

A Review of Equine Zoonotic Diseases: Risks in Veterinary Medicine

J. S. Weese, DVM, DVSc, Diplomate ACVIM

Zoonotic diseases, those that can be transmitted from animals to humans, are an ever-present threat in veterinary medicine. A number of zoonotic agents may be encountered in veterinary practice and the severity of human disease can range from mild to fatal. The risk of zoonotic infection cannot be completely eliminated. The goal of the veterinary practitioner should be to reduce the risk of developing a zoonotic illness. Prompt recognition of zoonotic agents, the use of protective clothing, identification of potential fomites and, most importantly, close attention to personal hygiene can help reduce the risk of developing a zoonotic illness. Author's address: Department of Clinical Studies, Ontario Veterinary College, University of Guelph, Guelph, Ontario N1G 2W1, Canada. © 2002 AAEP.

1. Introduction

Zoonotic diseases are diseases of animals that can be transmitted to humans. Some zoonotic diseases can be further classified as direct zoonoses; diseases that are transmitted by contact or through an inanimate vehicle and that require only one reservoir vertebrate to maintain the cycle of infection.¹ Zoonotic diseases are highly variable with respect to their transmissibility and seriousness of disease. Some may cause only mild transient disease, whereas others such as anthrax and *Burkholderia mallei* (formerly *Pseudomonas mallei*) are so lethal and contagious that they have been used as biological warfare agents. This paper discusses some of the more relevant or interesting direct zoonotic diseases that equine veterinarians may encounter.

2. Rabies

Rabies is a highly fatal neurologic disease of mammals caused by a *Lyssavirus*.² Rabies is perhaps the best-known zoonotic disease; however, human

rabies is very rare in North America. No cases of human rabies were reported in the United States in 1999 and five cases were reported in 2000.^{3,4} Four of these cases were associated with bats and the other was from a dog, and all were fatal. Only 22 cases have been reported in Canada over the last 56 yr.⁵

Veterinary exposure to rabies is less likely in equine practice than small animal or wildlife practice but is still possible because there were 82 reported cases of equine rabies in the United States in 1998, 65 reported cases in 1999, and 52 reported cases in 2000.^{3,4} Despite the low incidence of disease, veterinary personnel must remain vigilant because of the severity of disease. One of the problems with the diagnosis of equine rabies is the impressive array of clinical signs it can produce. The "paralytic" and "dumb" forms are most common in horses, whereas the furious form is not as common as in other species.² Intense rubbing or biting of the inoculation site, as a result of paresthesia,

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may be the initial sign.² Other obscure signs such as lameness or colic may be the only abnormalities evident early in disease.⁶ Rabies should be considered as a differential diagnosis for all cases of acute encephalitis or undifferentiated neurological disease. Affected animals usually die of cardiorespiratory failure within 2 to 5 days of onset of clinical signs; however, progression can be slower (up to 2 wk) in some cases.² A history of exposure to a rabid animal is not commonly reported, and absence of visible wounds does not preclude rabies.⁶ Further, a history of vaccination does not completely rule out the possibility of rabies, because one study reported that 5 of 21 affected horses had been previously vaccinated.⁶

Rabies can be excluded early in most cases based on results of other diagnostic tests or progression of disease; however, it is important that rabies be considered initially and appropriate precautions should be taken. All tissues of infected animals are potentially infectious, with highest titers in the central nervous system, saliva, and salivary glands.⁷ Rabies virus is most commonly transmitted through contact of saliva with broken skin or mucous membranes,⁸ so strict barrier precautions should be used in all suspected cases. Reporting procedures vary with jurisdiction, but veterinarians should notify the appropriate authorities and all people involved in handling that rabies is a possibility. All in-contact individuals should report immediately to a physician to determine whether post-exposure prophylaxis is required. The attending veterinarian may play an important role in this decision by conveying the likelihood of rabies, and it would be wise for the veterinarian and/or public health personnel to be in contact with the physician. The Centers for Disease Control and Prevention recommend pre-exposure vaccination for those more likely to be exposed to rabies than the general public.⁹ This would include veterinarians and veterinary technicians in all areas of North America. In some areas, the prevalence of rabies is quite low; however, given the severity of disease, it seems prudent to ensure that all veterinary personnel are adequately protected. Serologic evaluation of antibody titers should be performed every 2 yr to ensure that adequate protection persists.⁹ Rabies virus is susceptible to bleach, aldehydes, ethanol, lipid solvents, ultraviolet radiation, and heat (1 h at 50°C).⁷

3. Arboviral Encephalitis

A number of mosquito-borne arboviruses are known to cause encephalitis in horses in North America, including eastern equine encephalitis virus (EEEV), western equine encephalitis virus (WEEV), Venezuelan equine encephalitis virus (VEEV), and West Nile virus (WNV).¹⁰⁻¹² One or more of these viruses, in addition to rabies virus, should be considered in cases of acute encephalitis, depending on geographic region and time of year.

Clinical signs of arboviral encephalitis can be highly variable and are indistinguishable from other causes of encephalomyelitis. Disease may range from inapparent to peracute, severe encephalomyelitis with sudden death.

None of the arboviruses are directly transmissible from horses to humans under normal circumstances. In fact, most do not produce an adequately high viremia to infect mosquitos and disseminate disease. However post-mortem examination and handling of infected blood or cerebrospinal fluid may pose a risk. It is believed that there is only limited evidence that occupational acquisition of infection may occur though handling carcasses¹³; however, it cannot be ruled out. Necropsy recommendations for West Nile virus suspects are provided by the United States Department of Agriculture (USDA) at <http://aphis.usda.gov/oa/wnv/wnvguide.html>. These protocols should be used for any case of acute encephalitis. Briefly, procedures should be employed to prevent aerosolization of the virus and to prevent contact of tissues and fluids with skin and mucous membranes.¹⁴ Proper sharps-handling procedures should be in place. Mechanical saws should not be used to obtain spinal cord samples because of the risk of aerosolization. Three pairs of gloves should be worn, including an inner pair of disposable gloves, a middle pair of waterproof gloves (i.e., kitchen gloves), and an outer pair of metal or Kevlar gloves. A face shield or goggles should be worn and a disposable "half-mask" high efficiency particle arresting (HEPA) respirator should be used. The Centers for Disease Control and Prevention recommend that clinical material such as cerebrospinal fluid (CSF) and serum be handled under level 2 biocontainment conditions in laboratories with restricted access. Arboviruses are susceptible to bleach, aldehydes, ethanol, moist and dry heat, and drying.¹⁵

4. Acute Diarrhea

Diarrhea in horses can be caused by a number of pathogens, including one or more zoonotic agents. Even with aggressive diagnostic testing, an etiologic agent is typically only identified in less than 50% of cases. It is important to remember that "idiopathic" cases still have an underlying etiology that, while undiagnosed, may be infectious and zoonotic. Therefore, all cases of diarrhea in horses should be treated as infectious and potentially zoonotic. Specific pathogens are discussed in greater detail below.

5. Salmonellosis

Salmonellosis is a relatively common enteric disease in horses and many other species caused by serotypes of *Salmonella enterica* sp *enterica*. This gram-negative bacterium can cause disease in a wide range of species including humans and horses. Of special concern is the emergence of virulent, multi-drug resistant strains of *Salmonella*. Recently, infection with *S. typhimurium* DT104 was

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reported in a number of horses in Ontario.¹⁶ This multi-drug resistant phagetype carries a higher-than-average mortality rate in people and has been reported to have an increased potential for zoonotic transmission.¹⁷

Acute toxic enterocolitis is the typical presentation of salmonellosis; however, fever of unknown origin, chronic diarrhea, or septicemia may occur. Horses of all ages can be affected. Salmonellosis more commonly occurs following antimicrobial therapy, hospitalization, or stressors such as shipping or training; however, these risk factors do not have to be present. Diagnosis of salmonellosis involves isolation of *Salmonella* sp. Fecal cultures should be submitted for *Salmonella* culture in all cases of diarrhea or fever of unknown origin, and affected animals should be considered infectious until proven otherwise. Because *Salmonella* can be shed intermittently, five negative cultures must be obtained before ruling out salmonellosis.

Zoonotic transmission of salmonellosis is through the fecal-oral route. Typically, ingestion of a relatively high number of organisms is required to cause clinical disease in healthy adults; however, concurrent disease, antibiotic use, or immunosuppression can greatly lower the required number of organisms. Suspected or confirmed cases should be isolated and treated as highly infectious. Close attention to personal hygiene (handwashing), barrier protection (gloves, disposable gowns, overboots), and disinfection of contaminated instruments will reduce the likelihood of zoonotic transmission. *Salmonella* is susceptible to many disinfectants including bleach, iodines, phenolics, and aldehydes, but can survive for long periods of time in the environment.¹⁸

6. *Clostridium difficile*

C. difficile is an anaerobic bacterium that can cause colitis in many species, including horses and people.^{19–21} Equine *C. difficile*-associated diarrhea (CDAD) can range from mild and self-limiting to peracute and rapidly fatal. Affected horses can range from a few hours of age to adults. *C. difficile* should be considered in all cases of acute diarrhea in adult horses and foals, and diagnosis is based on identification of bacterial toxins in fecal samples.

C. difficile is a well-recognized pathogen of people. It most commonly occurs following antibiotic administration and/or hospitalization; however, sporadic cases can occur. Human CDAD can range from mild and self-limiting to severe pseudomembranous colitis with risk of intestinal perforation and death.

Transmission between animals and humans has not been reported; however, this area has been poorly studied. Horses with *C. difficile*-associated diarrhea should be considered infectious, particularly to people undergoing antimicrobial or chemotherapeutic treatment. The use of barrier precautions (gloves, gowns, boots) and close attention to personal hygiene (i.e., handwashing) should limit chance of zoonotic transmission. Contami-

nated equipment and areas should be cleaned with a sporicidal disinfectant such as a 5–10% bleach solution. Veterinarians developing acute diarrheic illness following contact with a known or suspected case of CDAD in a horse should inform their physician of the possibility of CDAD, because testing for CDAD is not routinely performed in the absence of a history of antimicrobial therapy or hospitalization in some areas.

7. Cryptosporidiosis

Cryptosporidium parvum is a protozoal pathogen that can cause enteric disease in a number of species, including humans. The clinical relevance of cryptosporidiosis in horses is somewhat controversial; however, the potential for zoonotic infection should not be overlooked. Equine cryptosporidiosis is most commonly associated with foals and immunodeficient animals^{22–24}; however, it has been diagnosed in an immunocompetent adult horse.²⁵ Asymptomatic *Cryptosporidium* shedding rates of 0–21% have been reported in horses.^{26–28} A cumulative infection rate of 71% for *Cryptosporidium* in foals has been reported.²⁸ Given the apparent high prevalence of *C. parvum*, it would seem that horses are of minimal risk as a source of disease of immunocompetent people. However, infected animals shed oocysts that are immediately infective, and zoonotic transmission of *Cryptosporidium* from a foal to two veterinary students has been reported.²⁹

The most common presentation of cryptosporidiosis in humans is profuse watery diarrhea, the duration of which is dependent on the immune status of the individual. Whereas typically self-limiting, prolonged and potentially fatal disease can occur in immunocompromised people.³⁰ The relatively high rate of asymptomatic shedding of cryptosporidia makes it difficult to prevent exposure. Zoonotic cryptosporidiosis is almost always reported in association with diarrheic animals, perhaps because of higher levels of shedding. As a result, barrier precautions should be used when handling any diarrheic animal. *Cryptosporidium* oocysts are markedly resistant to conventional disinfectants and are most effectively killed by exposure to extreme temperatures (less than 20°C or greater than 60°C). Freezing contaminated instruments may be the most effective form of disinfection.

8. Giardiasis

Giardiasis is the most common intestinal parasitic disease of people in North America,³¹ although the role of the *Giardia intestinalis* in equine gastrointestinal disease is unclear. Asymptomatic *Giardia* shedding has been reported in 25% of adult horses,²⁶ and a cumulative infection rate of 71% has been reported in foals.²⁸

In humans, diarrhea is the most common clinical sign, and disease tends to be mild and transient, although severe and chronic infections can occur.³² Zoonotic transmission of *Giardia* involves the fecal-

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oral route, and regardless of the role of *Giardia* in equine enteric disease, fecal shedding of *Giardia* cysts by horses creates at least a theoretical risk of zoonotic transmission. Proper attention to personal hygiene, especially handwashing, should decrease the chance of occupational exposure to *Giardia* sp. Unlike *Cryptosporidium*, *Giardia* can be effectively killed with bleach or glutaraldehyde.

9. Anthrax

Anthrax is an acute, infectious disease of a variety of mammals, including humans, caused by the spore-forming bacterium *Bacillus anthracis*. Horses are considered to be less susceptible than ruminants, and horses may have a more protracted course of disease. Affected horses may present with marked pyrexia, colic, dyspnea, and subcutaneous edema, or may die suddenly.³³ Anthrax should be a differential diagnosis for any case of sudden death in endemic areas. Whereas cases of anthrax are reported worldwide, certain areas have higher rates of infection. In the United States, South Dakota, Arkansas, Missouri, Louisiana, Texas, and California have the highest rates of infection,³³ and outbreaks in horses in Minnesota and North Dakota have been reported recently. Most cases occur from July to September, during warm, dry conditions.

A variety of clinical forms are reported in people, including cutaneous, pulmonary (inhalation) and gastrointestinal. Approximately 95% of human anthrax cases are the cutaneous form, and often there is a history of contact with animals or animal products.³⁴ Whereas anthrax is quite rare and the cutaneous form is usually curable if diagnosed and treated properly, precautions to avoid infection should be taken.

Transmission of anthrax is through the spore form of the organism. Spores form when the vegetative form of *B. anthracis* is exposed to air. As a result, it is essential that carcasses of suspected cases not be opened, because this will result in spore formation. Spores can be infective through inhalation, ingestion, or contact with abrasions. Appropriate authorities should be contacted whenever suspected cases are identified. Contact with suspected cases should be minimized and barrier precautions consisting of impermeable gloves, overboots, and protective clothing should be used. Ideally, the carcass should be burned or buried where it died after inspection by the proper authorities. Anthrax spores are quite resistant to disinfectants, so bedding and in-contact materials should be considered infectious and burned. Articles or instruments that cannot be burned should be soaked with 5–10% bleach solution.

People can develop cutaneous anthrax after contact with an infected carcass.³⁵ If anthrax is suspected after a post-mortem examination has been performed, all exposed personnel should contact a physician to determine whether treatment is indicated. Although the risk of non-cutaneous anthrax

is low, the seriousness of disease mandates a high level of awareness. Veterinary or farm personnel that develop skin lesions after contact with a known or suspected case of anthrax should notify their physician promptly.

10. Leptospirosis

Leptospirosis is a bacterial disease of a number of species caused by serovars of *Leptospira interrogans*. *L. interrogans* is prevalent worldwide and is considered to be the most widespread zoonosis in the world.³⁶ Leptospirosis is a significant occupational hazard in the cattle and pig industries in certain areas. Uveitis is the most frequently encountered clinical manifestation of leptospirosis in horses; however, abortion and stillbirth are serious problems.^{37–41} Renal dysfunction in a stallion and neonatal mortality have also been reported.^{42,43} Non-specific disease characterized by fever, jaundice, anorexia, and lethargy may also occur.⁴⁴

Diagnosis of leptospirosis can be difficult and may involve antigen detection (PCR), serological evaluation, histological examination, culture, and/or dark field microscopy.⁴⁵

Leptospirosis can be readily transmitted between species, including between animals and humans through infected urine, contaminated soil or water, or other body fluids.^{36,46} Veterinarians can be infected through contact of mucous membranes or skin lesions with urine or tissues from an infected animal. Human leptospirosis can be highly variable, ranging from asymptomatic infection to sepsis and death.^{45,47} Headache, myalgia, nausea, and vomiting are common complaints; however, neurologic, respiratory, cardiac, ocular, and gastrointestinal manifestations can occur.^{36,47} In rare instances, leptospirosis can be fatal. The threat of zoonotic transmission of leptospirosis from horses is not considered great; however, it would be prudent to take basic precautions, particularly when evaluating abortions or stillbirths. Prevention of occupational leptospirosis among veterinarians involves early identification of infected animals, reducing contact with affected animals (particularly urine and other body fluids) and the use of waterproof barrier clothing.⁴⁵

11. Dermatophytosis

Dermatophytosis (ringworm) is a fungal dermatologic disease of a variety of animals caused by *Microsporum* or *Trichophyton* species. In horses, *T. equinum* is most commonly involved. Disease in horses can be quite variable, ranging from mild or subclinical disease to severe lesions mimicking pemphigus foliaceus.⁴⁸ Ringworm can also affect people and can be transmitted from horses to people through direct and indirect routes. It has been estimated that 2,000,000 cases of zoonotic ringworm occur in the United States annually,⁴⁹ and ringworm infection was reported to be the most commonly acquired zoonotic disease among British

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veterinarians.⁵⁰ Whereas the majority of these cases were likely the result of contact with small animals or cattle, transmission from horses to people can occur.⁵¹

Prevention of zoonotic dermatophytosis involves recognition and quarantine of infected animals, personal hygiene, and environmental disinfection. Contaminated areas or instruments should be triple cleaned with stabilized chlorine dioxide disinfectants or a 10% bleach solution.⁵² Blankets, equipment, brushes, and other items that have had contact with the horse should also be disinfected or discarded. Infected animals should be handled with barrier protection including gloves and gowns.

12. Hendravirus (morbillivirus)

Equine hendra virus (morbillivirus) was first reported in Queensland, Australia in 1994–1995 involving two outbreaks that caused the deaths of 15 horses and 2 people.⁵³ Affected horses developed peracute respiratory disease, and the two affected people had close contact with infected horses.^{54,55} Subsequent studies detected antibodies in a significant percentage of fruit bats, suggesting that they act as reservoir hosts.⁵⁴ It is suspected that infected bat urine or reproductive fluids are involved in transmission, although the virus does not seem to be highly contagious.⁵⁴

In horses, the clinical course is very acute with the time from onset of signs to death, being only 1–3 days. Pyrexia, anorexia, and depression are the initial signs after an incubation period of 8–11 days (maximum 16 days).⁵⁵ Signs of respiratory disease progress and copious frothy yellow nasal discharge are common terminal features. Affected animals tend not to cough. Two affected horses also displayed neurological abnormalities. Differential diagnoses include shipping fever, acute circulatory catastrophes, poisoning, acute bacterial infections, and intoxications such as anthrax.⁵⁴

In people, serious influenza-like signs predominate. Of the two deaths that were reported, one was caused by severe respiratory disease whereas the other was caused by meningoencephalitis.

Under experimental conditions, the virus did not appear to be highly contagious between animal species, and urine is the most likely source of excretion and infection.⁵⁶ Experimental infection of horses, however, did not produce the copious frothy nasal discharge that was evident in naturally occurring cases, so it cannot be ruled out that this discharge was a source of infection.^{56,57} Very close contact between naturally affected horses is apparently necessary for transmission of disease.

Clinical infection Hendra virus in horses is rare and has not been reported outside of Australia. However the severity of disease for both affected horses and in-contact people necessitate vigilance by veterinarians involved in examining horses recently shipped from Australia. Gloves and protective glasses should be considered when examining

horses recently imported (within 16 days) from Australia that have developed acute, severe respiratory disease.

13. Methicillin-Resistant *Staphylococcus aureus*

Methicillin-resistant strains of *Staphylococcus aureus* (MRSA) are nosocomial pathogens of serious concern in human hospitals because of the degree of antimicrobial resistance.^{58,59} MRSA infection has been reported in hospitalized horses,^{60,61} and transmission between infected horses and veterinary personnel has been documented.^a In general, colonization of health care personnel is asymptomatic, and the main concern is transmission of the organism to susceptible patients. However, clinical MRSA cases in human health care professionals have been reported.⁶² It is likely that risk of exposure to MRSA from horses is much higher among personnel at referral hospitals. Personal hygiene and judicious antimicrobial use should help decrease the likelihood of MRSA acquisition by equine veterinarians.

14. Brucellosis

Brucellosis is a bacterial disease of significant historical importance that still exists in certain populations of animals. Horses are relatively resistant to infection; however, disease can occur and brucellosis can be transmitted from horses to humans. Brucellosis is caused by the gram-negative coccobacillus *Brucella abortus*, and equine disease is most commonly manifested as fistulous withers, poll evil, or fistulous bursitis. Cattle are the main reservoir of infection. The frequency of association of *B. abortus* with fistulous withers varies with geographic region; it is high in Texas and low in New York.^{63,64} Because *B. abortus* is often difficult to isolate, diagnosis is based on seropositivity. Isolation of another bacterial organism from draining tracts does not rule out the involvement of *B. abortus*, because it may only reflect secondary colonization.

Human brucellosis is considered to be an occupational disease that mainly affects slaughterhouse workers, butchers, and veterinarians.⁶⁵ Transmission typically occurs through contact of infected animals or materials with skin abrasions. Human brucellosis can be highly variable, ranging from non-specific, flu-like symptoms (acute form) to undulant fever, arthritis, and orchiepididymitis in males (undulant form).^{66,67} Neurological abnormalities may occur in up to 5% of cases. The chronic form can result in chronic fatigue, depression, and arthritis. In 2000, 87 cases of human brucellosis were reported in the United States⁶⁸; however, it is unclear how many were zoonotic in origin. Most human cases in the United States are reported in California, Florida, Texas, and Virginia.⁶⁷

Zoonotic transmission from horses is not considered high risk; however, appropriate precautions

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should be taken. Infection with *B. abortus* should be considered in cases of fistulous withers, particularly in the southern United States. Risk of transmission is present in cases with draining tracts or during surgical debridement. Some clinicians recommend against surgical debridement in seropositive horses.⁶⁹ Serologic testing should be performed in all horses with fistulous withers. Culture should be performed on all cases, including those that are seronegative.⁷⁰ Seroconversion takes approximately 2 wk, so repeated serologic testing of acute lesions is warranted.⁷¹ Prevention of infection involves prompt recognition of potential cases and reduction or elimination of human-animal contact, barrier precautions (gloves, gown, surgical mask, and protective eyewear), and careful handling of laboratory materials. Appropriate public health authorities should be contacted before initiating treatment of confirmed cases.

15. Trauma

Trauma may be associated with infections not typically considered to be transmissible to healthy, immunocompetent people. Meningitis caused by *Streptococcus zooepidemicus* has been reported following head trauma from a kick by a horse.⁷² Similarly, *Rhodococcus equi* was isolated from a chronic scalp infection following trauma in an immunocompetent person.⁷³

16. Conclusion

This paper does not describe every possible zoonotic disease that an equine practitioner may encounter. Other less common or geographically limited zoonotic diseases, including *Halicephalobus gingivalis* (*Micronema deletrix*),^{74,75} glanders,⁷⁶ and Nipah virus,⁵⁷ were not discussed but may be relevant in rare situations or certain geographic areas. Other diseases, such as Borna disease, may be zoonotic, although definitive evidence has not yet been obtained.⁷⁷

Disease in immunocompromised individuals may be caused by pathogens that are not considered to be zoonotic in normal situations. *Rhodococcus equi* is increasingly being recognized as a pathogen in people infected with the human immunodeficiency virus.^{78,79} The role that contact with horses plays in these cases, however, is unclear, because a history of contact with horses is not present in most cases.⁸⁰ Veterinarians with disease- or treatment-induced immunosuppression should be especially vigilant and discuss possible risks with their physician.

Whereas early identification of potential zoonotic diseases is important, personal hygiene and the use of barrier precautions when handling animals, body fluids, or post-mortem specimens will greatly reduce the possibility of disease transmission. Physicians receive limited training in the recognition of zoonotic diseases.³⁰ As a result, it is important for veterinarians to be aware of potential risks and no-

tify their health care workers if possible exposure to zoonotic agents has occurred. Veterinarians can also play a key role in detection of emerging zoonotic diseases because of their close contact with both animals and owners. There is also increasing concern about the use of zoonotic pathogens as agents of bioterrorism, and veterinarians may play an important role in early detection of bioterrorism-associated outbreaks of zoonotic diseases.

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