NAIROBI SHEEP DISEASE STANDARD OPERATING PROCEDURES: 1. OVERVIEW OF ETIOLOGY AND ECOLOGY

FAD PReP

Foreign Animal Disease Preparedness & Response Plan

United States Department of Agriculture

United States Department of Agriculture • Animal and Plant Health Inspection Service • Veterinary Services

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The Foreign Animal Disease Preparedness and Response Plan (FAD PReP) Standard Operating Procedures (SOPs) provide operational guidance for responding to an animal health emergency in the United States.

These draft SOPs are under ongoing review. This document was last updated in **September 2013.** Please send questions or comments to:

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Disease
Nairobi Sheep Disease

Mortality & Morbidity
Ranges from 30–95 percent. Mortality is higher among indigenous breeds than among exotic and crossbred sheep or goats.

Clinical Signs
Fever, leukopenia, rapid breath, anorexia, depression, and bloody diarrhea. Pregnant animals often abort. Typically death results from dehydration due to hemorrhagic diarrhea early in the course of the disease.

Susceptible Species
Sheep and goats. A few cases have been observed among duikers in zoos and the wild. The African field rat is experimentally susceptible.

Zoonotic Potential
Yes, mild influenza-like illness. Those affected all recover quickly. Not considered a threat to public health.

Reservoir
Maintained through transovarial (to offspring) and transstadial (through life stages) transmission in Ixodid ticks for more than two years.

Transmission
Vector-borne, Ixodid species ticks.

1.1 Introduction

Nairobi sheep disease (NSD) was first observed as acute hemorrhagic gastroenteritis near Nairobi, Kenya in 1910. It was not until 1917 that the causative agent was identified as a virus that infected both sheep and goats. This highly pathogenic, tick-borne virus is a World Organization for Animal Health (OIE) 2013 Listed Disease. NSD is a notifiable disease in the United States, where it has never occurred. Ganjam virus, an Asian variant of NSD will also be covered, only as it diverges from NSD.

1.1.1 Goals

As a preparedness goal, the Animal and Plant Health Inspection Service (APHIS) will provide etiology and ecology summaries for NSD, and update these summaries at regular intervals.

As a response goal, the Unified Command and stakeholders will have a common set of etiology and ecology definitions and descriptions to ensure proper understanding of NSD when establishing or revising goals, objectives, strategies, and procedures.

1.1.2 Further Information

This document is intended to be an overview, focusing on NSD in domestic sheep and goats. Additional resources on NSD are listed in Attachment 1.A. Foreign Animal Disease Preparedness and Response Plan (FAD PReP) documents are available on the APHIS public website (http://www.aphis.usda.gov/animal_health/emergency_management) or on the APHIS Intranet (http://inside.aphis.usda.gov/vs/em/fadprep.shtml, for APHIS employees).

1.2 Purpose

The purpose of this document is to provide responders and stakeholders with a common understanding of the disease agent.

1.3 Etiology

1.3.1 Name

NSD takes its name from where it was originally isolated, Nairobi, Kenya in 1910. For the rest of the 20th Century, it was believed that NSD was endemic to East Africa only until it was shown that Ganjam virus of India and NSDV shared significant sequence homology.[1] Ganjam virus is now recognized as an Asian variant of NSDV and was named after the location of isolation, a city in Orissa, India.

1.3.2 Virus Characteristics

According to the International Committee on the Taxonomy of Viruses, NSDV/Ganjam virus has the following characteristics:

- Family: *Bunyaviridae*
- Genus: *Nairovirus*

[1] Marczinke BI, Nichol ST. 2002. "Nairobi sheep disease virus, an important tick-borne pathogen of sheep and goats in Africa is also present in Asia." *Virology*. 303: 146 – 151.

- Genome: segmented (3), negative-sense, single-stranded, ribonucleic acid (ssRNA).

The *Nairovirus* genus is also home to other important pathogens such as Dugbe virus and Kupe virus, as well as the zoonotic agent Crimean-Congo hemorrhagic fever. More distantly related viruses include other members of the *Bunyaviridae* family such as Rift Valley fever virus and Akabane.[2]

1.3.3 Morphology

NSDV is an enveloped virus with a segmented, single-stranded, negative sense RNA genome. The three segments of the NSDV genome, the small (S), medium (M), and large (L) segments encode four different viral proteins: the viral nucleocapsid (N) protein, two glycoproteins (G1 and G2), and the viral RNA polymerase (L).[3] Ganjam virus morphology closely mirrors that of NSDV.

1.4 Ecology

1.4.1 Susceptible Species

Of domestic livestock, only sheep and goats are susceptible to NSDV infection. There have been a few fatal cases among duikers (*Cephalophus monticola*) in zoos and in the wild and the African field rat (*Arvicathus abysinicus nubilans*) has been experimentally infected.[4] Ganjam virus primarily infects goats, though serological surveys show that sheep are susceptible as well.

Both NSDV and Ganjam virus are capable of human infection, causing only a mild influenza-like illness; those affected all recover. Neither NSD nor Ganjam virus are considered a significant threat to public health, however they are to be studied at biological safety level 3.[5]

1.4.2 Reservoirs and Carriers

Ixodid ticks are able to maintain NSDV by passing it onto their offspring (transovarial transmission) and maintaining it through life stage changes (transstadial transmission). Ticks can remain infective for more than two years.[4]

1.4.3 Distribution

Historically the distribution of NSD is limited to East and Southern Africa. As of January 2013, the World Animal Health Information Database shows that NSD is currently not reported in any part of the world. The most recent outbreak was reported in Somalia in 2007, prior to that it was found in Kenya (last seen in 2003), Tanzania (2003), Cote d'Ivoire (1993), and suspected in Mozambique.[6] Outbreaks of Ganjam virus are typically not reported to the OIE.

[2] International Committee on Taxonomy of Viruses. 2011. www.ictvonline.org (Accessed December 2012).
[3] Holzer, B, Bakshi S, Bridgen A, Baron MD. 2011. "Inhibition of interferon induction and action by the Nairovirus Nairobi sheep disease virus/Ganjam virus." *PLOS ONE*. 6(12): e28594
[4] Center for Food Security and Public Health (CFSPH), Iowa State University. 2009. *Nairobi Sheep Disease*. Technical Fact Sheet. www.csfph.iowa.edu.
[5] Sudeep AB, Jadi RS, Mishra AC. 2009. "Ganjam virus." *Indian Journal of Medical Research*. 130: 514–519.
[6] OIE. World Animal Health Information Database. www.oie.int.

1.4.4 Introduction and Transmission of Nairobi Sheep Disease

Both NSD and Ganjam virus are tick-borne viruses. In East Africa, the most important vector for NSDV is the tick *Rhipicephalus appendiculatus*. Other Ixodid ticks can serve as vectors: *R. pulchellus, R. simus,* and *Amblyomma varigatum*. Transovarial transmission—passing the virus to offspring—has been demonstrated by *R. appendiculatus* and *R. pulchellus*. All tick hosts are able to maintain the virus from life stage to life stage (transstadial transmission).

Ganjam virus is primarily transmitted through the tick *Haemaphysalis intermedia*. *H. wellingtoni*, *R. haemaphysaloides,* and the mosquito *Culex vishnui* have also been described as competent vectors.

Though present in urine and feces, direct contact does not result in infection. Animals have however, been experimentally infected when injected with infected blood, serum, or organ suspensions.[7]

Animals that were bred in areas where *R. appendiculatus* is prevalent are immune to NSD. When young animals are bitten by the infected ticks, they are protected by maternal antibodies and then gain their own protective antibodies when exposed to the virus. Typically only naïve animals who are brought into endemic areas suffer from the disease.[8]

1.4.5 Incubation Period

The incubation period varies from 1–15 days; the majority of infections manifest in clinical signs within 2–6 days.

1.4.6 Morbidity and Mortality

The mortality rate of NSD ranges from 30–95 percent; very few animals who acquire NSD recover once clinical signs are apparent. Indigenous African breeds have higher rates of mortality (75 percent or higher) than exotic or crossbred sheep and goats (30–40 percent) such as Romney or Corriedale sheep.[7]

Unlike NSD, Ganjam virus affects breeds exotic to India and crossbred animals more severely, causing higher rates of mortality than among indigenous populations. However, in general, Ganjam virus infections are milder than NSD infections.[9]

1.4.6.1 Clinical Signs

As previously mentioned, NSD was first recognized as acute hemorrhagic gastroenteritis. Disease is characterized first by fever, leukopenia (decrease in white blood cell count), rapid breath, anorexia, depression followed by diarrhea (may contain blood and mucus), and a drop in body temperature. Some animals may experience conjunctivitis and/or mucopurulent/bloody nasal discharge. Pregnant animals often abort. Death frequently occurs early in the course of the disease and is typically the result of hemorrhagic diarrhea and dehydration. Goats may

[7] CFSPH, Iowa State University. 2009. *Nairobi Sheep Disease*. Technical Fact Sheet. www.csfph.iowa.edu.
[8] bin Tarif A, Lasecka L, Holzer B, Baron MD. 2012. "Ganjam virus/Nairobi sheep disease virus induces a pro-inflammatory response in infected sheep." *Veterinary Research*. 43(1): 71.
[9] Sudeep AB, Jadi RS, Mishra AC. 2009. "Ganjam virus." *Indian Journal of Medical Research*. 130: 514 – 519.

experience less severe clinical signs than sheep. Ganjam virus is reported to cause similar but less severe symptoms that NSD.[7]

1.5 Environmental Persistence of Nairobi Sheep Disease

The OIE does not provide specific guidance on the physical and chemical resistance of NSD but like other bunyaviruses, it is susceptible to hypochlorite, phenolics, 2% glutaraldehyde, and other disinfectants.[10] The *Nairovirus* Crimean-Congo Hemorrhagic Fever is destroyed by heating at 133° F (56° C) for 30 minutes.[11]

1.6 Risk of Introduction to the United States

Various genera of Ixodid ticks (*Amblyomma, Rhipicephalus, Ixodes, Dermacentor*) are present in the United States and transmit diseases such as Lyme disease, Rocky Mountain spotted fever, and tularemia among others.[12] Whether NSDV would find any one of these a suitable vector has not been studied. There are instances where animal diseases, specifically Bluetongue[13], have successfully invaded areas where the primary vector does not exist, suggesting that local vectors are capable of spreading disease. Further research is needed on vector competence for NSD in the United States.

In 2011, the only live animals imported from Africa were birds and horses, neither animal typically hosts the ticks most likely to carry or transmit NSD. Humans are susceptible to tick bites and it is possible that a traveler could carry a tick back to the United States on their person. Travelers should be cautious and maintain self-awareness, checking themselves while traveling in areas where the ticks are endemic. Considering these factors, the risk of NSD introduction to the United States seems negligible. Nevertheless, producers, veterinarians, mangers and other industry personnel should maintain vigilance.

[10] CFSPH, Iowa State University, 2009. *Nairobi Sheep Disease*. Technical Fact Sheet. www.cfsph.iowa.edu.
[11] CFSPH, Iowa State University, 2009. *Crimean-Congo Hemorrhagic Fever.* Technical Fact Sheet. www.cfsph.iowa.edu.
[12] Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases, Division of Vector-Borne Diseases. 2012. "Ticks: Geographic Distribution." Available at http://www.cdc.gov/ticks/geographic_distribution.html.
[13] Wilson A, Mellor P. 2008. "Bluetongue in Europe: vectors, epidemiology and climate change." *Parasitology Research.* 103: S69–S77.

Attachment 1.A References and Resources

bin Tarif A, Lasecka L, Holzer B, Baron MD. 2012. "Ganjam virus/Nairobi sheep disease virus induces a pro-inflammatory response in infected sheep." *Veterinary Research*. 43(1): 71.

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Center for Food Security and Public Health, Iowa State University, 2009. *Crimean-Congo Hemorrhagic Fever*. Technical Fact Sheet. www.cfsph.iowa.edu.

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World Organization for Animal Health (OIE). World Animal Health Information Database. www.oie.int.

Attachment 1.B Abbreviations

APHIS	Animal and Plant Health Inspection Service
CFSPH	Center for Food Security and Public Health
FAD PReP	Foreign Animal Disease Preparedness and Response Plan
NSD	Nairobi sheep disease
NSDV	Nairobi sheep disease virus
OIE	World Organization for Animal Health
RNA	ribonucleic acid
SOP	standard operating procedure
USDA	United States Department of Agriculture
TDD	telecommunications device for the deaf