisture, dust and irritating gasses (e.g. ammonia) as possible. Some hospitals with large animal haul-in services have well ventilated, open facilities; others may have to use large fans and consider roll-up doors to increase ventilation. Properly operating ventilation systems with adequate air exchanges are important, especially in crowded environments. For example, 6-10 air exchanges per hour have been shown to be effective in reducing the number of air-borne microorganisms in animal-holding facilities. Ventilation systems need to be inspected regularly and updated as needed. Ventilation systems with air inlets near the ceiling and air outlets closer to the floor are best as air travels down toward the more heavily contaminated floor region. Negative and positive pressure ventilation rooms are being built into new hospital designs to help control the spread of infectious disease.

Adequate ventilation following application of disinfectants will reduce residual chemical fumes which may injure delicate sinuses and mucous membranes impairing the animal's ability to clear potentially infectious organisms. Hospital floors should not be dry mopped or swept with brooms as this may increase aerosolization of particles. Impervious floor coverings and using wet mops or filtered vacuums can reduce spread of aerosolized agents. Pressure washing of cages, stalls or pens may aerosolize pathogens, increasing disease transmission risk. Animals should be removed from their cages or runs while cleaning to minimize exposure to aerosolized particles. Care must be taken to protect staff and other animals during cleaning. Air conditioning systems should reduce turbulent airflow and be electronically filtered. UV radiation decontamination devices that are effective in inactivating environmentally resistant organisms in air ducts, such as *Pseudomonas aeruginosa* and *Mycobacterium tuberculosis*, are commercially available and show promise in helping reduce aerosol transmission. (Greene 1998)

Oral Transmission

Oral transmission of disease involves the consumption of pathogenic agents in contaminated feed, water or licking/chewing on contaminated environmental objects. Feed and water contaminated with feces or urine are frequently the cause of oral transmission of disease agents. Contaminated environmental objects could include equipment, food and water dishes, cages or fencing and other items an animal may lick or chew. Oral transmission can occur through a single incident or as a common source transmission in which a number of individuals are exposed. Oral transmission of diseases between animals, such as parvovirus, salmonellosis, Johne's disease and leptospirosis may occur by the oral route with improper or untimely clean up of feces, urine or bodily fluids and/or inadequate disinfection. Parking lot areas as well as outdoor patient exercise areas must be cleaned up on a regular basis, with separate exercise areas used for patients with suspected or diagnosed infectious disease. Prompt handling/isolation of patients with diarrhea will help control the spread of potentially infective organisms in feces. Proper cleaning and disinfecting of food and water dishes will decrease the risk of oral transmission between animals. Food and water dishes should be removed from cages after feeding, then cleaned and disinfected and dried before re-use.

Animal feed can become a potential threat if not handled and stored correctly. Food source outbreaks of gastroenteritis caused by *Salmonella* have been observed in small animal practice. Preventing access and contamination by pests including insects (i.e. flies, cockroaches) as well as wildlife, feral cats, birds, and vermin which may urinate, defecate or otherwise introduce disease is an important safeguard. Feed storage rooms at veterinary clinics should be kept clean and free from rodents; any spilled feeds should be immediately cleaned up and disposed of.

Stored animal food must be properly rotated on a first in, first out basis and new feed should not be added to, or poured on top of, older feed.

Direct Contact Transmission

Direct contact transmission requires the presence of an agent or organism in the environment or within an infected animal. A susceptible animal becomes exposed when the agent directly touches open wounds, mucous membranes, or the skin through blood, saliva, nose to nose contact, rubbing, or biting. It is important to note that depending on the disease agent, it is possible for direct contact transmission to occur between animals of different species, as well as to humans. Reproductive transmission is a subtype of direct contact that encompasses those diseases spread through venereal and in-utero routes. Venereal transmission is the spread of pathogenic agents from animal-to-animal through coitus. In-utero transmission is the spread of pathogenic agents from dam to offspring during gestation.

Transmission of disease by direct contact requires direct or close approximation between individual animals. Animal bites to other animals can spread disease, such as feline immunodeficiency virus (FIV), by direct contact. Venereal transmission of *Brucella canis* between dogs is another means of direct contact transmission as is the spread of leptospirosis through skin contact with infected urine. Aerosolized respiratory droplets (i.e. sneezing, coughing), genitourinary secretions, fecal material or skin contact with infective material can also transmit disease by close or direct contact.

Direct contact transmission may occur in parking areas or in the waiting room between animals, in the exam room between patient and doctor, in close contact between animals as they move through the hospital, or in livestock pens or chutes in mixed/large animal facilities. A build up of clients in the waiting areas may increase the potential for direct contact. Scheduling of appointments to reduce overlap or placement of clients into to exam rooms may help reduce direct contact.

Direct transmission is generally more easily controlled than diseases caused by other routes of transmission. The most important effort to reduce transmission via direct contact is the isolation of infected animals and minimizing contact with them. Since not all infected animals show signs of illness, generalized efforts to decrease the likelihood of direct contact are warranted.

Fomite Transmission

Fomite transmission requires an inanimate object to carry a pathogen from one susceptible animal to another. Fomite transmission often involves a secondary route of transmission such as oral or direct contact for the pathogen to enter the host. Traffic transmission is a subtype of fomite transmission in which a vehicle or human causes the spread of a pathogenic agent through contaminated tires, wheel wells, undercarriage, clothing, or shoes/boots by spreading organic material to another location.

Numerous diseases can be spread by fomites: common examples include ringworm (i.e. brushes, bedding), brucellosis (i.e. artificial insemination instruments), and *Streptococcus equi* (i.e. water buckets, halters, fences). Canine parvovirus and feline panleukopenia are often spread through fomites (i.e. food bowls, litter pans, bedding in cages) because of their hardiness in the environment. All hospital areas from the parking lot to the waiting room, exam rooms, treatment areas and hospital wards contain potential fomites.

Virtually any object can serve as a fomite and include anything contaminated with body fluids of infective animals (i.e., blood, saliva, nasal secretions, urine, feces) or those in direct contact with infected skin or tissues. Fomite examples for a small animal practice could include: waiting and exam room surfaces, needles, syringes, brushes, stethoscopes, thermometers, muzzles, food dishes, surgical equipment and cages. Additional examples of objects in a mixed and large animal practice would include implant needles, tattoo and dehorning equipment, halters, grooming supplies, feed and water buckets, oral speculums, balling guns, chutes, corral fencing and many others. In addition to having a successful BRM plan for the other routes of transmission, it is vitally important that all potential fomites be recognized and handled appropriately. Proper cleaning and disinfecting of cages, stalls and pens is of primary importance. Improperly cleaned surgical equipment can also be a fomite. Autoclaving is preferred over cold disinfection as cold disinfection has been associated with increased risk of infections from *Clostridium tetani* .

Often humans play a principle role in facilitating fomite exposure. In veterinary practice, human hands are the most common indirect form of disease transmission. Other culprits are clothing, coveralls, exam smocks, scrubs, neck ties, boots, shoes, and objects that are used or worn when working with animals. For this reason, it is imperative that people follow proper hygiene and biosecurity standards, such as frequent hand washing, removal of dirty clothing and cleaning of boots/shoes. Boot baths should be considered for clients in large animal facilities, since individuals from different farms tend to congregate in these areas. Clients may also be a source of fomite transmission by their shoes, hands, and clothing and should be encouraged to follow clinic protocols for hand and footwear hygiene.

The most important means of controlling transmission by fomite is through proper cleaning and disinfection. Additionally important is appropriate recognition and isolation of diseased animals. Consequently, all ill animals should be handled and treated only after all healthy animals have been handled. Small animal hospitals with boarding facilities should tend to boarded animals first, before hospitalized patients. Large animal haul-in facilities should be managed so that healthy animals are seen at the beginning of the day and sick animals brought in later. Due to unknown disease carrier status, the working area, chute and holding pen should be washed down, sanitized, rinsed and disinfected between different clients' animals. All materials used for treatment and processing should be handled similarly so as not to expose other animals brought in. The preferred option would be to have dedicated equipment, facilities and devices for treatment. This may not be feasible in some circumstances, and careful disinfection can accomplish many of the same results. In other situations, items may need to be disposed of properly rather than re-used.

Vector Transmission

Vector-borne transmission occurs when an insect acquires a pathogen from one animal and transmits it to another. Diseases can be transmitted by vectors either mechanically or biologically. Mechanical transmission means that the disease agent does not replicate or develop in/on the vector; it is simply transported by the vector from one animal to another (flies). *Moraxella bovis*, or pink eye in cattle, can be transmitted mechanically by flies. Biological transmission occurs when the vector uptakes the agent, usually through a blood meal from an infected animal, replicates and/or develops it, and then regurgitates the pathogen onto or injects it into a susceptible animal. Fleas, ticks, and mosquitoes are common biological vectors of disease. Heartworm disease and West Nile virus (WNV) are transmitted biologically by mosquitoes. Various other encephalitides are spread via mosquitoes to humans, birds and

horses, and many other mammals as in the case of WNV. Fleas infected with *Mycoplasma haemophilus,* formerly *Hemobartonella felis*, may transmit bartonellosis to susceptible cats and to humans. Plague can also be transmitted by fleas from cats or wildlife to humans and other animals.

Ticks can transmit anaplasmosis and babesiosis to susceptible cattle, Q fever to dogs, cats, livestock and humans, and tularemia to wildlife and humans. While humans will not acquire Lyme disease, Rocky Mountain spotted fever or ehrlichiosis directly from an infected dog, exposure to the same tick species has the potential to cause human disease.

Other insect vectors are responsible for the transmission of some protozoal pathogens such as trypanosomiasis (Chagas disease transmitted by the reduuvid or kissing bug), and leishmaniasis (transmitted by sand flies). Equine infectious anemia (EIA) is spread from horse to horse via biting flies (tabanids and deer flies).

Regardless of whether vector transmission is mechanical or biological, the most effective means to prevent transmission is the elimination or reduction of the insect vector, or at a minimum, separation of the vector from the host. Hospital insect control should be maintained to the highest level possible. Large animal holding and treating areas may require pest strips or timed pesticide misters that are labeled for use in food producing animals.

For small animals, flea and tick control, as well as treating their environment, is important to break the cycle. Clients should be encouraged to use flea and tick prevention on their animals and to treat their home environments and animals, especially in areas where plague and tick borne diseases are present.

Anything that can be a breeding ground for insects, such as old bedding or standing water, should be removed or changed often (every 2-3 days for mosquitoes; weekly for fly control). Animal food supplies should be kept sealed and pest/rodent free.

In most instances, chemical insect control is ineffective as a sole measure. An integrated approach is best, where efforts are directed at eliminating the vectors and reducing their presence in the animals' environment through insecticide use and cleaning up animal waste and organic materials.

Zoonotic Transmission

Zoonotic transmission occurs when diseases are transmitted from animals to humans. Human exposure will actually occur through one of the other five routes of transmission, but because of its importance, it is addressed as a separate route of transmission.

For humans, zoonotic disease transmission by the aerosol route occurs as it does between other animals; close proximity with sick animals is normally required. Sweeping and high pressure washing of cages, stalls or pens during cleaning of infected premises may also expose humans to disease pathogens transmitted by the aerosol route. Density of animals, ventilation, levels of moisture, dust and irritating gasses will greatly affect potential aerosol disease transmission to humans.

Oral transmission of zoonotic diseases may occur due to lack of, or inappropriate, hand washing techniques. Rules should be implemented on appropriate areas for staff eating and drinking;

and on the use of separate refrigerators for human food. Limiting food and drink access to only non-animal contact areas will help minimize the potential for oral transmission of zoonotic disease. Oral transmission can also occur when infective body fluids are splashed into the mouth or mucous membranes, or when needle caps are pulled off by mouth. These types of transmission can be minimized by the use of masks and eye protection when handling potentially infective materials and only using hands to remove needle caps.

Direct contact may be the most common way for humans to become infected with zoonotic disease. Transmission of rabies is a prime example of direct contact transmission. Cat scratches may transmit bartonellosis or "cat scratch fever" to humans. Purulent material from an infected cat abscess can transmit plague to humans. Q fever may be spread through infected droplets especially when handling reproductive tissues; and leptospirosis may be spread from contact with infected urine on broken skin. When contact with animals infected with zoonotic disease is necessary, barrier protection is the simplest means of protection. Proper use of restraint, heavy gloves or sedation when handling fractious animals can also decrease incidence of direct transmission to humans.

For certain zoonotic diseases, humans can actually be infected with the organism, and shed it into the environment. Certain human influenza viruses can be spread to ferrets and swine, causing clinical disease. Cattle can be infected with tuberculosis from humans. These facts require that people follow proper hygiene avoid animal contact when infected with certain diseases.

A summary of risks and the designed BRM plan should be written and agreed upon by all interested parties. Procedures for monitoring and review of BRM plans must be established; perhaps becoming part of the regularly scheduled staff meetings. Record keeping, tracking compliance and biological risk management related events are also essential to the success of the program. Communicating risk to those involved, staff and potentially clients is of utmost importance.

Risk Communication

Risk communication is a two-way, interactive process that has been occurring throughout the risk assessment process. Information has been collected and now information needs to be delivered. Staff need to be informed and educated on new ideas and protocols. In order to be effectively implemented, it is important that a BRM program is understood, supported and adopted by everyone. This can be difficult because many employees will not have knowledge of disease transmission routes and may not be able to understand the chain of events involved in disease spread. Staff may not fully appreciate the significance of the measures they are asked to follow. Effectively communicating these issues is essential for success of the biological risk management plan.

Educational programs that inform employees and other affected individuals of the risk assessment and management plan should not be limited to one form. Hospital owners may incorporate many education methods to create a program that best fits the needs of their clinic. An example is:

- Face to face/group meetings. This is one of the best communication forms when it allows for open dialogue between the presenter and participants. Group meetings require adequate planning and preparation. Important information should be presented in more than one way to appeal to different learning styles.
  - Visual learners prefer pictures. They form pictures in their heads to help them achieve understanding.
  - Auditory learners like to hear messages as well as vocalize what they have learned. They learn most effectively when participating in topic discussions.
  - Kinesthetic learners learn by doing and gain understanding best when physically active and moving while hearing new messages. Keeping these individuals confined to their seats for long periods interferes with their learning. Frequent stretching breaks are important.

It is important to keep the meeting focused to a few concise points, and offer the opportunity for participants to discuss, share information and provide input. Sessions will more valuable if they are timely and the participants can apply the new information immediately. Limit meetings to a reasonable amount of time, probably not longer than 45 minutes. If possible, schedule meetings earlier in the day as meetings at the end of the working day are less effective.

Additional educational tools include:

- Newsletter or bulletin
- Videos, CD's or web-based instruction
- Posted signs or information panels placed around the workplace – standard precautions handout, hand washing signs, etc.
- Employee questions and suggestions – question/answer board, suggestion box, and question period during meetings, etc.
- Mentoring of new employees by experienced employees
- Knowledge testing
- Recognition program - any type of incentive program that rewards employees for reaching BRM goals.

Proper communication of the BRM plan is of utmost importance for effective infectious disease control. However, few management plans are successful if records are not kept or some form of audit performed so that progress can be measured. Part of the risk communication process should include helping to ensure that some system is put in place to measure progress.

Conclusion

Biological risk management is an essential component of keeping any veterinary facility as clean and secure as possible. Risks of disease transmission cannot be completely eliminated, but by employing some basic hygiene and biological risk management principles, these risks can be effectively managed and significantly reduced. It may take time to persuade your staff, clients or colleagues to adopt some of these principles, but the results of your efforts will reflect the efficacy of this program.