

# Ovine Pulmonary Adenocarcinoma

*Ovine Pulmonary Adenomatosis,  
Ovine Pulmonary Carcinoma,  
Jaagsiekte,  
Sheep Pulmonary Adenomatosis*

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## Importance

Ovine pulmonary adenocarcinoma is a contagious viral disease of sheep that results in pulmonary neoplasia in some animals. The economic impact can be significant: up to 80% of the flock can be lost upon first exposure to the virus, with continuing losses that may be as high as 20% each year in some flocks. Excluding this disease from a flock is difficult, in part because no diagnostic test can detect animals in the preclinical stage. No effective treatment or vaccine is available, and eradication is challenging. Currently, ovine pulmonary adenomatosis exists in most sheep-raising areas of the world, with the exception of New Zealand and Australia. Iceland is the only country to have successfully eradicated this disease.

## Etiology

Ovine pulmonary adenocarcinoma results from infection by jaagsiekte sheep retrovirus (JSRV), which is also known as the pulmonary adenomatosis virus. This virus is a member of the genus *Betaretrovirus* in the Retroviridae.

## Species Affected

Ovine pulmonary adenocarcinoma mainly affects domesticated sheep (*Ovis aries*). Sardinian mouflon (*Ovis musimon*, a species of wild sheep) can also become ill, and a few cases have been reported in domesticated goats.

## Geographic Distribution

Ovine pulmonary adenocarcinoma can be found in sheep-raising countries in Europe, Africa, Asia and the Americas. This disease does not occur in Australia or New Zealand. It has been eradicated from Iceland.

## Transmission

Ovine pulmonary adenocarcinoma can be transmitted by the respiratory route, probably via aerosols or droplets. Infectious virus occurs in the respiratory exudates of infected sheep. Jaagsiekte sheep retrovirus can be found in tumors, lung fluids, peripheral blood leucocytes and lymphoid organs; before tumors develop, the virus is detected in lymphoreticular cells. Horizontal transmission has been demonstrated among sheep of all ages, but neonates seem to be particularly susceptible to infection. There is no evidence that *in utero* transmission is significant in the epidemiology of this disease; however, recent studies suggest that JSRV might be spread in milk or colostrum. Jaagsiekte sheep retrovirus does not survive for long periods in the environment.

## Incubation Period

The incubation period in naturally infected animals is reported to be six months to three years. It appears to be age-dependent, and is longer in older sheep. In one experiment, 1-week-old lambs developed clinical signs in 70 to 74 days, 1-month-old lambs in 92 to 209 days, and 1 to 6 month-old lambs in approximately 160 days or longer. Experimentally infected adult sheep become ill in several months to years.

## Clinical Signs

Clinical signs occur only in animals that have developed tumors. The signs may include progressive emaciation, weight loss and respiratory compromise, particularly after exercise. Affected sheep often lag behind the flock. There is usually a thin mucus discharge from the nostrils, and if the head is lowered, a copious frothy exudate may pour from the nares. Moist rales may be heard on auscultation, but coughing is not usually prominent. The clinical signs are slowly progressive, ending in severe dyspnea. Death usually occurs in days to a few months, often from secondary bacterial pneumonia.

## Post Mortem Lesions

The lungs are usually enlarged in animals with tumors, and in advanced cases, they do not collapse upon opening the chest cavity. Frothy fluid may be seen in the trachea and bronchi. Tumors are found in the lungs, particularly in the apical, cardiac

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and ventral portions of the diaphragmatic lobes. They vary from small nodules to solid masses, and are sharply demarcated, firm, and gray or pinkish-gray. On cut surface, the tumors are glistening and granular; a frothy fluid may be expressed. Secondary pneumonia and fibrinous pleuritis are often found. Tumor metastasis usually occurs only to nearby lymph nodes.

Atypical cases that have solitary or aggregated hard white nodules with a dry cut surface can also be seen. These tumors are usually clearly demarcated, and excess fluid in the lungs is not a prominent feature.

## Morbidity and Mortality

Most cases of ovine pulmonary adenocarcinoma occur in sheep over the age of two years; the peak incidence is in 3- to 4-year-old animals. This disease is rare in sheep less than 7 to 9 months of age. Once tumors appear, cases always end in death. Recently infected flocks have high morbidity and mortality rates, with up to 80% of the flock dying of tumors. When JSRV has been present longer, the annual rate of loss is usually 2-5%, although losses up to 20% have been reported on some farms. The incidence of infection is much higher than the morbidity rate; most sheep in an infected flock do not develop tumors during their commercial lifespan.

## Diagnosis

### Clinical

Ovine pulmonary adenocarcinoma should be suspected in sheep with chronic respiratory signs, particularly in 2- to 4-year-old animals with a frothy mucoid discharge from the nostrils. The “wheelbarrow test” – raising the hind legs to lower the head of the animal – can be used to check for excess fluid in the lungs. This test does not detect all sheep with tumors. Early cases are difficult to distinguish from other respiratory diseases.

### Differential diagnosis

The differential diagnosis includes maedi-visna, bacterial pneumonia and infestation by lungworms. In the early clinical stages, ovine pulmonary adenocarcinoma is difficult to distinguish from many respiratory diseases.

### Laboratory tests

Jaagsiekte sheep retrovirus cannot be recovered in culture. No reliable antemortem test exists, and in living animals, ovine pulmonary adenocarcinoma is often diagnosed using clinical signs combined with flock history. At necropsy, the diagnosis is based on gross lesions, histopathology, and testing to detect viral antigens or RNA. Immunohistochemistry, immunoblotting and polymerase chain reaction (PCR) assays can detect JSRV antigens or RNA in tumors and lung fluids. An ELISA to detect antigens has been described in the literature, but it is not available in diagnostic laboratories.

Immunohistochemistry can occasionally identify JSRV antigens in the draining lymph nodes of animals with tumors, but only PCR can reliably detect this virus in the lymphoreticular system. Animals without tumors carry a much lower viral burden than those that are ill. PCR can detect jaagsiekte sheep retrovirus in the peripheral blood mononuclear cells of subclinically infected animals, as well as in colostrum and milk. It might become a flock test in the future. PCR is also promising for antemortem diagnosis of clinical cases using bronchoalveolar lavage samples.

Serology is not helpful, as infected animals do not produce antibodies to this virus.

### Samples to collect

Samples of affected lungs and regional lymph nodes should be collected. Specimens should be taken from several locations. Secondary bacterial pneumonia can mask the lesions, and if possible, ovine pulmonary adenocarcinoma should be confirmed in more than one sheep. Duplicate samples should also be collected for histopathology.

## Recommended actions if ovine pulmonary adenocarcinoma is suspected

### Notification of authorities

Ovine pulmonary adenocarcinoma is a reportable disease in many states. Specific guidelines should be consulted for each state.

Federal: Area Veterinarians in Charge (AVIC):

[http://www.aphis.usda.gov/animal\\_health/area\\_offices/](http://www.aphis.usda.gov/animal_health/area_offices/)

State Veterinarians:

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

## Control

Ovine pulmonary adenocarcinoma is usually introduced into a flock in an infected sheep, often one that is subclinically infected. Because there is no diagnostic test to detect these animals, preventing entry is difficult. Herd replacements should be bought only from flocks with no history of ovine pulmonary adenomatosis; however, this does not ensure that the animals are free of jaagsiekte sheep retrovirus, as the incubation period is long. There is no effective treatment for animals with lung tumors, and no known method to prevent the infection from progressing to this stage. No vaccine is available.

Removing affected sheep and the offspring of infected ewes may reduce losses, but it cannot eradicate the disease from a flock. Embryo transfer can be used to save the genetic potential from flocks that are euthanized. A recent study suggests that ovine pulmonary adenomatosis may also be significantly reduced or eradicated by removing lambs at birth and hand-rearing them with colostrum substitutes or cow colostrum,

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followed by milk replacer. Good disinfection and general hygiene should be used when handling the lambs, and they should be placed in an uncontaminated environment. Retroviruses are fragile in the environment, and they are susceptible to most common disinfectants. Ovine pulmonary adenocarcinoma was eradicated from Iceland by slaughtering all sheep in affected areas.

## Public Health

Antibodies against jaagsiekte sheep retrovirus can recognize some human bronchoalveolar carcinomas. A recent study suggests that this phenomenon might be due to a cross-reaction with another retrovirus, possibly a human endogenous retrovirus.

## Internet Resources

- Food and Agriculture Organization of the United Nations (FAO). Manual for the Recognition of Exotic Diseases of Livestock  
<http://www.spc.int/rahs/>
- 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>
- 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](http://www.oie.int/eng/normes/mmanual/a_summry.htm)
- OIE Terrestrial Animal Health Code  
[http://www.oie.int/eng/normes/mcode/A\\_summry.htm](http://www.oie.int/eng/normes/mcode/A_summry.htm)

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