Outbreaks of the virus have been occurring in places where populations of horses are mixed, such as equestrian competitions. Source: Sue Huerter

Equine Herpesvirus Type 1 and Equine Herpes Myeloencephalopathy

TABLE OF CONTENTS

In January 2007, the Center for Emerging Issues (CEI) at USDA-APHIS-VS Centers for Epidemiology and Animal Health declared that equine herpes virus myeloencepholopathy (the neurological manifestation of equine herpesvirus-1, or EHV-1) met two criteria for an emerging infectious disease:

1. *the occurrence of a more virulent strain of EHV-1 than previously seen in the United States*
2. *increased recognition of outbreaks of disease at equine events with associated high case fatality rates.*

The following document chronicles the 2012 outbreak of EHV-1 at Hawthorne Racetrack in Cicero, Illinois. It serves as an example of a DVM dealing with a difficult emerging disease situation in which there was, and still is, incomplete information about the virus. The approach she took was based on infectious disease principles.

Hawthorne Racetrack, Illinois

On Sunday, October 14, 2012, Dr. Dawn Folker, DVM and State Veterinarian with the Illinois Racing Board at Hawthorne Racetrack in Cicero, Illinois, received a phone call. A horse was down with a fever. Another horse in the same barn was exhibiting neurologic signs. Suspicious of equine herpesvirus myeloencepholopathy (EHM), she acted quickly, closing the gates to the track and requesting blood samples and nasal swabs from all horses in the barn. Laboratory tests confirmed EHV-1. By Tuesday, the first two cases were euthanized, and two more horses tested positive for the virus. With 1,900 horses at Hawthorne Racetrack at risk for contracting the virus, biosecurity measures were implemented in every barn at the track, and warning signs were posted.

Dr. Folker quarantined the initially infected barn immediately and used pink duct-tape to mark all the infected stalls with an X. She also required every trainer to monitor and record their horses' temperatures twice daily. To enforce this practice, she randomly audited temperature log books every day. Dr. Folker knew monitoring for pyrexia was the best way to quickly identify horses shedding the virus and to prevent further spread.

After receiving the first positive test results, Dr. Folker contacted the Illinois State Veterinarian, Dr. Mark Ernst, to inform him of the outbreak. Although not reportable in Illinois, EHV-1 is a serious disease and is reportable in many other states (listed at the end of this document). Dr. Folker wanted Dr. Ernst to be aware of the situation.

Dr. Folker and Dr. Ernst initiated a conference call with the Illinois Racing Board, the Illinois Thoroughbred Horseman's Association, and the trainers at the track. During the call, they briefed everyone on the biosecurity protocols for EHV-1 they obtained from the University of Florida and the University of Kentucky's Gluck Equine Research Center. To enhance communication with trainers, owners, riders, grooms, veterinarians, and the public, Dr. Folker posted updates with journalists at the Daily Racing Forum, with the general manager at the track, and on the Illinois Thoroughbred Horseman's Association (ITHA) website. The ITHA also sent mass texts and e-mails to owners, trainers, and breeders in an effort to keep everyone current on the outbreak.

Control of viral spread between equines demands stringent biosecurity measures. At Hawthorne Racetrack, Dr. Folker isolated affected horses to prevent transmission via direct contact, such as nasal secretions and aerosols. She also mandated that personnel wear Tyvek® suits, gloves, and booties when handling potentially infected horses. Biohazard bags were set up for disposal of protective gear and potentially contaminated materials. Feed containers, feed scoops, and water buckets were kept separate and disinfected after each use. Manure/bedding from the affected barns was kept in an enclosed area and equipment used to move or handle manure/bedding from affected barns, such as trucks, wheel barrels, and scoops, was disinfected after use. These practices were put in place to prevent fomite transmission. Although EHV-1 is an enveloped virus and considered labile outside the horse, indirect transmission of virus by respiratory secretions on fomites can occur.

The heightened biosecurity measures also included closely monitoring traffic in and out of the barns. A list of permitted personnel was maintained, and IDs were required for admittance into positive barns. Dr. Folker held bilinqual question and answer sessions to educate all of the barn help, and she banned visiting between all barns. All paddock stalls and starting gates were disinfected, outriders and handlers were required to disinfect equipment and themselves, and everyone was mandated to bring their own buckets, scrappers, and sponges.

In addition to the biosecurity measures activated to contain the disease at Hawthorne Racetrack, Dr. Folker implemented testing for the virus in every lead pony and outrider horse. These horses, 87 in total, were in contact with all horses racing at the track. Testing these ponies and horses served as a litmus test to ensure the virus had not spread during racing. All 87 horses tested negative.

Throughout the quarantine, Dr. Folker recognized the need for fit thoroughbred horses to exercise. Standing in a stall all day during quarantine is taxing on a fit thoroughbred's mental health and potentially increases the horse's stress levels. As an opportunistic virus, EHV-1 takes advantage of reduced immunity in stressed animals. Dr. Folker set up separate exercise times for healthy, unaffected horses, for the recovered horses with negative EHV-1 tests, and for nonclinical horses with EHV-1 positive tests.

The quick reaction to the disease, including quarantine, stringent biosecurity, communication with all individuals at the track, ongoing diagnostic testing, and addressing exercise needs of the thoroughbreds, successfully kept the virus from halting racing at the track.

What is EHV-1?

EHV-1, an alphaherpesvirus, consists of a linear double stranded DNA genome encoding 100-200 genes. It causes respiratory, reproductive, and/or neurologic dysfunction in horses. EHV-1 infects most horses by age two and causes acute respiratory disease—apparent clinically through bi-lateral nasal discharge, anorexia, and depression. After infection in young equines, the virus can become latent and the horse a carrier of the disease. Estimates suggest 80% to 85% of the global equine population is latently infected with either EHV-1 or EHV-4. With some infections, either initial exposure or recrudescence induced by stressful situations (i.e. transportation, illness, nutritional insufficiencies, etc.), the horse becomes viremic. Viremia is a prerequisite to reproductive or neurologic infection.

An active EHV-1 infection in pregnant broodmares can cause reproductive disease. Fetal abortion typically occurs during the last four months of gestation. The fetus is often delivered in a fresh condition or alive if near term, but it dies soon after delivery. The virus infects the vascular endothelium of uterine blood vessels causing placental-endometrial detachment. The mare expels the asphyxiated fetus and placenta (the amniotic sac remains intact) without signs that allude to the disease. The virus may be limited to the placenta, but in most cases it reaches the foal, and histopathology of fetal tissues reveals a multi-organ infection. The highly infected fetus is capable of transmitting the EHV-1 virus and must be handled and disposed of according to appropriate biosecurity methods. Although a foal is lost, the mare's reproductive health remains viable for the future.

EQUINE HERPESVIRUS-1 VS. EQUINE HERPESVIRUS-4

Equine herpesvirus-1 is closely related to equine herpesvirus-4. These viruses share 55% to 84% of their genes and can be differentiated from each other through diagnostic tests, such as PCR, virus isolation, immunofluorescent staining, histopathological examination, serology, and immunohistochemistry. While both of these herpesviruses cause respiratory disease, especially in young, naive horses, EHV-1 is able to cross the basement membrane of the respiratory epithelium. EHV-1 infections, therefore, result in higher incidences of viremia, which lead to abortion and neurologic disease. EHV-4 rarely leaves the respiratory tract; therefore, it is less likely to cause neurologic deficits and abortions. Both diseases latently infect equines, have similar incubation and viral shedding periods, and may recrudesce when horses become stressed and immunosuppressed. Subsequent infections in latently infected horses have a reduced chance of exhibiting clinical signs of the disease; however, they can still actively shed the virus and may infect others.

The neurologic manifestation of EHV-1, EHM, is devastating. In cases of EHM, neurologic signs often appear approximately eight to twelve days following initial respiratory infection. During viremia, the virus infects the vascular endothelium of the brain and spinal cord leading to vasculitis, hemorrhage, thrombosis, and ischemic injury to nervous tissue. The virus's predilection for the lumbar intumescence and conus medullarus of the spinal cord causes ischemic damage to this area, which leads to signs of urinary incontinence, fecal retention, hind limb ataxia, and tail paresis. Prognosis for non-recumbent horses remains good but is poor for recumbent horses due to the challenges of managing their condition.

Equine Herpesvirus Myeloencephalopathy as an Emerging Disease

The EHM manifestation of EHV-1 was discovered in the 1970s when it was isolated from brain and spinal cord tissue of horses with paralytic signs. Pathologically, the horses were diagnosed with "disseminated necrotizing myeloencephalitis." The reporting of cases of EHM has been rising since 2003 with higher levels of morbidity and fatality. The disease's increased virulence, and its continued evolution into a more devastating neurologic form, justify its classification as an emerging disease.

EHM has been associated largely attributed to a single point mutation in EHV-1 from adenine (A) to guanine (G) in the DNA polymerase gene. The substitution of G for A results in an amino acid change in the protein of aspartic acid (D) in place of asparagine(N), which results in the production of the neurologic (D-strain) of the virus versus the non-neurologic (N-strain) of the virus. The mutation results in more efficient replication that initiates viremia earlier and allows it to reach a higher peak in the bloodstream, both of which lead to longer lasting viremia. This strain also shows a higher predilection for central nervous system (CNS) tissue. Both the earlier established, longer lasting viremia, and the predilection for CNS tissue, lead to a higher probability of EHM. However, the non-neurologic strain of EHV-1 cannot be completely dismissed as a causative agent of EHM. While the neurologic strain has been responsible for up to 75% of reported EHM cases, the non-neurologic strain has caused 25%.

Despite the discovery of the neurologic strain, predicting which EHV-1 infected horses will develop EHM remains challenging (estimates suggest 10% to 50% of horses with the N-strain develop EHM). This suggests that other predilection factors may also play a role in EHM, such as age, environment, breed, and host immunity. In addition to increased virulence, changes in horse husbandry (more horses in large boarding facilities), horse movement (more horses traveling to larger competitions), reporting practices, and improved diagnostic techniques may also be contributing to the increased incidence of EHM. Ongoing research is directed at developing a better understanding of this emerging disease.

Diagnostic Testing For EHV-1

Tests often used to determine a horse's infection with EHV-1 require a nasal swab and a whole blood sample. Determining EHV-1 infection by virus isolation from nasal swabs and blood samples is accurate but time consuming; therefore, quicker results from polymerase chain reaction (PCR) tests are often obtained. A positive blood test suggests the horse is viremic, actively infected, and at risk of developing neurologic disease. A positive nasal swab test indicates the horse is shedding the virus, but does not necessarily indicate progression to EHM.

STATES WHERE EHV-1 IS REPORTABLE

Alabama

Alaska*

Arizona*

Arkansas

California — EHV-1 reported monthly, EHM reported within two days

Colorado

Connecticut

Delaware — Policy, but not law, to report any neurological cases in equines

Florida

Georgia — by the close of the next business day

Hawaii*

Indiana

Kentucky — not specified, but abortion storms are reportable

Louisiana — within 24 hours

Maine**

Maryland**

Michigan

Minnesota**

Mississippi — not specified, but abortion storms are reportable

Missouri

Montana
requires immediate reporting

Nebraska*

Nevada

New Hampshire

New York — immediate notification

North Dakota

Ohio**

Oklahoma

Pennsylvania**

Rhode Island

South Carolina

South Dakota

Texas

Utah

Virginia

Washington*

West Virginia

Wisconsin

Wyoming

*Reportable monthly

**Only EHM is reportable

Which horses to test and which horses not to test is a dilemma faced by many veterinarians in charge of large equine venues. Many recommend only testing horses showing clinical signs of the disease, such as pyrexia and/or bilateral nasal discharge and coughing. Testing protocols may ultimately depend on how many horses in the population are at risk and on the economic situation of trainers and owners.

Vaccination

No current vaccines for EHV-1 protect horses against neurologic disease. Vaccination has been shown to decrease respiratory clinical signs and viral shedding; therefore, one of the main goals of vaccination is to reduce the virus's spread in at risk populations. Current EHV-1 vaccines are risk-based vaccines. The benefit of administration depends on each individual horse's risk level. When considering a horse's risk level, their age and potential exposure to the virus should be considered. It is important to remember vaccination is not a substitute for responsible biosecurity measures and herd management practices.

Preparation/Prevention of Future Outbreaks

Nineteen hundred horses resided at Hawthorne Racetrack in 26 barns with 103 trainers at the time of this outbreak. In all, 69 out of the 400 horses tested were positive for EHV-1. Fourteen horses developed neurologic signs and seven died during the outbreak. Dr. Ernst attributes the limited number of affected horses (compared to the number of horses residing on the track) to the quick activation of heightened biosecurity protocols.

Increased biosecurity measures at Hawthorne Racetrack have become part of the standard operations since the outbreak. Vaccination records and health papers of incoming horses are checked before they are allowed into the track. Communication, education, and increased awareness of EHV-1 and the impact it can have at equine venues remain a priority. Dr. Folker encourages trainers to continue to monitor and record temperatures twice daily; their vigilance is crucial in noticing any potential disease emergence.

Summary

Recognizing an EHV-1 outbreak and preventing its spread is not an easy task. Current research is focusing on understanding the strains that cause EHM, on the predisposing factors that contribute to its manifestation, and on developing an efficacious vaccine. Until a vaccine that provides protection from EHM is available, the best practices to minimize the impact of this disease are early detection by monitoring for pyrexia, isolation of infected horses, and implementation of strict biosecurity protocols. The latency of EHV-1 and its ability to recrudesce make it a continual threat to equine populations.

Who do you call?

Although EHV-1 is not a reportable disease in the state of Illinois, Dr. Folker reported the outbreak to the State Veterinarian, Dr. Mark Ernst, who then reported it to the AVIC (Area Veterinarian In Charge). Dr. Ernst assisted with the release and movement of horses from Hawthorne Racetrack and communicated with the state veterinarians in states accepting horses from Hawthorne. Although not all states require reporting of EHV-1 cases, it is important for all practicing veterinarians to establish good communications with state and federal (AVIC) veterinarians in order to develop a comprehensive plan to contain and manage disease. See text box for a list of states where EHV-1 is a reportable disease.

Authors: Mary Huerter, Center for Food Security and Public Health and Dr. Cody Alcott Iowa State University College of Veterinary Medicine, 2014

Sources of Information

Internet Resources

American Association of Equine Practitioners website
Equine Herpes Virus Resources
http://www.aaep.org/ehv_resources.htm and http://www.aaep.org/ehv.htm

International Society for Infectious Diseases ProMED website
Promedmail.org

UC Davis Veterinary Medicine Center for Equine Health website.
Equine Herpesvirus
http://www.vetmed.ucdavis.edu/ceh/ehv1_general.cfm

University of Florida, College of Veterinary Medicine. Neurological EHV-1 Outbreak information.
Biosecurity Guidelines:
http://extension.vetmed.ufl.edu/files/2011/10/EHV-1-Biosecurity-Guidelines.pdf

Clinical Signs/Testing:
http://extension.vetmed.ufl.edu/files/2011/10/EHV-1-Clinical-Signs-and-Testing.pdf

What to do with a suspect premise:
http://extension.vetmed.ufl.edu/files/2011/10/EHV-1-Suspect-Premises-Guidelines.pdf

University of Kentucky College of Agriculture Gluck Equine Research Center Department of Veterinary Science website.
Diseases of the Horse Caused by Equine Herpesvirus Type 1(EHV-1) – A Bibliography of Source Materials
http://www.ca.uky.edu/gluck/BiblioEHV1.asp

References:

Allen, G.P., et al. Equine herpesvirus 1 and equid herpesvirus 4 infections. Infectious Diseases of Livestock, (Ed.) JAW Coetzer and RC Tustin. Oxford Press (Cape Town). Ch. 76, pp 829-859. 2004.

Allcott, Cody. Veterinary Clinical Sciences. Iowa State University College of Veterinary Medicine. Personal Communication. October 6, 2013.

Borchers, K., et al. Pathogenesis of equine herpesvirus associated neurological disease: a revised explanation. Equine Vet J. 2006; 38 (3): 283-287.

Ernst, Mark. Illinois State Veterinarian, Bureau Chief. Personal Communication. November 7, 2013.

Fitzpatrick, David. Chief Veterinarian, Illinois Racing Board. Belmoral Racetrack, Crete, Ill. Personal Communication. June 12, 2013.

Folker, Dawn. State Veterinarian, Hawthorne Racetrack, Cicero, Ill. Personal Communication. July 1, 2013.

Goehring, L. S., et al. Control of EHV-1 viremia and nasal shedding by commercial vaccines. Vaccine. 2010; 28: 5203-5211.

Goehring, L.S. , et al. Infection of central nervous system endothelial cells by cell-associated EHV-1. Veterinary Microbiology. 2011; 149: 389-395.

Goehring, L.S. A critical view on Equine Herpesvirus-1 and on Equine Herpesvirus-associated Myeloencephalopathy (EHM). Colorado State University. Fort Collins, Colo. www.colorado.gov website. Accessed Jan. 6, 2014

Lunn, D. P., et al. Equine Herpesvirus-1 Consensus Statement. J of Vet Intern Med. 2009; 23: 450-461

Pronost, S., et al. Relationship between equine herpesvirus-1 myeloencephalopathy and viral genotype. Equine Vet. J. 2010; 42 (8): 672-674.

Pustrela, Nicola, et al. Equine herpesvirus-1 myeloencephalopathy: a review of recent developments. The Veterinary Journal. 2009; 180: 279-289.

Schott, Hal. Equine Herpes virus: questions and answers. Ohio Harness Horsemen's Association website. Ohha.com/pdfs/notes/tMHHA-EHV-1.pdf

Tewari, Deepanker, et al. Equine herpesvirus 1 (EHV-1) nucleotide polymorphism determination using formalin fixed tissues in EHV-1 induced abortions and myelopathies with real-time PCR and pyrosequencing. Journal of Virological Methods. 2013; 193: 371-373.

USDA. Equine Herpesvirus Myeloencephalopathy: Mitigation Experiences, Lessons Learned, and Future Needs. USDA-APHIS-VS, CEAH. 2008. Fort Collins, Colo. #N522.0708.

USDA. Equine Herpesvirus Myeloencephalopathy: A potentially emerging disease. USDA-APHIS-VS, CEAH. 2007. Fort Collins, Colo.

Vanderkerckhove, Annelies P., et. Al. Equine alphaherpesviruses (EHV-1 and EHV-4) differ in their efficiency to infect mononuclear cells during early steps of infection in nasal mucosal explants. Veterinary Microbiology. 2011; 152: 21-28

Vanderkerckhove, Annelies P., et. Al. Replication kinetics of neurovirulent versus non-neurovirulent equine herpesvirus type 1 strains in equine nasal mucosal explants. Journal of General Viralogy. 2010; 9: 2019-2028.

Wilkins, P.A., et al. Acyclovir as Treatment for EHV-1 Myeloencephalopathy. 49th Annual Convention of the American Associateion of Equine Practitioners, 2003, New Orleans, La. American Association of Equine Practitioners, Lexington, Ky., and International Veterinary Information Service (www.ivis.org), Ithaca, New York. Nov. 21, 2003.