

# Aino Disease

## *Aino Virus Infection*

**Last Updated:** January 2018



The Center for  
Food Security  
& Public Health



INSTITUTE FOR  
INTERNATIONAL  
COOPERATION IN  
ANIMAL BIOLOGICS

IOWA STATE UNIVERSITY  
College of Veterinary Medicine



OIE Collaborating Centre for  
• Diagnosis of Animal Disease and  
Vaccine Evaluation in the Americas  
• Day-One Veterinary Competencies  
and Continuing Education



## Importance

Aino virus is one of several closely-related viruses that can cause a syndrome of reproductive losses and fetal deformities in ruminants. Relatively little information has been published about this virus, and some assumptions in the literature are based on the other viruses that cause this syndrome, particularly Akabane virus.

## Etiology

Aino virus (official species name: *Shuni orthobunyavirus*) is a member of the genus *Orthobunyavirus* in the family Bunyaviridae. Obsolete names for this virus include Samford virus and Kaikalur virus. Serologically, Aino virus belongs to the Simbu serogroup of the Bunyaviridae. This serogroup contains some other viruses that are also teratogenic in ruminants, such as Akabane virus and Schmallerberg virus, as well as some viruses that seem to be nonpathogenic. Simbu serogroup viruses can exchange gene segments (reassort) with each other.

## Species Affected

Aino virus has been linked to fetal deformities in cattle and sheep, and it is suspected to affect goats. Antibodies to Aino virus have also been found in horses, pigs, wild boar, water buffalo and wild ruminants, although there is currently no evidence that it is pathogenic in these species. This virus is teratogenic in chick embryos inoculated directly into the yolk sac; however, there are no reports that it affects birds outside this experimental setting.

### *Zoonotic potential*

Antibodies to Aino virus have been detected in humans, but there are no reports of human disease. These antibodies might represent a cross-reaction to other bunyaviruses.

## Geographic Distribution

Aino virus is known to occur in Australia and Asia. It is said to be widely distributed in parts of Asia, with reports of its presence in Japan, South Korea, Indonesia and India, and recent serological evidence suggesting that it may exist in China. Antibodies to Aino virus have also been found in a few countries in the Middle East and Africa. Clinical cases have been reported mainly from Japan and Australia; however, a recent outbreak in Jordan was thought to be caused by either Aino virus or a very close relative, rather than Akabane or Schmallerberg virus.

## Transmission

Simbu serogroup viruses are transmitted between animals by insect vectors. Biting midges (gnats) in the genus *Culicoides* are thought to be the primary vectors for this group of viruses; however, there is little specific information about the transmission of Aino virus. In addition to being found in *Culicoides brevitarsis*, *C. oxystoma* and other members of this genus, Aino virus has also been detected in mosquitoes (e.g., various species of *Culex*). It can be transmitted across the placenta to the fetus, causing congenital defects.

## Disinfection

There is no specific information about the disinfectant susceptibility of Aino virus; however, other Bunyaviridae are susceptible to common disinfectants such as sodium hypochlorite, glutaraldehyde, 70% alcohol, hydrogen peroxide, peracetic acid and iodophors. They are also sensitive to heat and UV light.

## Incubation Period

Most studies and reports suggest that Aino virus infections are asymptomatic in adults, but the virus can infect the fetus at this time. Fetal infections do not become evident until the affected animals are born or aborted, which may not occur for several weeks or months.

## Clinical Signs

In naturally infected pregnant cattle and sheep, Aino virus has been associated with abortions, stillbirths, premature births, and birth defects including arthrogryposis, scoliosis, sunken eyes, cataracts, maxillary retraction and dental irregularities. Some calves may have a domed head from hydranencephaly. Surviving calves may be weak and can have difficulty suckling or standing. They may also be blind or have visual defects, as well as a variety of neurological signs (e.g., ataxia, torticollis, tetany, paresis, swimming movements, opisthotonus, circular walking). In most reports, the dam does not seem to show any signs of illness at the time of the infection, although a transient fever was observed in experimentally infected pregnant cows. However, fetal abnormalities can result in dystocia at parturition. One outbreak investigation in Jordan, tentatively attributed to Aino virus or a closely-related agent, reported a history of abortions, congenital malformations, diarrhea and decreased feed intake and milk production in a seropositive dairy cattle herd, as well as congenital malformations and reproductive losses in small ruminants.

Clinical signs have not been reported in non-pregnant adults, except for one report of sudden astasia and leukopenia in a naturally infected dairy cow.

## Post Mortem Lesions

Affected calves may be aborted, stillborn or premature. The typical birth defects associated with Aino virus infection are arthrogryposis, hydranencephaly, and cerebellar hypoplasia or agenesis. Some reports mention necrotic foci in the cerebrum, porencephaly, partial absence of the cerebrum, micrencephaly, hydrocephalus, scoliosis, torticollis, maxillary retraction, sunken eyes, cataracts and dental irregularities.

## Diagnostic Tests

In outbreak descriptions, Aino disease has generally been diagnosed by serology, using serum or body fluids from the fetus or presuckle neonate and/or by demonstrating rising titers in the dams. However, antibody titers are often stable by the time a pregnant animal gives birth to affected offspring, and such titers are indistinguishable from exposure before the pregnancy. Virus neutralization seems to be the most commonly used serological test, although hemagglutination inhibition assays have also been described in research papers. Cross-reactivity has been reported between Aino virus and other Simbu serogroup viruses in some serological tests, although it is more likely to be an issue when the titers are low. Histopathology is also helpful.

Virological evidence of infection is most likely to be found in fresh fetuses aborted soon after they were infected, but before they have developed an immune response. Aino virus, its nucleic acids and antigens have been detected in

the central nervous system of the fetus. The placenta and fetal skeletal muscle are also reported to be useful samples in cases caused by Akabane virus, a Simbu serogroup virus that causes similar congenital defects. Although most affected fetuses have cleared Akabane virus infections by the time they are born, real-time RT-PCR assays may sometimes find residual nucleic acids in neonatal tissues or the placenta. Whether this is also true for Aino virus has not been published. Published RT-PCR assays for Aino virus include both single tests and multiplex assays that can simultaneously identify other Simbu serogroup viruses that cause reproductive losses. Immunohistochemistry has been used to identify Aino virus antigens in the brain. Virus isolation is also possible. The ability of Simbu serogroup members to exchange gene segments may complicate the development and interpretation of some diagnostic tests.

## Treatment

There is no treatment for animals affected by Aino virus.

## Control

### Disease reporting

A quick response is vital for containing outbreaks in disease-free regions. Veterinarians who encounter or suspect an Aino virus infection 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

Aino virus is not thought to be transmitted between animals except by insect vectors. If this virus is introduced into an area where it is not endemic, care should be taken to prevent it from infecting potential vectors, especially *Culicoides* spp. gnats.

Vaccines for Aino disease are available in Japan. Similar reproductive losses caused by Akabane virus can also be controlled by moving pregnant animals into an endemic area in time to develop immunity before they are first bred. Insect control techniques, including the use of repellents, might be effective for a few days; however, they are ineffective for controlling diseases caused by Simbu serogroup viruses in the long term.

## Morbidity and Mortality

Aino disease is seasonal, although fetal defects can occur months after the insect vectors were active. In one outbreak in Japan, this virus was isolated primarily from July to August, and affected calves were born mainly from November to March. Clinical cases caused by Aino virus are generally thought to be uncommon compared to those caused by other Simbu serogroup viruses; however, it is possible that this disease is underdiagnosed, especially when it affects few animals. There have been reports of

both sporadic infections and severe outbreaks, some potentially involving up to 2000 calves.

Some other Simbu serogroup viruses have varying effects on the fetus, depending on its gestational age when infected. An analysis of one outbreak caused by Aino virus suggested that this virus may affect bovine fetuses between 120 and 180 days of gestation, based on a comparison between the periods when viruses were isolated and when affected calves were born. In an experimental study in cattle, the critical gestational age for congenital malformations appeared to be 132 to 156 days. One experimental study suggests that the fetal infection rate may be low, as all of the calves from five intravenously inoculated cattle were normal. However, 43% of cows with evidence of exposure were affected during one large outbreak in Japan. The mortality rate is high in calves with congenital defects.

## Internet Resources

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/>

## Acknowledgements

This factsheet was written by Anna Rovid Spickler, DVM, PhD, Veterinary Specialist from the Center for Food Security and Public Health. The U.S. Department of Agriculture Animal and Plant Health Inspection Service (USDA APHIS) provided funding for this factsheet through a series of cooperative agreements related to the development of resources for initial accreditation training.

The following format can be used to cite this factsheet. Spickler, Anna Rovid. 2018. *Aino Disease*. Retrieved from <http://www.cfsph.iastate.edu/DiseaseInfo/factsheets.php>.

## References

- Abutarbush SM, La Rocca A, Wernike K, Beer M, Al Zuraikat K, Al Sheyab OM, Talafha AQ, Steinbach F. Circulation of a Simbu serogroup virus, causing Schmallenberg virus-like clinical signs in northern Jordan. *Transbound Emerg Dis*. 2017;64(4):1095-9.
- Agerholm JS, Hewicker-Trautwein M, Peperkamp K, Windsor PA. Virus-induced congenital malformations in cattle. *Acta Vet Scand*. 2015;57:54.

- Ali H, Ali AA, Atta MS, Cepica A. Common, emerging, vector-borne and infrequent abortogenic virus infections of cattle. *Transbound Emerg Dis*. 2012;59(1):11-25.
- Boughton CR, Hawkes RA, Naim HM. Arbovirus infection in humans in NSW: seroprevalence and pathogenicity of certain Australian bunyaviruses. *Aust N Z J Med*. 1990;20(1):51-55.
- Brenner J, Tsuda T, Yadin H, Chai D, Stram Y, Kato T. Serological and clinical evidence of a teratogenic Simbu serogroup virus infection of cattle in Israel, 2001-2003. *Vet Ital*. 2004;40(3):119-23.
- Cybinski DH, St George TD. A survey of antibody to Aino virus in cattle and other species in Australia. *Aust Vet J*. 1978;54(8):371-3.
- De Regge N, Akabane, Aino and Schmallenberg virus-where do we stand and what do we know about the role of domestic ruminant hosts and Culicoides vectors in virus transmission and overwintering? *Curr Opin Virol*. 2017;27:15-30.
- Garner G, Saville P, Fediaevsky A. Manual for the recognition of exotic diseases of livestock: A reference guide for animal health staff [monograph online]. Food and Agriculture Organization of the United Nations [FAO]; 2004. Akabane. Available at: <http://www.spc.int/rahs/Manual/Manuale.html>. \* Accessed 2 Nov 2005.
- Hamana K. Bovine congenital defects caused by an arbovirus of tropical origin. In: The progress report of the 1999 survey of the research project "Social homeostasis of small islands in an island-zone." Kagoshima University Research Center for the Pacific Islands, Occasional Papers. 2001;34:163-7. Available at: <http://cpi.kagoshima-u.ac.jp/occasional/vol-34/34-21.pdf>. \* Accessed 3 Nov. 2005.
- Hubálek Z, Rudolf I, Nowotny N. Arboviruses pathogenic for domestic and wild animals. *Adv Virus Res*. 2014;89:201-75.
- Ishibashi K, Asada K, Shirakawa H, Nakamura H, Watanabe A. Isolation of Aino virus from a cow with astasia and leukopenia. *J Jpn Vet Med Assoc*. 1992;45:837-40.
- Ishibashi K, Shirakawa H, Uchinuno Y, Ogawa T. Seroprevalence survey of Aino virus infection in dairy cattle of Fukuoka, Japan in 1990. *J Vet Med Sci*. 1995;57(1):1-4.
- Kim YH, Oem JK, Lee EY, Lee KK, Kim SH, Lee MH, Park SC. Seroprevalence of five arboviruses in sentinel cattle as part of nationwide surveillance in South Korea, 2009-2012. *Vet Med Sci*. 2015;77(2):247-50.
- Kirkland PD. Akabane virus infection. In: Kahn CM, Line S, Aiello SE, editors. *The Merck veterinary manual* [online]. Whitehouse Station, NJ: Merck and Co. Available at: [http://www.merckvetmanual.com/mvm/generalized\\_conditions/congenital\\_and\\_inherited\\_anomalies/akabane\\_virus\\_infection.html](http://www.merckvetmanual.com/mvm/generalized_conditions/congenital_and_inherited_anomalies/akabane_virus_infection.html). Accessed 2 Jan 2018.
- Kirkland P, Macarthur E. Akabane disease. In: *Foreign animal diseases*. 7th edition. Boca Raton, FL: United States Animal Health Association; 2008. p. 117-23.
- Kitano Y, Ohzono H, Shimizu T. Proliferation and teratogenicity of Aino virus in chick embryos. *Microbiol Immunol*. 1996;40(1):85-8.
- Kitano Y, Ohzono H, Yasuda N, Shimizu T. Hydranencephaly, cerebellar hypoplasia, and myopathy in chick embryos infected with Aino virus. *Vet Pathol*. 1996;33(6):672-81.
- Kitano Y, Yamashita S, Makinoda K. A congenital abnormality of calves, suggestive of a new type of arthropod-borne virus infection. *J Comp Pathol*. 1994;111(4):427-37.

- Kitano Y, Yasuda N, Shimizu T, Ohzono H, Iwamoto T. Teratogenicity of Aino virus in the chick embryo. *Res Vet Sci.* 1997;62(2):195-8.
- Lee JH, Seo HJ, Park JY, Kim SH, Cho YS, Kim YJ, Cho IS, Jeoung HY. Detection and differentiation of Schmallenberg, Akabane and Aino viruses by one-step multiplex reverse-transcriptase quantitative PCR assay. *BMC Vet Res.* 2015;11:270.
- Lim SI, Kweon CH, Tark DS, Kim SH, Yang DK. Sero-survey on Aino, Akabane, Chuzan, bovine ephemeral fever and Japanese encephalitis virus of cattle and swine in Korea. *J Vet Sci.* 2007;8(1):45-9.
- Mathew C, Klevar S, Elbers AR, van der Poel WH, Kirkland PD, Godfroid J, Mdegela RH, Mwamengele G, Stokstad M. Detection of serum neutralizing antibodies to Simbu sero-group viruses in cattle in Tanzania. *BMC Vet Res.* 2015;11:208.
- Noda Y, Uchinuno Y, Shirakawa H, Nagasue S, Nagano N, Ohe R, Narita M. Aino virus antigen in brain lesions of a naturally aborted bovine fetus. *Vet Pathol.* 1998;35(5):409-11.
- Parsonson IM, Della-Porta AJ, MaPhee DA. *Viral disease in Southeast Asia and the western Pacific.* Victoria, Australia: Academic Press; 1982. Pathogenesis and virulence studies of Australian Simbu serogroup Bunyaviruses; pp. 644-7.
- Public Health Agency of Canada (PHAC). Pathogen Safety Data Sheet – Crimean-Congo hemorrhagic fever virus. Pathogen Regulation Directorate, PHAC; 2011 Nov. Available at: <http://www.phac-aspc.gc.ca/lab-bio/res/psds-ftss/crim-congo-eng.php>. Accessed 2 Jan 2018.
- Shirafuji H, Yazaki R, Shuto Y, Yanase T, Kato T, Ishikura Y, Sakaguchi Z, Suzuki M, Yamakawa M. Broad-range detection of arboviruses belonging to Simbu serogroup lineage 1 and specific detection of Akabane, Aino and Peaton viruses by newly developed multiple TaqMan assays. *J Virol Methods.* 2015;225:9-15.
- Sugiyama I, Shimizu E, Nogami S, Suzuki K, Miura Y, Sentsui H. Serological survey of arthropod-borne viruses among wild boars in Japan. *J Vet Med Sci.* 2009;71(8):1059-61.
- Tsuda T, Yoshida K, Ohashi S, Yanase T, Sueyoshi M, Kamimura S, Misumi K, Hamana K, Sakamoto H, Yamakawa M. Arthrogryposis, hydranencephaly and cerebellar hypoplasia syndrome in neonatal calves resulting from intrauterine infection with Aino virus. *Vet Res.* 2004;35(5):531-8.
- Uchinuno Y, Noda Y, Ishibashi K, Nagasue S, Shirakawa H, Nagano M, Ohe R. Isolation of Aino virus from an aborted bovine fetus. *J Vet Med Sci.* 1998;60(10):1139-40.
- University of Nebraska. Selection and use of disinfectants [monograph online]. Nebraska Cooperative Extension G00-1410-A. Lincoln, Nebraska: University of Nebraska; 2001. Available at: <http://ianrsearch.unl.edu/pubs/animaldisease/g1410.htm>. \* Accessed 7 Nov 2005.
- Ushigusa T, Uchida K, Murakami T, Yamaguchi R, Tateyama S. A pathologic study on ocular disorders in calves in southern Kyushu, Japan. *J Vet Med Sci.* 2000;62(2):147-52.
- Wang J, Blasdell KR, Yin H, Walker PJ. A large-scale serological survey of Akabane virus infection in cattle, yak, sheep and goats in China. *Vet Microbiol.* 2017;207:7-12.
- Yamakawa M, Yanase T, Kato T, Tsuda T. Molecular epidemiological analyses of the teratogenic Aino virus based on the sequences of a small RNA segment. *Vet Microbiol.* 2008;129(1-2):40-7.
- Yanase T, Aizawa M, Kato T, Yamakawa M, Shirafuji H, Tsuda T. Genetic characterization of Aino and Peaton virus field isolates reveals a genetic reassortment between these viruses in nature. *Virus Res.* 2010;153(1):1-7.
- Yanase T, Kato T, Kubo T, Yoshida K, Ohashi S, Yamakawa M, Miura Y, Tsuda T. Isolation of bovine arboviruses from *Culicoides* biting midges (Diptera: Ceratopogonidae) in southern Japan: 1985-2002. *J Med Entomol.* 2005;42(1):63-7.
- Yang DK, Hwang IJ, Kim BH, Kweon CH, Lee KW, Kang MI, Lee CS, Cho KO. Serosurveillance of viral diseases in Korean native goats (*Capra hircus*). *J Vet Med Sci.* 2008;70(9):977-9.
- Yang DK, Kim BH, Kweon CH, Nah JJ, Kim HJ, Lee KW, Yang YJ, Mun KW. Serosurveillance for Japanese encephalitis, Akabane, and Aino viruses for Thoroughbred horses in Korea. *J Vet Sci.* 2008;9(4):381-5.
- Yoshida K, Ohashi S, Kubo T, Tsuda T. Comparison of intertypic antigenicity of Aino virus isolates by dot immunobinding assay using neutralizing monoclonal antibodies. *J Clin Microbiol.* 2000;38(11):4211-4.

\* Link is defunct