Proceedings of the
Society for Theriogenology
Annual Conference 2014

Aug. 6-9, 2014 – Portland, OR, USA

Next SFT Meeting:

Aug. 5-8, 2015 – San Antonio, TX, USA

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Biosecurity approaches for equine reproduction
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Objectives of the presentation
- Review basic principles of biosecurity
- Discuss practical applications of biosecurity to prevent transmission of contagious pathogens

Take home message
- Biosecurity and infection control are important aspects of the day-to-day operation of any equine facility and are especially important for equine hospitals.
- It is essential that the people in charge, such as clinicians, owners, and trainers observe the implemented infection control measures.
- Leadership by example is the best way to ensure compliance of all personnel.
- In addition, educational efforts should be undertaken to make sure all workers understand the importance of biosecurity and their role in maintaining the facility as a safe place for horses and their human caregivers.

Introduction
Application of the concepts of biosecurity and bio-containment is important not only in veterinary hospitals, but also for ambulatory practices, equine breeding facilities, training facilities and other facilities that house horse populations. A passive attitude towards infection control may have detrimental consequences, including a large financial impact. Outbreaks at equine veterinary hospitals are often associated with public relations issues, such as loss of confidence and business of those who would bring their animals to the premise. Further, some contagious diseases can lead to severe disease with possible death in infected animals. This may potentially lead to litigation issues. Last but not least, outbreaks diminish morale of hospital staff and clinicians.

Basic principles of biosecurity
Properly implemented biosecurity measures may significantly decrease the risks for disease introduction and spread of infectious pathogens. Infectious disease control relies on several basic principles, which include understanding the biology of infectious pathogens and route of pathogen transmission, housing horses based on exposure risk, daily monitoring for signs associated with infectious diseases, implementing proper hygiene and cleanliness protocols, educating the horse community and having a contingency plan in place in case of an outbreak. Most of these steps will prevent and minimize exposure to infectious pathogens at an individual and population level.

Farm-based infectious disease control measures should include the segregation of horses into small groups based on age, use and gestational time. This measure may not eliminate infectious diseases in horses but, hopefully, may limit the severity of the problem by minimizing the number of affected animals. Housing at boarding facilities or horse event may represent a true challenge due to the high traffic and horse density. However, in order to minimize risk of disease outbreak, each horse should be considered at risk and handled like a single unit. Ideally such horses should be kept in individual stalls with no direct contact to other horses. The health status of such horses needs to be assessed and possibly recorded daily. Further, reducing unnecessary movement of animals and humans is an effective way to minimize spread. If equipment (grooming, cleaning and tack equipment) is shared between horses, it should be cleaned and disinfected after every individual use. Specific housing measures apply to hospitalized patients. This means that all patients are to be screened before admission to the hospital for signs of contagious disease (physical examination and accurate history). Patients should be hospitalized in dedicated stalls/barns based on their infectious status. Isolation wards should be available for patients.
with confirmed and/or suspected contagious diseases. It is important to maintain hygiene of personal and facility so that hospitalized horses and their bodily fluids and excrements stay separated from other horses. It is important to monitor patients daily for the occurrence of infectious diseases through observation of clinical signs (fever, diarrhea, nasal discharge, coughing) and through strategic testing of biological samples. For example, feces may be collected for culture or polymerase chain reaction (PCR) to detect *Salmonella* spp. in high risk patients on admission and at regular intervals thereafter during the entire hospitalization time. Even with well-established infectious control protocols, it may not be possible to virtually eliminate all risks of nosocomial infections.

Probably one of the most underutilized principles of biosecurity is the daily monitoring of at-risk horses. The idea behind the assessment of daily health is to recognize early clinical signs and to take proper action to prevent disease spread. Daily monitoring by owners, trainers and care takers should include the assessment of attitude, appetite and rectal temperature. Additional signs such as nasal discharge, coughing, changes in fecal character and acute onset of neurological signs should also be recognized and reported to a health care provider.

Of all the possible measures that can be taken to reduce nosocomial and zoonotic infections, hand hygiene is perhaps the most important and cost-effective, easiest to use but also most underused measure. Hands should be washed before and after attending each individual animal. In addition to soap and water, alcohol-based hand sanitizers can be a useful adjunct to hand washing in veterinary hospitals and can provide a practical option for improving hand hygiene for ambulatory practitioners.

One additional means to prevent exposure to zoonotic pathogens and prevent transmission via contaminated hands and clothing is the use of personal protective equipment (PPE). Standard outerwear should be clean and should be changed if contamination occurs. Also dedicated clothing and footwear should be worn when working with infectious patients and in high-risk areas such as intensive care unit, isolation, foaling facility, quarantined barns, etc. Minimal PPE when working with infectious pathogens should include designated scrubs/coveralls/lab coats, disposable gloves and shoe covers/dedicated shoes/boots. Contamination of personal items such as stethoscope, thermometer, pencil, phone, pager, etc. occurs routinely when working with horses. In order to minimize exposure and transmission with infectious pathogens, one should strongly consider disinfecting all mentioned items if such items have been used while attending the patient.

Virtually all pathogens in equine facilities are associated with some organic matter, including feces, urine, saliva and sweat. Experimentally, cleaning alone has been shown to decrease the bacterial load by 90% on a concrete surface. Another 6-7% of bacteria are killed by disinfectants. There is enough convincing evidence of the necessity to clean surfaces thoroughly before disinfection. Even the best disinfectants are less effective in the presence of organic matter. Housing stalls and trailers should be cleaned and disinfected between horses. Also consider regular hosing and disinfection of aisles and high traffic areas such as wash stalls and treatment/examination rooms.

It is important to have a contingency plan in place on what to do when dealing with a potentially infectious animal. The plan should be known by all caretakers, trainers and owners at a boarding facility and by all staff and veterinarians at a veterinary hospital. Ideally, written protocols should be available and regularly reviewed and updated if needed. A logical action plan should include: general recommendations to what represents a trigger point (i.e fever, acute onset of nasal discharge, coughing, ataxia, diarrhea); isolating a sick animal(s) in previously designated areas; designate a dedicated caretaker and equipment to attend the care of the sick horse; use of PPE when attending the sick horse; close or disinfect areas where the sick horse was housed or held; institute barrier nursing to prevent spread of infectious pathogens (foot bath, gloves, dedicated clothing and foot wear); contact the care provider to evaluate the horse and collect diagnostic samples; reduce overall traffic within premise and monitor horses with possible contact to the index case.

**Infection control for gastrointestinal pathogens**

Horses are very vulnerable to infectious enteric disorders, especially salmonellosis and clostridial infections. Several factors including stress, transportation, changes in feed, fasting, surgery, antimicrobial
use, concurrent gastrointestinal (GI) disturbances and elevated ambient temperature have been linked to an increased susceptibility to \textit{Salmonella enterica} infection. Salmonellosis and/or clostridial infection should be considered when horses develop gastrointestinal signs (colic, diarrhea), fever and leukopenia. Further, the previous use of antimicrobials in patients developing any of the mentioned clinical signs is highly suggestive of an infectious GI disorder. Outbreaks with enteric pathogens can be devastating in any situation (farm and hospital). To determine the magnitude of the outbreak, all horses or a representative sample of resident horses should be screened for enteric pathogens using conventional microbiology and/or PCR detection. Horses testing positive for an enteric pathogen (clinical or subclinical) should always be isolated from the rest of the population to decrease the exposure risk and environmental contamination. Establish barrier nursing in the form of footbath or mats in front of the isolation unit and each stall. This will minimize the spread of pathogens from stalls to clean areas.

Phenolics compounds, quaternary ammonium compounds (QAC) and peroxygens compounds have been shown to retain activity in the presence of organic matter. Phenolics and peroxygen compounds are the only disinfectant to have an activity against rotavirus. Peroxygens and high concentration of bleach (8 oz/gallon) are effective at neutralizing clostridial spores. Phenols, QAC and bleach at 4 oz/gallon are effective against \textit{Salmonella}. Caretakers and owners should wear gloves, protective clothing (coveralls, disposable gowns) and dedicated footwear. Good hand hygiene should be instituted (faucet with warm/cold water or hand sanitizer). It is very important to control traffic and minimize contact of affected horses with the general public. Remember that enteric pathogens such as \textit{Salmonella}, \textit{Cryptosporidium} and \textit{Clostridium difficile} are potential zoonotic agents and represent a greater risk for immunocompromised humans, infants, and elderly people. Instruct caretakers/owners to handle diseased horses last and to use separate equipment (cleaning equipment, tractor, hay wagon, wheelbarrow, etc). Hygiene should be maximized by regular cleaning and disinfecting. Waste from positive animals should be either removed from the premise, or composted or spread in sunlight in a place with no direct access to horses.

**Infection control for respiratory pathogens**

During outbreaks of respiratory disease, aerosol and droplet infection can be minimized by separating animals according to their infections status (infected, exposed versus non-exposed). Air movement may play an important role in transmission of aerosolized virus, since viral respiratory pathogens, such as equine influenza virus (EIV), have been shown to be transmissible over a distance of 150 feet. The $\alpha$-herpesviruses (EHV-1/-4) require closer contact and are generally transmitted via nose-to-nose contact or fomites. Transmission of \textit{Streptococcus equi} subsps. \textit{equi} usually requires direct physical contact between infected and susceptible horses but can also be transmitted via fomites (hands, shared equipment). Fortunately, outbreaks of respiratory pathogens can successfully be controlled via appropriate infectious disease control measures (separation of infected animals, cleanliness and hygiene, restrict movement and traffic, use of PPE and barrier nursing). Common infectious respiratory pathogens are susceptible to the majority of commercially available disinfectants.

**Infection control for venereal diseases**

Venereally transmitted diseases such as contagious equine metritis (\textit{Taylorella equigenitalis}), equine coital exanthema (EHV-3) and equine viral arteritis (EAV) can have a devastating impact for breeders and veterinarians involved in breeding management of mares and stallions. These diseases are highly contagious and can be transmitted by direct horse-to-horse contact, contaminated biological samples (semen), contaminated equipment and personnel. To minimize the risk of disease instruction at a breeding facility the following steps should be undertaken: examine all new horses on arrival for signs consistent with a contagious disease; determine the status of the stallion/mare for selected infections prior to use; separate new arrivals from resident horses; monitor horses daily for signs of infectious diseases; use hygienic procedures during breeding; properly clean and store breeding equipment (vaginal speculum, artificial vagina, breeding phantom); and increase cleanliness at breeding facility. In general if performed properly, artificial insemination (AI) reduces the risk of bacterial contamination of the uterus by
eliminating the contact between stallion and mare. However, viruses are generally not killed or eliminated by cooling or freezing. The venerally transmitted pathogens are susceptible to the majority of commercially available disinfectants.