

# Diseases Caused by the Epizootic Hemorrhagic Disease Virus Serogroup

*Epizootic Hemorrhagic Disease,  
Hemorrhagic Disease,  
Ibaraki Disease*

**Last Updated:** March 28, 2006



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## Importance

Epizootic hemorrhagic disease (EHD) is one of the most important diseases of deer in North America. The epizootic hemorrhagic disease viruses (EHDV) are widespread in white-tailed deer and periodically cause serious epidemics in wild populations.

Some of these viruses can also cause disease in cattle. In the U.S., EHD in cattle is uncommon, rarely fatal, and usually associated with an epidemic in deer. However, an EHDV serogroup virus called the Ibaraki virus causes serious epidemics in Japan, Korea, and Taiwan that may affect as many as 39,000 cattle. The disease caused by the Ibaraki virus is known as Ibaraki disease; some authorities consider it to be a synonym for epizootic hemorrhagic disease in cattle.

## Etiology

The epizootic hemorrhagic disease viruses belong to the genus *Orbivirus*, family *Reoviridae*. Ten serotypes of EHDV are known worldwide.

The Ibaraki virus is closely related to EHDV. According to some authors, it is a distinct virus belonging to the EHDV serogroup. According to others, the Ibaraki virus and the Australian (but not the American) EHDV serotype 2 are nearly identical topotypes. There is more than one strain of the Ibaraki virus.

## Species affected

The epizootic hemorrhagic disease viruses can infect most wild and domestic ruminants. Clinical signs are seen mainly in white tailed deer, with mule deer and pronghorn antelope affected to a lesser extent. Other wild animals found to be seropositive include black-tailed deer, red deer, wapiti, fallow deer, and roe deer. Rare outbreaks of EHD have been reported in cattle. Sheep can be infected experimentally but rarely develop clinical signs, and goats do not seem to be susceptible to infection.

Ibaraki disease is seen in cattle.

## Geographic distribution

Epizootic hemorrhagic disease occurs in North America, Australia, Asia and Africa. Seropositive animals have been found in South America. Of the ten serotypes known worldwide, the only two serotypes currently endemic in North America are EHDV-1 and EHDV-2.

Ibaraki disease has been reported from Japan, Korea, and Taiwan. Seropositive animals have also been found in Australia and Indonesia.

## Transmission

The viruses of the EHDV serogroup are transmitted by biological vectors, usually biting midges in the genus *Culicoides*. In North America, *C. variipennis* is the major vector. Some species of gnats and mosquitoes can also transmit EHDV. Infected deer can be viremic for up to 2 months.

## Incubation period

The incubation period for epizootic hemorrhagic disease in deer is 5 to 10 days.

## Clinical signs

### Deer

Three syndromes may be seen in deer. Peracute disease is characterized by high fever, anorexia, weakness, respiratory distress, and severe and rapid edema of the head and neck. Swelling of the tongue and conjunctivae is common. Deer with the peracute form usually die rapidly, typically within 8-36 hours; some animals may be found dead with few clinical signs. In the acute form (classical EHD), these symptoms may be accompanied by extensive hemorrhages in many tissues including the skin, heart, and gastrointestinal tract. There is often excessive salivation and nasal discharge, which may both be blood-tinged. Animals with the acute form can also develop ulcers or erosions of the tongue, dental pad, palate, rumen, and omasum. High mortality rates are common in both the peracute and acute forms.

In the chronic form, deer are ill for several weeks but gradually recover. After recovery, these deer sometimes develop breaks or rings in the hooves caused by growth inter-

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ruptions, and may become lame. In severe cases, animals slough the hoof wall or toe; some of these deer may be found crawling on their knees or chest. Deer with the chronic form may also develop ulcers, scars, or erosions in the rumen; extensive damage to the lining of the rumen can cause emaciation even when there is no shortage of food.

## Cattle

Ibaraki disease in cattle is characterized by fever, anorexia, and difficulty swallowing. The swallowing disorders are caused by damage to the striated muscles of the pharynx, larynx, esophagus and tongue, and may lead to dehydration, emaciation, and aspiration pneumonia. Edema, hemorrhages, erosions, and ulcerations may be seen in the mouth, on the lips, and around the coronets. The animals may be stiff and lame, and the skin may be thickened and edematous. Abortions and stillbirths have also been reported in some epidemics. Some affected cattle die.

Outside Japan, Korea and Taiwan, most EHDV infections in cattle appear to be subclinical. Symptomatic infections resemble Ibaraki disease, but tend to be less severe. Typical symptoms include fever, oral ulcers, salivation, lameness associated with coronitis, and weight loss. In pregnant cows, the fetus may be resorbed or develop hydranencephaly if it is infected between 70 and 120 days of gestation. Deaths are uncommon with the North American strains of EHDV; however, some animals may be lame and unthrifty for a prolonged period. Epizootic hemorrhagic disease has not been reproduced in experimentally infected cattle; although animals become viremic, they remain asymptomatic.

## Other species

Sheep can be infected by EHDV but rarely develop symptoms. Experimentally infected goats do not become viremic.

## Post mortem lesions

### Deer

In deer, the lesions of epizootic hemorrhagic disease vary with the form of the disease. In the peracute form, there may be severe edema of the head, neck, eyes, and lungs. In the acute form, widespread hemorrhages and edema can be seen in the many parts of the body including the mucous membranes, skin and viscera, particularly the heart and gastrointestinal tract. There may also be erosions and ulcerations in the mouth, rumen, and omasum. Dry, gray-white necrotic lesions can sometimes be found in the hard palate, tongue, dental pads, esophagus, larynx, rumen, and abomasum. The lesions of the chronic form may include rings or breaks on the hooves, or sloughing of the tips or walls of the hooves. Deer with chronic disease can also develop ulcers, scars, or erosions in the rumen.

Histopathologic lesions may include widespread vasculitis with thrombosis, endothelial swelling, hemorrhages, degenerative changes, and necrosis in many organs.

## Cattle

Ibaraki disease is characterized by degeneration of the striated muscles in the esophagus, larynx, pharynx, tongue, and skeletal muscles. There may be marked edema and hemorrhages in the mouth and lips, abomasum, and around the coronets. Erosions or ulcerations may also be present. Signs of aspiration pneumonia may be seen, and the carcass may be emaciated and dehydrated.

## Morbidity and Mortality

### Deer

In North America, most outbreaks of epizootic hemorrhagic disease occur in late summer or early autumn, and are often associated with wet weather. The onset of freezing weather usually stops the appearance of new cases, but hoof sloughing can be seen throughout the year.

Among the Cervidae, epizootic hemorrhagic disease is most severe in white-tailed deer. In this species, the morbidity and mortality rates may be as high as 90%. However, the severity of the disease varies from year to year. It also varies with the geographic location. In the southeastern U.S., most cases are mild and the mortality rates are low. In the Midwest and Northeast, EHD typically recurs each year, but can vary from a few scattered cases to severe epizootics with high mortality rates. This variability is thought to be caused by many factors including the abundance and distribution of the insect vectors, the EHDV serotype, existing herd immunity, and genetic variations in the susceptibility of the host.

Surviving deer develop long-lived neutralizing antibodies. Nearly 100% of the deer population can be seropositive in some regions.

## Cattle

Outbreaks of Ibaraki disease are seen periodically in Japan, Korea and Taiwan. These outbreaks usually occur in the late summer and autumn, and can be severe. In Japan, some epidemics have affected up to 39,000 cattle. The mortality rate may be as high as 10%.

Rare outbreaks of epizootic hemorrhagic disease have also occurred in North American cattle, in conjunction with epidemics in deer. The morbidity rate can be as high as 5%, but most cattle recover within a few weeks. Deaths are uncommon. Most infections with the North American strains of EHDV appear to be subclinical and seropositive cattle may be common in some regions.

## Diagnosis

### Clinical

Acute or peracute EHD should be suspected in deer with swelling of the head and neck, respiratory distress, or excessive blood-tinged salivation. This disease should also be considered in cases of sudden death, particularly when the animal is found dead near water (an indication of high fever). Chronic disease can be the cause of hoof abnormalities and emaciation.

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Ibaraki disease or EHD should be suspected in cattle with symptoms of fever, lameness, oral erosions or difficulty swallowing, particularly in late summer or fall.

## Differential diagnosis

In deer, the differential diagnosis includes foot-and-mouth disease, bluetongue, and plant photosensitization. A hemorrhagic disease caused by an adenovirus has also been described in deer in California.

## Laboratory tests

In deer, EHDV infections should be confirmed by virus isolation, immunofluorescence, or molecular techniques. EHDV can be isolated in a variety of cell lines or embryonated chicken eggs. Immunofluorescence can be used to identify the virus in frozen tissue sections. Molecular techniques including reverse transcriptase polymerase chain reaction (RT-PCR) tests, dot blot or *in situ* hybridization may also be used. Viral RNA can sometimes be found in deer tissues for up to 160 days. As many deer have pre-existing antibodies to EHDV, serology is less useful than detection of the virus. Serologic tests in deer include enzyme-linked immunosorbent assays (ELISA), serum neutralization, and agar gel immunodiffusion (AGID).

Ibaraki virus can be isolated in eggs or bovine cell cultures, including primary cultures of bovine, sheep or hamster lung origin, and L cells. This virus can also be isolated by intracerebral inoculation of mice. Serology, using paired serum samples, may be useful. EHDV infections in North American cattle have been diagnosed by RT-PCR, virus isolation, or serology using paired serum samples.

## Samples to collect

In deer, the preferred tissues for virus isolation are spleen, lymph node, and unclotted whole blood in EDTA or heparin. Other useful samples may include serum (for serology), liver, and lung. Both fresh and fixed tissues should be collected if possible. Samples for virus isolation should be transported under refrigeration.

In cattle, blood should be collected into anticoagulant (calcium citrate, EDTA, or heparin) and sent chilled for virus isolation or RT-PCR. Paired serum samples should also be collected if possible.

## Recommended actions if epizootic hemorrhagic disease is suspected

### Notification of authorities

Although epizootic hemorrhagic disease is endemic in the U.S., it is a reportable disease in some states. State authorities should be consulted for more specific information. Only EHDV-1 and EHDV-2 are currently found in the U.S.

### Quarantine and disinfection

Viruses of the EHDV serogroup are transmitted between animals by *Culicoides* vectors and are not directly conta-

gious. There are few practical measures to prevent infection; however, vector controls such as modifying the environment to reduce *Culicoides* breeding areas, spraying with insecticides or larvacides, and using insect repellents could theoretically decrease the risk of infection.

Effective disinfectants for EHDV serogroup viruses include acids, oxidizing agents such as sodium or calcium hypochlorite at 20,000-30,000 ppm (2-3%), alkalis such as sodium hydroxide at 2% (w/v), or glutaraldehyde at 2% (w/v). These viruses are, like most nonenveloped viruses, resistant to lipid solvents. They can be inactivated by heat treatment at 50°C for 3 hours, 60°C for 15 minutes, or 121°C for 15 minutes.

No vaccines are available for most EHDV viruses; however, a live attenuated Ibaraki disease vaccine is used in Japan.

## Public health

None of the epizootic hemorrhagic disease viruses, including Ibaraki virus, are known to infect humans.

## Internet Resources

- Fact Sheet - Hemorrhagic Disease in White-tailed Deer  
Maryland Department of Natural Resources  
<http://www.dnr.state.md.us/wildlife/hdfacts.asp>
- International Veterinary Information Service (IVIS)  
<http://www.ivis.org>
- Iowa State University Investigation of the Potential Effects of Epizootic Hemorrhagic Disease Virus on Iowa Cattle. A.S. Leaflet R1767.  
<http://www.extension.iastate.edu/Pages/ansci/beefreports/asl1767.pdf>.
- Epizootic hemorrhagic disease. Pathogen Safety Data Sheets - Canadian Food Inspection Agency  
<http://www.inspection.gc.ca/english/sci/bio/epizooe.shtml>
- USAHA Foreign Animal Diseases Book  
[http://www.vet.uga.edu/vpp/gray\\_book/FAD/](http://www.vet.uga.edu/vpp/gray_book/FAD/)

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