Nairobi Sheep Disease

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Importance

Nairobi sheep disease is a one of the most pathogenic diseases of small ruminants. In susceptible animals, this tick-borne viral infection results in a hemorrhagic gastroenteritis with very high morbidity and mortality rates. Until recently, the causative viruses were only known to exist in parts of Africa and on the Indian subcontinent. However, viral RNA was recently identified in ticks in China. There is no effective treatment, and eradication is generally not feasible once the virus has become established in ticks.

Etiology

Nairobi sheep disease is caused by Nairobi sheep disease virus (NSDV) in Africa or a variant called Ganjam virus in Asia. Despite the two names, NSDV and Ganjam virus are now considered to be the same virus, which belongs to the genus *Nairovirus* in the family Bunyaviridae. Currently, its officially accepted species name is *Dugbe nairovirus.* It shares this name with two viruses, Dugbe virus and Kupe virus, which have been isolated from livestock ticks but are not known to cause any illness in animals. However, at least one genetic analysis has questioned this taxonomy, and suggested that NSDV and Ganjam virus should, in future, be reclassified as a new viral species *Nairobi sheep disease virus*. Some sources classify nairoviruses by serology. In this classification, NSDV/ Ganjam virus belongs to the Nairobi sheep disease virus serogroup, together with Dugbe virus and Kupe virus.

Species Affected

Among domesticated and laboratory animals, only sheep and goats can be infected readily by NSDV/ Ganjam virus, and only these species appear to be important as reservoir hosts. A few fatal cases of Nairobi sheep disease have been reported among blue duikers (*Cephalophus monticola*) in zoos or in the wild. However, African wildlife are not thought to be important in maintaining this virus. Experimental infections with NSDV and Ganjam virus, respectively, have been established in the African field rat (*Arvicathus abysinicus nubilans*) and langur monkeys (*Presbytis entellus*). Bonnet monkeys (*Macaca radiata*) inoculated with Ganjam virus did not become viremic.

Zoonotic potential

Ganjam virus and NSDV can cause a mild, influenza-like disease in humans. Most of the few reported clinical cases occurred in laboratory workers; however, antibodies have been found in some populations, and infections might be more widespread.

Geographic Distribution

Nairobi sheep disease is found in East and Central Africa. Serological evidence suggests that this virus may also be present in Botswana and Mozambique. Ganjam virus has been reported from parts of Asia including India and Sri Lanka. In 2013, viral RNA of NSDV/ Ganjam virus was detected in ticks in northeastern China.

Transmission

Nairobi sheep disease virus and Ganjam virus are transmitted by tick bites. *Rhipicephalus appendiculatus* is the most important vector for NSDV in East Africa. Unfed adult ticks can transmit this virus for more than two years after they are infected. Other vectors in Africa include *R. pulchellus*, *R. simus* and *Amblyomma variegatum*. Transovarial transmission has been demonstrated in *R. appendiculatus*, as well as in *R. pulchellus* in Somalia. Transstadial transmission can occur in all host ticks that have been described. In Asia, *Haemaphysalis intermedia* is the principal tick vector for Ganjam virus, but it has been described in the ticks *H. wellingtoni* and *R. haemaphysaloides*. Ganjam virus was also found in the mosquito *Culex vishnui*; however, it does not seem to replicate in this mosquito in the laboratory, and could have been a contaminant from a blood meal. In China, viral RNA of NSDV/Ganjam virus was mainly found in the tick *Haemaphysalis longicornis*, although it was also detected in *Dermacentor silvarum*, *D. nuttalli* and *Ixodes persulcatus*. Additional

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arthropod vectors can be infected with NSDV/ Ganjam virus in the laboratory.

Although it may be found in urine and feces, NSDV does not seem to be contagious via casual contact. However, animals may be infected experimentally with large oral doses (50 cc) of blood or serum. Experimental infections can also be established by injecting blood, serum or organ suspensions. NSDV survives for only short periods outside the body; its half-life (in 2% serum) is reported to be 1.5 hours at 37°C (99°F) and 7 days at 0°C (32°F).

Disinfection

Nairobi sheep disease virus is not transmitted between animals by direct contact; however, this virus is reported to be sensitive to lipid solvents and detergents, and high or low pH. Some of the disinfectants listed for other Bunyaviridae include hypochlorite, glutaraldehyde, 70% alcohol, hydrogen peroxide, peracetic acid and iodophors. They are also sensitive to heat and UV light.

Incubation Period

The incubation period is 1 to 15 days; most infections become apparent in 2 to 6 days.

Clinical Signs

Nairobi sheep disease is characterized by acute hemorrhagic gastroenteritis. In severe cases, the disease begins with a fever, leukopenia, rapid respiration, anorexia and profound depression, followed by fetid diarrhea and a concomitant drop in body temperature. At the onset, the feces are thin, profuse and watery; later, blood and mucus may appear. Straining and signs of colicky pain can also be seen. The superficial prescapular and precrural lymph nodes are often palpable, and some animals have a bloodstained mucopurulent or serosanguineous nasal discharge. Conjunctivitis may also be seen. Pregnant animals frequently abort. Many animals die during the early febrile stage of the disease, in some cases within 12 hours of the onset of the fever. Deaths are also seen later, from hemorrhagic diarrhea and dehydration. Goats may have less severe clinical signs than sheep.

Ganjam virus infections in Asia are reported to be similar but less severe in sheep and goats native to India. However, at least two outbreaks with severe clinical signs have been reported in non-indigenous breeds. These outbreaks resembled severe Nairobi sheep disease, although stiffness of the knee joints was also seen in one herd.

Post Mortem Lesions

Early in the course of the disease, the only abnormalities may be enlargement of the superficial and mesenteric lymph nodes, with congestion of most organs, and ecchymotic and petechial hemorrhages on the serosal surfaces of various organs including the heart, gastrointestinal tract, spleen, liver, lungs and kidney. In animals that survive longer, evidence of catarrhal mucoid or hemorrhagic gastroenteritis is apparent. Typically, the intestinal contents are liquid and bloodstained. Extensive ulceration and/or hemorrhages may be present, especially in the abomasum (particularly in the folds), colon, cecum and distal ileum, and around the ileocecal valve. Zebra striping of the cecum and colon (congestion or hemorrhages appearing as longitudinal striations in the mucosa) may be seen. The gall bladder is often swollen and hemorrhagic. The nasal mucosa may be congested and inflamed, and signs of conjunctivitis can be apparent. The genital tract may be inflamed, hyperemic and hemorrhagic if the animal has aborted. Aborted fetuses may have hemorrhages throughout their organs, and the fetal membranes can be edematous and hemorrhagic.

Diagnostic Tests

NSDV/ Ganjam virus can be isolated from uncoagulated blood (plasma) of live animals during the initial febrile stage, but little or no virus can be found in the blood after the body temperature falls. At necropsy, virus can be recovered from the spleen and mesenteric lymph nodes. Various cell lines, particularly BHK-21-C13 or BSR cells, can be used for virus isolation, with identification of the virus by RT-PCR, immunofluorescence to detect viral antigens, or other techniques.

RT-PCR is used for diagnosis in some laboratories, and is reported to detect virus in the blood even after the animal's temperature has returned to normal. No commercial tests to detect viral antigens are currently marketed; however, antigens can be found in clinical samples (e.g., spleen and mesenteric lymph nodes) by agar gel immunodiffusion, and an ELISA has been described in the literature. Cross-reactions can occur with the antigens of other nairoviruses.

Various serological tests have been used to detect antibodies to NSDV/ Ganjam virus. Paired serum samples should be collected to detect a rising titer. According to the World Organization for Animal Health (OIE), indirect immunofluorescence is the most suitable assay, but ELISAs can also be used. Complement fixation and indirect hemagglutination have also been employed, although rarely, Virus neutralization antibodies are often difficult to demonstrate. Cross-reactions can occur with other nairoviruses, especially Dugbe virus, in serological tests.

Animal inoculation, using suckling mice inoculated intracerebrally or laboratory-raised sheep, might be employed in some situations.

Treatment

There is no specific treatment for Nairobi sheep disease; however, supportive treatment, good shelter and quality feed may improve survival.

Control

Disease reporting

A quick response is vital for containing outbreaks in disease-free regions. Veterinarians who encounter or suspect Nairobi sheep disease should follow their national and/or local guidelines for disease reporting. In the U.S., state or federal veterinary authorities should be informed immediately.

Prevention

In areas where Nairobi sheep disease is not endemic, the disease might be eradicated by movement controls, quarantines and euthanasia of infected animals, together with tick control measures. NSDV can persist in an infected tick for more than two years, and eradication is generally not feasible once the virus becomes established in vector populations.

Sheep and goats can be protected from tick vectors by dipping and/or spraying with an acaricide. These treatments are generally used short-term in areas bordering enzootic regions when extension of the ticks' range is expected or seen, or to help protect unaffected animals in a flock. In enzootic areas, the use of tick controls may weaken immunity, and animals are usually allowed to develop resistance via tick bites (although a few deaths may occur). Experimental vaccines have been developed for use in naive animals entering enzootic areas, or to protect animal populations when the tick vector expands its geographic range. However, these vaccines are not produced commercially and their availability is unclear. Strict quarantine is not necessary in enzootic areas, as the infection is not transmitted by casual contact. Dead animals should be buried or incinerated.

Morbidity and Mortality

Sheep and goats in enzootic regions are often immune to Nairobi sheep disease, and their offspring are likely to be protected by maternal antibodies on first exposure to the virus. Outbreaks are usually seen in animals without immunity. This may occur when susceptible animals are imported into an enzootic area, or when they are moved from dry regions where tick vectors are absent into forests and grasslands where ticks are abundant. Outbreaks can also be seen when tick populations temporarily expand their range during a period of high rainfall or other ecological change.

In animals showing clinical signs, the prognosis is generally poor. Although some animals can have mild infections and recover, the mortality rate is usually 30-95% in an outbreak. Breed-related differences in susceptibility have been reported. In Africa, Nairobi sheep disease is less likely to be fatal in non-native breeds, such as Romney and Corriedale sheep, with reported mortality rates of 30-40% in such exotic breeds and crossbred animals. Indigenous African breeds are more susceptible; the mortality rate can be 75% or higher in East African hair sheep and Persian fat-tailed sheep. The opposite situation occurs in India, where Ganjam virus infections are mild or subclinical in indigenous breeds, but at least two severe outbreaks have been seen in imported sheep. Dorset Horn and Suffolk sheep were affected in one of these outbreaks, and Madras red sheep in the other.

Nairobi sheep disease is typically thought to be less virulent in goats than sheep; however, mortality rates as high as 90% have been reported in some indigenous breeds in Africa.

Public Health

Several Ganjam virus infections have been reported from laboratories in India, and one European child acquired this virus naturally. Illnesses caused by NSDV have been documented very rarely among laboratory workers in Africa. NSDV/ Ganjam virus infections might be acquired via tick bites, needlestick injuries or other means. The reported illnesses have been mild and resembled influenza, with symptoms that included fever, headache, back and abdominal pain, joint pains, nausea and vomiting. Antibodies to NSDV/ Ganjam virus have also been found among the general population, laboratory workers and/or agricultural workers in Uganda, India and Sri Lanka. Investigators should take precautions to prevent infections when working with these viruses. NSDV/ Ganjam virus is classified as a Biosafety Level 3 agent in the U.S.

Internet Resources

Food and Agriculture Organization of the United Nations (FAO). Manual on Meat Inspection for Developing Countries
http://www.fao.org/docrep/003/t0756e/T0756E00.HTM

The Merck Veterinary Manual
http://www.merckvetmanual.com/mvm/index.jsp

United States Animal Health Association. Foreign Animal Diseases.
http://www.aphis.usda.gov/emergency_response/downloads/nahems/fad.pdf

World Organization for Animal Health (OIE)
http://www.oie.int

OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals
http://www.oie.int/international-standard-setting/terrestrial-manual/access-online/

OIE Terrestrial Animal Health Code
http://www.oie.int/international-standard-setting/terrestrial-code/access-online/

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*Link defunct as of 2016