TRENDS IN AGRICULTURE SCIENCE
ISSN:2583-7850

Popular Article
Domain: Veterinary Science
Vol 4 Issue 9, September 2025, 5126-5130

Emerging re-emerging viral infections of equines: a challenge in the foothills of the Himalayas

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DOI:10.5281/TrendsinAgri.17256885

1. Introduction

The horse family (*Equidae*) comprises horses (*Equus cabalus*), donkeys (*Equus asinus*), and zebras (*Equus zebra*). Mules are not a distinct species but a cross between a female horse and a male donkey. Mule bears the body of a horse and the extremities of a donkey. As per the 20th livestock census 2019, India possesses a population of 0.55 million horses, ponies, donkeys, and mules; of this population, Uttarakhand holds the highest population of mules (0.26 lakhs). While other states of the country, like Himachal Pradesh, Jammu and Kashmir, Uttar Pradesh, and Madhya Pradesh have seen a steep decline from -12.44 to -63.61% in mule population, Uttarakhand observed only a -02.25% change. Mules are used to provide logistics support, carry men and luggage in rugged hilly terrains where vehicles cannot reach due to their surefootedness and lower feed requirements.

Viruses have caused severe outbreaks in the equine population all over the world. In the last few decades, there has been an increase in the transmission of equine diseases due to a spike in the transport of animals and relaxation in rules regarding the movement of animals. Viral diseases not only impact the health of animals but also negatively impact the economic status of the livestock production system. In the Indian scenario, mules play an important role in the transmission of viral diseases due to their movements across the borders of different states. Amongst viral diseases of equines, India was declared free of African horse sickness fever in 2006 by the OIE.

2.1 Equine Influenza

Equine Influenza (EI) is a highly contagious respiratory disease of equines. Disease is caused by the Influenza A virus of the family *Orthomyxoviridae*. The virus has two subtypes: A/equi-1, i.e., H7N7, and A/equi-2, i.e., H3N8. Severe respiratory disease is caused by the H3N8 virus, with morbidity of 60-90% while the mortality is <1%. This virus is present in the nasal secretion of infected animals and transmitted through aerosols and droplet infection. It causes inflammation of the upper respiratory tract, pneumonia, and myocarditis. In India, a similar respiratory disease was first reported in horses from Bombay (now Mumbai) in 1964, affecting 400 horses. In 1987, influenza virus

epidemics were reported from the northern states of India, affecting almost 83,000 equine population. Re-emergence of this virus in India was reported in 2008 from northern states Jammu and Kashmir, Gujarat, and Uttarakhand, and it also spread to the southern state of Karnataka. The virus was confirmed to be H3N8. However, reports of viral antigen characterization are still not published. In India, an inactivated EI vaccine was developed by NRCE (National Research Centre for Equines) based on isolates from the 2008 outbreaks. Another inactivated vaccine, Calvenza 03 EIV of A2 type, is approved for import in India. However, EI vaccination is not practiced in India. The disease severity depends on the health status of animals and the treatment provided; hence, both factors should be regarded when dealing with viral epidemics.

2.2 Equine Infectious Anemia

Equine infectious anemia (EIA), also known as swamp fever, Coggin's disease, is caused by virus of the genus *Lentivirus* of the *Retroviridae* family. The disease is characterized by icterus, anemia, edema of the subcutaneous tissue of the ventral abdomen, and thrombocytopenia. Virus is transmitted by blood sucking vectors and directly by blood from infected syringe needles or during blood transfusion from infected animals. Venereal transmission and vertical transmission are also reported. The disease can be acute, fatal, or chronic, with asymptomatic carriers. In India EIA was first reported in 1987 from Karnataka, later in 1998 positive cases of EIA were reported from Uttar Pradesh. In January 2010, a single case of EIAV seropositive mule confirmed by Coogins test and cELISA was reported from Haldwani in Uttarakhand. Later in 2012, Haryana also reported seropositivity. Although no test could detect the presence of antigen, the animal was quarantined. There is no vaccine available for EIA. Control and prevention measures include routine testing, never sharing needles between equines, and vector management. It is advised to practice biosecurity in cases of report of infection in equines.

2.3 Equine Herpes Virus

Equine herpes virus (EHV) is highly infectious virus of the *Herpesviridae* family, affecting all members of the *Equidae* family. EHV-1 and EHV-4 cause outbreaks of respiratory diseases in equines. EHV-3 is the causal agent of coital exanthema. EHV-3 was reported from a case in a stud farm in Southern India. EHV-1 predominantly causes neurological disease, abortions in the last trimester and neonatal death in severe cases. It causes equine herpes myeloencephalopathy; EHV-4 is primarily associated with respiratory disease. National assessment of EHV-1 infection among *Equidae* family revealed 13.5 % seropositivity. Virus is transmitted by direct contact, inhalation of aerosols, nasal secretion, and ingestion of contaminated food. Once infected animal becomes a carrier for its lifetime. A study in 1989 by Tewari et al. revealed that EHV-1 was the major pathogen involved in neonatal mortality in equines of northern India. In Gujarat, Vala et al. (2021) reported a seroprevalence of 16.60% of EHV-1/4 virus from equines with respiratory illness. Vaccination is an important strategy to reduce disease incidence. In the year 2022, Punjab was also under a threat of outbreak as many equines reported of neurological disease by The Tribune. An indigenous inactivated vaccine of the EHV-1 virus was developed from strain Hisar-90-7 by the NRCE EquiherpAbort vaccine. Vaccination

is done in 6-month-old equines and also in pregnant mares.

2.4 Equine Encephalosis

Equine encephalosis virus (EEV) is a non-contagious arthropod-borne virus belonging to the genus *Orbivirus* of the *Reoviridae* family. The virus was first reported in horses in 1967 that died of an unknown peracute illness in South Africa. Infection is transmitted by midges (*Culicoides*), resulting in high morbidity (60-70 %), but mortality is rare. The incubation period for EEV is 2-5 days, with clinical presentation as fever, anorexia, tachycardia, and tachypnea. Nervous signs and respiratory signs have also been reported. EEV causes abortions in 5-6 months of gestation. The virus infects all equid species, but donkeys are considered to be relatively resistant to clinical disease. The virus was isolated in India from a dead horse in Pune, Maharashtra, in 2008. No vaccine is currently available worldwide against EEV.

2.5 Equine Viral Arteritis

Equine viral arteritis (EVA) is an infectious disease of equine caused by *Arterivirus* of the family *Togaviridae*. Only one serotype of the equine arteritis virus (EAV) has been reported so far. Disease is characterized by panvasculitis, depression, edema of limbs, ocular edema, conjunctivitis, enteritis, pneumonia and abortions. Virus is transmitted by the respiratory route, ingestion, and venereal transmission from infected stallions. Virus is also reported to cross the placental barrier and a few reports have been made in urine. The incubation period for the respiratory route is 2-3 days, while for venereal transmission is up to 9 days. Stallions infected with EAV are documented to be carriers of the virus and shed the virus in semen for several weeks to the rest of their lifetime. Attenuated and inactivated vaccines are available in North America and Europe.

2.6 West Nile Virus

West Nile virus (WNV) is an arthropod-borne Flavivirus of *the Flaviviridae* family. The virus is transmitted by vectors of the *Culex* species to wild birds which act as natural reservoirs of WNV. Humans and equines are also susceptible to WNV as transmission is done by mosquito bite from wild birds. Incubation period for WNV is 3-15 days. In equines the infection is characterized by pyrexia, muscle fasciculations, neurological signs like tremors, ataxia, abnormal gait, and recumbency. Neurovirulence depends on virus strain and host factors. Mortality in clinically infected horses may reach up to 40 %. In India, WNV antibodies were first detected in 1952 from humans. In India, the virus has been isolated from mosquitoes, bats and humans. In a study conducted from 2008 to 2010 across 13 states (including Himachal Pradesh and Uttar Pradesh), seropositivity of 2.46% for WNV was reported in wild birds in India. As the wild birds in the nearby states show seropositivity, a threat to the equine population of Uttarakhand also exists.

3. Biosecurity to control spread of infection

Biosecurity includes all the practices intended to prevent the introduction and minimize the spread of infectious disease agents in the equine population. Lack of biosecurity is a major threat to the equine population. Biosecurity includes bioexclusion and biocontainment. Bioexclusion includes

risk reduction protocols to minimize entry of pathogens to premises while biocontainment focuses on limiting the spread of infection by quarantine measures between the resident and infected population. Maintaining good hand hygiene, use of PPE kits, and the disinfection of farm equipment regularly. For newly arriving equids, there should be close inspection for any signs of clinical diseases, quarantine on arrival, daily temperature checks. Visitors should also be advised to take personal biosecurity measures. Equids should be housed age-wise to reduce direct contact. Isolation facilities should be available to minimize the shared air space of infected and non-infected equids. The interval between primary and booster vaccination should not be too long, as it will adversely affect vaccine efficacy.

4. Conclusion

Many respiratory and systemic viral infections pose a threat to economics of the horse population in hill terrains. The overlapping clinical presentation may make it difficult to correctly identify the causal agent where geographical locations limit the prompt lab diagnosis of samples. Vaccination in cases where the virus undergoes genetic changes in short period can also be challenging due to failure in the generation of protective immune response against heterologous virus strains. The control measures should be multifaceted with advanced projection of virus activity, studies on seasonal distribution of vectors, sero-surveillance, and controlled movement of equines across borders so that spread of infections and outbreaks can be curtailed.

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