

Sheep & Goat Pox

Capripoxvirus Infection

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the Center for
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Importance

Sheep and goat pox are contagious viral diseases of small ruminants. These diseases may be mild in indigenous breeds living in endemic areas, but are often fatal in newly introduced animals. Economic losses result from decreased milk production, damage to the quality of hides and wool, and other production losses. Sheep and goat pox can limit trade and prevent the development of intensive livestock production. They may also prevent new breeds of sheep or goats from being imported into endemic regions. The agents of sheep and goat pox could be used in agroterrorism, and are listed in the USDA National Select Agent Registry.

Etiology

Sheep pox and goat pox result from infection by sheeppox virus (SPV) or goat-pox virus (GPV), closely related members of the *Capripox* genus in the family Poxviridae. Most isolates are host specific, with SPV mainly causing disease in sheep and GPV predominantly affecting goats. However, some isolates can cause serious disease in both species. SPV and GPV cannot be distinguished from each other with serological techniques (including serum neutralization), and were once thought to be strains of a single virus. Genetic sequencing has now demonstrated that these viruses are distinct, but recombination can occur between them. Recombinant strains usually have intermediate host specificity.

SPV and GPV are closely related to the virus that causes lumpy skin disease in cattle (LSDV). The relationships between these three capripoxviruses are still being established, but one recent analysis suggests that GPV and LSDV are more closely related to each other than SPV is to LSDV.

Species Affected

Sheep and goat capripoxviruses cause disease only in these two species. Many SPV isolates are specific for sheep, and many GPV strains are specific for goats, but some strains of these viruses readily affect both species. Infections have not been reported in wild ungulates.

Geographic Distribution

Sheep pox and goat pox are found in parts of Africa and Asia, the Middle East, and most of the Indian subcontinent.

Transmission

SPV and GPV are often transmitted by the respiratory route during close contact, but they may also enter the body through other mucous membranes or abraded skin. These viruses can be found in saliva, nasal and conjunctival secretions, milk, urine and feces, as well as in skin lesions and their scabs. Ulcers on the mucous membranes are important sources of virus. Whether SPV and GVP can be transmitted in semen or embryos has not been established. Animals are most contagious before neutralizing antibodies develop, which occurs approximately a week after the onset of clinical signs. Experimentally infected sheep and goats can shed poxviruses in nasal, conjunctival and oral secretions for 1 to 2 months, but shedding peaks during the second week after inoculation, then declines rapidly. Chronically infected carriers are not seen.

SPV and GPV can also be spread on fomites or transmitted mechanically by insects such as stable flies (*Stomoxys calcitrans*), although the latter route may be uncommon. These viruses can remain infectious for up to six months in shaded sheep pens. They may also be found on the wool or hair for as long as three months after infection, and possibly longer in scabs. Whether the viruses in scabs are infectious is unknown; these viruses are complexed with antibodies and can be difficult to recover on tissue culture media.

Incubation Period

The incubation period varies from four to 21 days, but it is usually 1 to 2 weeks. Clinical signs generally appear sooner when the virus is inoculated by insects than when it is transmitted in aerosols. After experimental inoculation into the dermis, primary lesions can develop at the site within 2 to 4 days.

Clinical Signs

The clinical signs vary from mild to severe, depending on the animal's age, breed, immunity and other factors. Inapparent infections also occur.

In affected animals, an initial fever is usually followed in one to five days by the characteristic skin lesions, which begin as erythematous macules, and develop into 0.5-1.5 cm hard papules. In the common, papulovesicular form of the disease, the centers of the papules become depressed, whitish gray and necrotic, and are surrounded by an area of hyperemia. Dark, hard, sharply demarcated scabs eventually form over the necrotic areas. Vesicles might be seen during the intermediate stage, but are uncommon. In the uncommon, nodular form of the disease ('stonepox'), the papules develop into nodules. These nodules can be found in the epidermis, dermis and subcutaneous tissues. They become necrotic and slough, leaving a hairless scar. Some European breeds of goats may develop a flat hemorrhagic form of goat pox. In this form, the papules seem to coalesce over the body, and the animal invariably dies. Capripox lesions have a predilection for areas of sparsely woolled/ haired skin such as the axillae, muzzle, eyelids, ears, mammary gland and inguinal area, but in more severe cases, they may cover the body. In animals with heavy wool, the lesions can be easier to find by palpation than visual inspection. Mild infections can easily be missed; only a few lesions may be present, often around the ears or the tail. All superficial lymph nodes usually become enlarged within a day of the appearance of generalized papules; the prescapular lymph nodes are particularly noticeable.

Lesions can also develop on the mucous membranes and internal organs, causing systemic signs. In some cases, these symptoms may precede the onset of skin lesions by a day or two. Lesions in the mouth, nares, eyes or eyelids can cause salivation or inappetence, as well as rhinitis, conjunctivitis or blepharitis with mucopurulent discharges. Affected mucous membranes may become necrotic and ulcerate or slough. Animals with lung lesions may have respiratory signs including coughing, nasal discharge and dyspnea. Nodules in the intestines can cause diarrhea. Depression and emaciation may be seen in some animals. Abortions can occur but are not common. Some breeds of sheep can die of acute disease before the characteristic skin lesions appear.

Capripox lesions can take several weeks to heal, and may leave permanent scars on the skin. During healing, they are susceptible to fly strike. Secondary bacterial infections, including pneumonia, are common, and death can occur at any stage of the disease. Recovery can be slow if the animal was severely affected.

Post Mortem Lesions [Click to view images](#)

The skin usually contains macules, papules and/or necrotic lesions and scabs, surrounded by areas of edema, hemorrhage and congestion. The papules penetrate

through both the dermis and epidermis; in severe cases, they may extend into the musculature. Skin lesions may not be as apparent at necropsy as they are in living animals. The mucous membranes of the eyes, nose, mouth, vulva and prepuce may be necrotic or ulcerated. The lungs often contain congested, edematous or consolidated areas, and firm gray or white nodules. Nodules in the lungs can be up to 5 cm in diameter, and are particularly common in the diaphragmatic lobes. In early stages of the disease, they may appear as red spots. Papules or ulcerated papules are common on the abomasal mucosa. They may also be found on the rumen, large intestine, pharynx, trachea and esophagus. Pale, discrete subcapsular foci are sometimes present on the surface of the kidney, liver and testes. Lymph nodes throughout the body are usually enlarged and edematous, and may be congested and hemorrhagic.

Morbidity and Mortality

Morbidity and mortality vary with the breed of the animal, its immunity to capripoxviruses, and the strain of the virus. Mild infections are common among indigenous breeds in endemic areas, but more severe disease can be seen in young or stressed animals, animals with concurrent infections, or animals from areas where pox has not occurred for some time. Reported morbidity rates in indigenous breeds range from 1% to 75% or higher. Although the mortality rate is often less than 10%, case fatality rates of nearly 100% have been reported in some young animals.

Imported breeds of sheep and goats usually develop severe disease when they are moved into an endemic area. The morbidity and mortality rates can approach 100% in newly imported, highly susceptible flocks.

Diagnosis

Clinical

Sheep or goat pox should be suspected in febrile animals with the characteristic full-thickness skin lesions and enlarged lymph nodes. Dyspnea, conjunctivitis, nasal discharges and other signs may also be seen. The mortality rate is usually high in naïve animals. Although sheep pox and goat pox are usually distinctive in fully susceptible animals, these diseases can be subtler and more difficult to diagnose in indigenous animals.

Differential diagnosis

The differential diagnoses include contagious ecthyma (contagious pustular dermatitis), bluetongue, dermatophilosis/ streptothricosis, mange (e.g., psoroptic mange/sheep scab), photosensitization or urticaria, peste des petits ruminants, parasitic pneumonia, multiple insect bites and caseous lymphadenitis.

Laboratory tests

Sheep or goat pox can be tentatively diagnosed by electron microscopy; because the morphology of the virus

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particle is characteristic, capripoxviruses can be differentiated from most poxviruses that cause lesions in small ruminants. Histopathology can also be helpful.

A definitive diagnosis can be made by recovering the causative viruses. SPV and GPV can be isolated in lamb testis, sheep or goat kidney cell cultures, as well as in other (less sensitive) sheep, goat or bovine cell lines. Inhibition of the cytopathic effect (CPE) by specific antibodies in the medium provides presumptive identification. Capripoxviruses can be identified to at least the genus level by immunofluorescence or immunoperoxidase staining, nucleic acid recognition methods and other techniques. In some circumstances, these viruses have also been recovered by inoculation into sheep or goats.

Polymerase chain reaction (PCR) assays can detect capripoxvirus genomes in tissue samples or cultures, but cannot identify whether the virus is SPV or GPV. However, these two viruses can be distinguished if PCR is combined with a restriction fragment length polymorphism (RFLP) assay. Recombination between SPV and GPV can complicate identification of the virus.

Viral antigens can be detected in tissues by agar gel immunodiffusion (AGID) or various enzyme-linked immunosorbent assays (ELISAs). Counter-immunoelectrophoresis, latex agglutination and indirect agglutination tests (reverse-phase passive hemagglutination, coagglutination, passive hemagglutination and spot agglutination) have also been used. In the AGID test, cross-reactions occur between capripoxviruses and parapoxviruses; however, these two groups of viruses can be distinguished with electron microscopy.

Serology can identify GPV and SPV as capripoxviruses, but cannot distinguish these two viruses from each other. Antibodies to capripoxviruses can be found approximately one week after the skin lesions appear. Serological tests include virus neutralization, AGID, the indirect fluorescent antibody test (IFA), ELISAs and immunoblotting (Western blotting). Virus neutralization is the most specific serological test, but it is not sensitive enough to detect infections in all animals. Cross-reactions occur with other viruses in the AGID and IFA tests.

Samples to collect

Before collecting or sending any samples from animals with a suspected foreign animal disease, the proper authorities should be contacted. Samples should only be sent under secure conditions and to authorized laboratories to prevent the spread of the disease.

In live animals, biopsies of skin lesions should be taken for virus isolation and antigen detection. SPV and GPV can also be found in vesicular fluid, scabs and scrapings of skin lesions, as well as lymph node aspirates and blood (collected into heparin or EDTA). At necropsy, samples should be collected from skin lesions, lymph nodes and lung lesions. An additional set of samples

should be taken for histology; these samples should include a wide range of lesions from the skin, as well as spleen, rumen, trachea, lungs and other affected tissues. PCR can detect capripoxviruses in blood, nasal or oral swabs, scabs, skin lesions and tissue samples. Neutralizing antibodies can interfere with virus isolation and some antigen-detection tests; samples for these tests must be collected during the first week of illness. Samples for PCR can be taken after neutralizing antibodies have developed. Paired serum samples should be collected for serology.

Samples for virus isolation must be sent to the laboratory as soon as possible. They should be kept cold and shipped on wet ice or gel packs. If these samples must be shipped long distances without refrigeration, glycerol (10%) can be added; the tissue samples must be large enough that the medium does not penetrate into the center of the tissue and destroy the viruses there.

Recommended actions if sheep pox or goat pox is suspected

Notification of authorities

Sheep or goat pox must be reported immediately to state or federal authorities.

Federal: Area Veterinarians in Charge (AVIC):

http://www.aphis.usda.gov/animal_health/area_offices/

State Veterinarians:

<http://www.aphis.usda.gov/vs/sregs/official.html>

Control

Capripoxviruses are most likely to be introduced in infected animals, but fomites and animal products such as wool can also spread disease. Outbreaks can be controlled by quarantines, movement controls, and depopulation of infected and exposed animals, followed by stringent cleaning and disinfection of farms and equipment. Proper disposal of infected carcasses is important; burning or burial is often used. Capripoxviruses may persist for up to 6 months in shaded, uncleaned pens and for at least a few months in dry scabs on skin, fleece and hair. Poxviruses are resistant to drying, and can also survive freeze/thaw cycles, although the infectivity may be reduced. When the disease has spread more widely, vaccination may also be considered.

Capripoxviruses are reported to be destroyed by heating to 56°C (133°F) for 2 hours, or to 65°C (149°F) for 30 minutes. Heat sensitivity may vary between strains of capripoxviruses; 56°C for one hour can inactivate some isolates, but does not significantly reduce the titer of others. Capripoxviruses are generally sensitive to ether (20%), formalin and chloroform, although some strains were resistant to ether in studies done in the 1940s. Capripoxviruses are also reported to be susceptible to sodium hypochlorite, detergents that contain lipid solvents,

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hydrochloric acid (2% for 15 minutes), sulphuric acid (2% for 15 minutes) and phenol.

Infection results in good immunity, and vaccination is used to control sheep and goat pox in endemic areas. In these regions, new animals should be quarantined before adding them to the flock or herd. Infected herds and sick animals should be isolated for at least 45 days after they have recovered from clinical signs. In some outbreaks, the herd may be culled.

Public Health

SPV and GPV do not appear to infect humans. Two published cases suggested that capripoxviruses might be transmitted to humans, but these reports are questionable.

For More Information

The Merck Veterinary Manual

<http://www.merckvetmanual.com/mvm/index.jsp>

United States Animal Health Association.

Foreign Animal Diseases

http://www.vet.uga.edu/vpp/gray_book02/fad/index.php

World Organization for Animal Health (OIE)

<http://www.oie.int>

OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals

http://www.oie.int/eng/normes/mmanual/A_summry.htm

OIE Terrestrial Animal Health Code

http://www.oie.int/eng/normes/mcode/en_sommaire.htm

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*Link defunct as of 2008