

# Foot and Mouth Disease (FMD)

*Fiebre Aftosa*

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the Center for  
Food Security  
& Public Health

IOWA STATE UNIVERSITY®

College of Veterinary Medicine  
Iowa State University  
Ames, Iowa 50011  
Phone: 515.294.7189  
Fax: 515.294.8259  
cfsph@iastate.edu  
www.cfsph.iastate.edu



INSTITUTE FOR  
INTERNATIONAL  
COOPERATION IN  
ANIMAL BIOLOGICS

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## Importance

Foot-and-mouth disease (FMD) is a highly contagious viral disease of livestock. It can rapidly spread through a region if control and eradication practices are not implemented upon its detection. Weight loss, poor growth, permanent hoof damage, and chronic mastitis are just some of the sequelae of infection. The detection of FMD in a country impacts international trade and embargoes could cause significant economic losses.

## Etiology

The foot-and-mouth disease virus (FMDV) is in the family Picornaviridae, genus Aphthovirus. There are 7 immunologically distinct serotypes and over 60 subtypes. New subtypes occasionally develop spontaneously. The FMDV is inactivated at a pH below 6.5 or above 11. The virus can survive in milk and milk products when regular pasteurization temperatures are used. However, it is inactivated by ultra high-temperature pasteurization procedures. Virus stability increases at lower temperatures and can survive in frozen bone marrow or lymph nodes. The virus can also survive drying and may persist for days to weeks in organic matter under moist and cool temperatures. It is inactivated on dry surfaces and by UV radiation (sunlight).

## Species Affected

FMDV primarily affects cloven-hoofed domestic and wild animals, including cattle, pigs, sheep, goats, and water buffalo. Other susceptible species include hedgehogs, armadillos, nutrias, elephants, capybaras, rats, and mice.

## Geographic Distribution

Foot-and-mouth disease was found worldwide after World War II. The last U.S. outbreak was in 1929. Endemic areas include parts of Asia, Africa, the Middle East, and parts of South America. Recent outbreaks (2006-2007) have occurred in Argentina, Bolivia, Botswana, Brazil, China, Ecuador, Egypt, Guinea, Israel, Jordan, Kazakhstan, Korea, Lebanon, Palestine, Russia, South Africa and Turkey. In 2001, an outbreak of FMD occurred in the United Kingdom and other countries of Europe; no further outbreaks in the EU have occurred since. North America, Central America, Australia, and New Zealand have been free for many years.

## Transmission

Transmission primarily occurs by respiratory aerosols and direct or indirect contact with infected animals. Aerosol transmission requires proper temperature and humidity. The virus may survive for 24 to 48 hours in the human respiratory tract and could serve to spread the virus if precautions are not taken. Animals may also become infected by ingesting animal products contaminated with the virus such as meat, milk, bones, and cheese. Additionally, contaminated objects, such as boots, hands, clothing, vehicles or equipment can spread the virus from animal to animal or farm to farm.

Sheep and goats are considered maintenance hosts. They can have very mild signs; therefore, diagnosis may be delayed, which allows time for spread or environmental contamination. Pigs are considered amplifying hosts, as they can shed large quantities of the virus once infected. Cattle are generally the first species to manifest signs of FMD, so are considered 'indicators' of this disease. Lesions in cattle are typically more severe and progress more rapidly compared to other species.

Ruminants can carry the virus for long periods in their pharyngeal tissue. Recovered or vaccinated cattle exposed to diseased animals can be healthy carriers for 6 to 24 months. Sheep can be carriers for 4 to 6 months. Some strains of the virus can affect one species more than others.

## Incubation Period

Animals in contact with clinically affected animals will generally develop signs of disease in 3 to 5 days. The virus can enter through damaged oral epithelium or the tonsils in pigs fed contaminated garbage. In this case signs can be seen in 1 to 3 days.

# Foot and Mouth Disease (FMD)

Experimental exposure can elicit signs in 12 to 48 hours. Peak time of shedding of the virus and transmission usually occurs when vesicles rupture.

## Clinical Signs

Foot-and-mouth disease is characterized by fever and vesicles (blisters), which progress to erosions in the mouth, nares, muzzle, feet, or teats. Typical clinical signs include depression, anorexia, excessive salivation, serous nasal discharge, decreased milk production, lameness, and reluctance to move. Abortion may occur in pregnant animals due to high fever (FMDV does not cross the placenta). Death in young animals is due to severe myocardial necrosis. In cattle, oral lesions are common with vesicles on the tongue, dental pad, gums, soft palate, nostrils, or muzzle. Hoof lesions are in the area of the coronary band and interdigital space. In pigs, the hoof lesions are usually severe with vesicles on the coronary band, heel, and interdigital space. Vesicles can also be seen on the snout. Oral lesions are not as common as in cattle and are usually less severe. Drooling in pigs is rare. Sheep and goats show very mild, if any, signs of fever, oral lesions, and lameness. Animals generally recover in about two weeks with very low mortality in adult animals. Secondary infections may lead to a longer recovery time.

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

The characteristic lesions of foot-and-mouth disease are single or multiple vesicles/bullae from 2 mm to 10 cm in diameter. Early lesions range from a small pale area to a fluid-filled vesicle, sometimes coalescing with adjacent lesions to form bullae. Once vesicles rupture, red, eroded areas or ulcers will be noted. These may be covered with a gray fibrinous coating; a demarcation line of newly developing epithelium may be noted. Loss of vesicular fluid through the epidermis may lead to “dry” lesions. These will appear necrotic instead of vesicular and are more common in the oral cavity of pigs. Lesions also occur at the coronary band and can progress to the skin and hoof. Coronitis may be seen on the hooves and pigs may slough their claws in severe cases. In younger animals, gray or yellow streaking in the myocardium, also called “tiger heart” lesions, may be seen and are caused by zones of degeneration and necrosis in the tissue. Vesicular lesions may also be found on the ruminal pillars.

## Morbidity and Mortality

In susceptible populations, morbidity can be 100%. Mortality is generally less than 1% but can be up to 40% in younger animals or outbreaks situations.

## Diagnosis

### Clinical

Clinical signs of concurrent salivation and lameness with vesicles and/or erosions should make foot-and-mouth disease a differential consideration. Febrile animals should be carefully examined for early oral or digital lesions. The

mouth of any lame animal, and the feet of animals with oral lesions or drooling, should also be checked. Teats of lactating females should be examined. Tranquilization may be necessary for a thorough examination as vesicles may be difficult to see. Laboratory testing is an absolute requirement to confirm FMDV infection as all vesicular diseases have almost identical clinical signs.

### Differential diagnosis

The clinical signs of FMD can be similar to vesicular stomatitis, swine vesicular disease, vesicular exanthema of swine, foot rot, traumatic stomatitis induced by poor quality feed, and chemical and thermal burns. In cattle, oral lesions seen later in the progression of FMD (erosions, ulcers) can resemble rinderpest, infectious bovine rhinotracheitis (IBR), bovine viral diarrhea (BVD), malignant catarrhal fever (MCF), and epizootic hemorrhagic disease. In sheep, these later lesions can resemble bluetongue, contagious ecthyma, and lip and leg ulceration.

### Laboratory tests

FMDV can be identified using enzyme-linked immunosorbent assay (ELISA), complement fixation, and virus isolation. Virus isolation is done by inoculation of primary bovine thyroid cells and primary pig, calf and lamb kidney cells, inoculation of BHK-21 and IBRS-2 cell lines, or inoculation of mice. ELISA and virus neutralization tests can be used to detect antibodies in serum. Virus isolation and identification must be performed on the initial case. Subsequently, antigen or nucleic acid detection can be used to diagnose additional cases in an outbreak.

### Samples to collect

Before collecting or sending any samples from vesicular disease suspects, the proper authorities should be contacted. Samples should only be sent under secure conditions and to authorized laboratories to prevent spread of the disease. Since vesicular diseases can not be distinguished clinically, and some are zoonotic, samples should be collected and handled with all appropriate precautions.

Samples include vesicular fluid, the epithelium covering vesicles, esophageal-pharyngeal fluid, unclotted whole blood collected from febrile animals and fecal and serum samples from infected and non-infected animals.

## Recommended actions if FMD is suspected

### Notification of authorities

A quick response is vitally important in containing an outbreak of FMD. State and federal veterinarians should be immediately informed of any suspected vesicular disease.

Federal: Area Veterinarians in Charge (AVIC):

[http://www.aphis.usda.gov/vs/area\\_offices.htm](http://www.aphis.usda.gov/vs/area_offices.htm)

State Veterinarians:

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

# Foot and Mouth Disease (FMD)

## Quarantine and Disinfection

Suspected animals should be quarantined immediately and the premises should be disinfected. Sodium hydroxide (2%), sodium carbonate (4%), citric acid (0.2%), and Virkon-S® are effective disinfectants. Other disinfectants (e.g., iodophores, quaternary ammonium compounds, phenols) may be less ideal because they can be rapidly inactivated in the presence of organic matter.

## Vaccination

FMD vaccines, whether used prophylactically or for control of an outbreak, must closely match the type and subtype of the prevalent FMDV strain. With seven serotypes, and more than 60 subtypes of FMDV, this task is one of the biggest challenges in FMD vaccination. Currently, there is no universal vaccine against FMD. The U.S., Canada, and Mexico maintain the North American FMD Vaccine Bank, which contains vaccine strains for the most prevalent circulating serotypes in the world. The decision to use vaccination in control and eradication efforts is complex and depends upon scientific, economic, political, and societal factors specific to the outbreak situation. The final decision to use vaccination as an aid in controlling an outbreak of FMD in the U.S., Canada, or Mexico would be made by the Chief Veterinary Officer in each country.

## Public Health

FMDV infections in humans are rare, with just over 40 cases diagnosed since 1921. Vesicular lesions can be seen, but the signs are generally mild. Foot-and-mouth disease is not considered to be a public health problem.

## Internet Resources

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USAHA Foreign Animal Diseases Book

[http://www.vet.uga.edu/vpp/gray\\_book/FAD/](http://www.vet.uga.edu/vpp/gray_book/FAD/)

World Organization for Animal Health (OIE)

<http://www.oie.int>

OIE Manual of Standards

[http://www.oie.int/eng/normes/mmanual/a\\_summry.htm](http://www.oie.int/eng/normes/mmanual/a_summry.htm)

OIE International 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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