SCHMALLENBERG VIRUS STANDARD OPERATING PROCEDURES: 1. OVERVIEW OF ETIOLOGY AND ECOLOGY

National Preparedness and Incident Coordination Center

United States Department of Agriculture

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

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These National Preparedness and Incident Coordination Center 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 **February 2014.** Please send questions or comments to:

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Disease

Schmallenberg virus.

Morbidity and Mortality

Morbidity can be high (up to 70 percent) in adult animals, but they experience only subclinical or non-specific signs of illness. High morbidity is seen in newborn animals, and mortality primarily results from aborted fetuses.

Susceptible Species

Domestic and wild ruminants are susceptible, such as cattle, sheep, goats, bison, and deer. Most affected animals have been sheep.

Zoonotic Potential

No evidence that SBV is zoonotic.

Reservoir Hosts

Not fully known; related viruses have many reservoirs in wildlife and livestock.

Transmission

SBV can be transmitted by insect vectors, most likely *Culicoides* midges or mosquitos, or vertically, from mother to fetus.

Persistence in the Environment

Viruses of the same family as SBV are vulnerable to bleach, detergents, chlorhexidine, alchohols, phenols, and heat; they do not persist in the environment for long.

1.1 Introduction

Beginning in August 2011, farmers and veterinarians in North Rhine-Westphalia, Germany and the Netherlands began noticing an unfamiliar disease in dairy cattle that presented as fever, anorexia, decreased milk production, and diarrhea. In November 2011, there was an increase in aborted fetuses and congenital abnormalities primarily in newborn lambs; calves and goat kids were also affected to a degree. Analysis of blood samples revealed high sequence similarity to viruses of the *Bunyaviridae* family, genus *Orthobunyavirus*, viruses known for being teratogenic. This agent was subsequently named Schmallenberg; it is not a threat to public health.

1.1.1 Goals

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

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

1.1.2 Further Information

This document is intended to be an overview, focusing on Schmallenberg virus (SBV) in domestic animal species. Additional resources on SBV, such as articles referenced in this SOP, are listed in Attachment 1.A.

For more information on emergency management and animal health, please go to: http://www.aphis.usda.gov/animal_health/.

Case definitions and laboratory guidance for SBV are available here: http://www.aphis.usda.gov/animal_health/animal_diseases/schmallenberg/.

1.2 Purpose

This document provides responders and stakeholders with a common understanding of the disease agent.

1.3 Etiology

1.3.1 Name

This emerging vector-borne virus of ruminants has been provisionally named “Schmallenberg,” after the German town in which the first positive samples were identified.

1.3.2 Virus Characteristics

Schmallenberg virus has been categorized as follows:

- Family: *Bunyaviridae*
    - Genus: *Orthobunyavirus*

    - Serogroup: Simbu
- Genome characteristics: (-) ssRNA

Akabane, Aino, and Shamonda viruses are also members of the *Orthobunyavirus* genus, Simbu serogroup. Recent phylogenetic investigations suggest that SBV belongs to the Sathuperi virus species, and is likely an ancestor of Shamonda virus.[1] *Bunyaviridae* is a very large family and includes other viruses as Crimean-Congo hemorrhagic fever virus and Rift Valley fever virus.[2]

1.3.3 Morphology

Like other members of the *Bunyaviridae* family, Schmallenberg is an enveloped virus with a segmented genome composed of single-stranded, negative-sense RNA. The three segments, designated large (L), medium (M), and small (S), code for at least 5 proteins. In general, the L segment codes for a polyprotein with replicase and transcriptase activity. The M segment encodes virion surface glycoproteins (G1 and G2) and a non-structural protein (NSm). Lastly, the S segment codes for the nucleocapsid (N) protein and another non-structural protein (NSs).[3] Genomic studies have revealed significant sequence homology between the S segments of Shamonda virus and SBV resulting in the tentative characterization of SBV as a Shamonda-like virus.[4]

1.4 Ecology

1.4.1 General Overview

Members of the Simbu serogroup are distributed throughout Asia, Africa, the Middle East, and Australia. Prior to November 2011, Simbu serogroup viruses had not been detected in Europe. Cases have now been reported in countries including, but not limited to, Germany, the Netherlands, Belgium, the United Kingdom, Luxembourg, Italy, France, Spain, Switzerland, Austria, Ireland, Finland, Norway, Sweden, Poland, and Estonia.

1.4.2 Susceptible Species

SBV appears to cause disease in domestic and possibly wild ruminants. Cattle, sheep, and goats are susceptible. The large majority of affected animals are sheep. Bison are also susceptible and bison calves have been observed with teratogenic disease. Evidence of SBV infection has also been detected in wild British red deer (*Cervus elaphus*), fallow deer (*Dama dama*), roe deer (*Capreolus capreolus*), and Reeve's muntjac (*Muntiacus reevesi)*; whether wild ruminants

[1] Goller KV, Hoper D, Schirrmeier, Mettenleiter TC, Beer M. 2012. "Schmallenberg virus as possible ancestor of Shamonda virus." *Emerging Infectious Diseases*. 18(10): 1644-1646.
[2] International Committee on Taxonomy of Viruses. 2011. Family *Bunyaviridae*. Available at http://ictvonline.org/. Accessed March 2012.
[3] Saeed MF, Li L, Wang H, Weaver SC, Barrett ADT. 2001. "Phylogeny of the Simbu serogroup of the genus *Bunyavirus*." *Journal of General Virology.* 82: 2173 – 2181.
[4] Hoffman B et al. 2012. "Novel *Orthobunyavirus* in Cattle, Europe, 2011." *Emerging Infectious Diseases.* 18(3): 469 – 472.

experience clinical disease is unknown[5]. Other potential susceptible wildlife include mouflon sheep (*Ovis aries*) and wild boar (*Sus scofra*).

1.4.3 Reservoir and Carriers

Preliminary experimental data have shown that the viremic period in cattle is short; three infected animals were negative 6 days post-inoculation. Information on reservoirs and carriers has not yet been established for Schmallenberg virus. However, orthobunyaviruses of the Simbu serogroup have a variety of reservoirs in both wildlife and livestock.

1.4.4 Introduction and Transmission of Schmallenberg Virus

The origin of Schmallenberg and its means of introduction to European domestic ruminants remain unknown. A vector-borne disease, it appears that Schmallenberg is predominately transmitted by *Culicoides* midges or mosquitoes (*Culicidae*). Thus far, two pools of midges, *C. obseletus* and *C. dewulfi,* tested positive for SBV via RT-PCR.[6] *Culicoides* midges are widely distributed throughout the world in temperate and tropical climates. The spread of SBV through Europe has been rapid, similar to the 2006-2009 spread of bluetongue virus, which is also disseminated by a *Culicoides* vector.[7] Vertical transmission, across the placenta, is also possible. Fetuses may be most vulnerable early in the pregnancy, as malformations to fetuses and newborns occur several months after an acute infection in the mother.[8]

1.4.5 Incubation Period

According to experimental challenge trials, calves inoculated intravenously or subcutaneously were seropositive 2 to 5 days post-inoculation. The World Organization for Animal Health (OIE) additionally reports that in experiments with both adult cattle and sheep incubation time was 1 to 4 days and viremia lasted 1 to 5 days.[9]

1.4.6 Morbidity and Mortality

Morbidity in adult animals may be inapparent or present with non-specific signs of illness. Recovery occurs within a few days for individual animals and within 2 to 3 weeks for the herd. Herd morbidity rates can be high (20 to 70 percent). Mortality appears to be mainly confined to aborted fetuses. Seroprevalence testing found detectable antibody levels in 70 to 100 percent of dairy cattle and sheep in the Netherlands.[10]

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[5] Barlow A, Green P, Banham T, Healy N. 2013. "Serological confirmation of SBV infection in wild British deer". *Veterinary Record*. 172(16): 429.

[6] European Livestock Association. Belgium: Pools of Culicoides spp. found positive for Schmallenberg virus by RT-qPCR. 2012a; accessed 14 March 2012.

[7] Noad R, Brownlie J. 2013. "Schmallenberg virus: continuing a trend?" *Virus Adaptation and Treatment*. 5:11-19.

[8] Wernike K, Hoffmann B, Beer M. 2013. Schmallenberg Virus. In: Roth JA, Richt JA, Morozov IA, editors. *Vaccines and Diagnostics for Transboundary Animal Diseases*. Basel, Switzerland: Karger.

[9] OIE, 2013."Schmallenberg Virus." Technical Factsheet. www.oie.int.

[10] European Livestock Association. Antibodies against Schmallenberg virus [SBV] in 70 per cent of the dairy cattle population in the Netherlands. 2012b; accessed 14 March 2012.

1.4.6.1 Clinical Signs

The primary signs of illness are fever, loss of appetite, reduced milk production, and in severe cases, diarrhea. These signs are very mild in sheep and goats, but more noticeable in adult cows.[11] Illness lasts approximately one week. SBV (and other Simbu serogroup viruses) also induces malformations in fetuses, stillborn or newborn lambs, calves, and goat kids. Common malformations include severe arthrogryposis, torticollis, brachygnathia, hydroencephaly, ataxia, paralysis, muscle atrophy, joint malformations, scoliosis, behavioral abnormalities and blindness. Together these malformations have been designated arthrogryposis hydranencephaly syndrome (AHS). AHS occurs primarily in sheep and goats.

1.4.6.2 In Humans

While some members of the Simbu serogroup are zoonotic (Oropouche virus and Iquitos virus) and do cause disease outbreaks in humans, there is no evidence that SBV is zoonotic and it is not a threat to public health. Akabane, Aino, and Shamonda viruses, with which it shares greatest sequence homology, only cause disease in livestock. The European Food Safety Authority (EFSA) considers the risk to be negligible.[12] No zoonotic potential was found in epidemiological and virological studies of at-risk humans.[13]

1.5 Environmental Persistence

Bunyaviridae are typically susceptible to common disinfectants like hypochlorite (bleach), detergents, chlorhexidine, alcohol and phenols. The following (Table 1) is from extrapolation of the California serogroup of Orthobunyaviruses.

Table 1. Resistance to physical and chemical action of Schmallenberg virus

Action	Resistance
Temperature	Infectivity lost (or significantly reduced) at 50–60° C (122–140° F) for at least 30 minutes.
Chemicals/Disinfectants:	Susceptible to common disinfectants: 1% sodium hypochlorite, 2% glutaraldehyde, 70% ethanol, formaldehyde.
Survival	Does not survive outside the host or vector for long periods.

Source: OIE. 2013. “Schmallenberg Virus” *Technical Factsheet*. www.oie.int.

[11] Doceul V, Lara E, Sailleau C, Belbis G, Richardson, J, Breard E, Viarogue C, Dominguez M, Hendrikx R, Calavas D, Desprat A, Languille J, Comtet L, Pourquier P, Eleouet J, Delmas B, Marianneua P, Vitour D, Zientara S. 2013. “Epidemiology, molecular virology and diagnostics of Schmallenberg virus, an emerging orthobunyavirus in Europe.” *Veterinary Research.* 44(31).

[12] European Food Safety Authority (EFSA). "Schmallenberg" virus: likely epidemiological scenarios and data needs. Supporting Publications 2012:EN-241. [31 pp.]. Available online: http://www.efsa.europa.eu/en/supporting/doc/241e.pdf

[13] OIE. 2013. “Schmallenberg Virus.” Technical Factsheet. www.oie.int

1.6 Risk of Introduction to the United States

If SBV were introduced into the United States, it would spread rapidly and be difficult to control due to the lack of immunologic resistance in domestic ruminants and the abundance of potentially competent vectors. *Culicoides* species of midges do exist in the United States and are likely to be competent vectors for transmission of SBV. The European Food Safety Authority recently modeled the risk of spread to susceptible populations based on bluetongue virus serotype 8 (BTV-8) data. The model suggests that SBV distribution is more extensive than BTV-8, which, like SBV, is not currently found in the United States.

Existing import regulations, along with recently enacted restrictions on imports of live animals from the European Union (EU) and on germplasm from the EU and countries following EU legislation, help to protect the United States from SBV.

Attachment 1.A References

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Attachment 1.B Abbreviations

AHS	arthrogryposis hydroencephaly syndrome
APHIS	Animal and Plant Health Inspection Service
BTV-8	bluetongue virus serotype 8
EFSA	European Food Safety Administration
EU	European Union
OIE	World Organization for Animal Health
ssRNA	single-stranded ribonucleic acid
SBV	Schmallenberg virus
USDA	United States Department of Agriculture