Foot-and-mouth disease virus (FMDV) **System:** Terrestrial

Kingdom	Phylum	Class	Order	Family
Virus				Picornaviridae

Common name foot-and-mouth disease virus (FMDV) (English), foot-and-mouth disease (English)

Synonym

Similar species *Vesicular stomatitis, Bovine virus diarrhea, Swine vesicular disease, Vesicular exanthema of swine*

Summary Foot-and-mouth disease virus (FMDV) is a viral disease of cloven-hoofed animals both domestic and wild. The disease does not typically kill adults but will cause pregnant females to abort and mortality among some young animals. Recovery is slow and can cause permanent reduction in milk yield. Temporary reductions in meat output and other livestock products are common. Vaccination can help prevent outbreaks, but when actual outbreaks occur quick action and mass slaughter is most widely accepted course of management action to prevent the spread of the virus.

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Species Description
FMDV is a highly infectious viral disease that affects cloven-hoofed animals (pigs, sheep, deer, goats and cattle). It causes fever and lameness in animals, with blisters in the mouth or on the feet. It is not usually fatal in adult animals and most recover naturally within 2-3 weeks. It is not a direct threat to human health. Vesicles (blisters) in the mouth, on the tongue and lips, on the teats, or between the toes -and the resulting excessive salivation or lameness- are the best-known signs of the disease. Blisters may not be observed until they have ruptured. Other signs, including fever, reduced feed consumption, and abortions, also may appear in affected animals. Even before clinical signs appear, the virus can be shed through exhaled air, lesions, milk, semen, and blood, making its transmission difficult to control (FIWG, 2003).
Sheep: FMDV often produces only a mild clinical disease in sheep and goats. Sudden lameness may be seen in a large proportion of the flock. If infection enters around the time of lambing, mortality in lambs can be very high due to myocarditis. Vesicles can often be small and difficult to find. Close examination of each cleat of each foot is important in a thorough clinical examination of sheep for FMDV. Lesions due to FMDV are prone to secondary bacterial infection and, conversely, lesions of the hoof can predispose to infection with FMD virus by the percutaneous route (AVIS, 2002).
Cattle: In cattle, the incubation period is 2 to 14 days. A dramatic drop occurs in milk yield, which precedes clinical signs in dairy cows. Clinical signs include all or some of the following: pyrexia up to 41°C, salivation, nasal discharge, vesicles on the tongue, lips, dental pad, inner aspects of cheeks, vesicles on the feet which often form slightly later than those on the tongue, vesicles on the teats and udders, acute lameness usually in more than one foot, feet are hot to the touch and palpation is resented, chomping' of the jaw and grinding of teeth due to pain in the mouth, there may be mortality in young animals due to myocarditis. Although animals will generally recover from the acute clinical phase of the disease there may be permanent loss of performance such as: chronic lameness, permanent drop in milk yield, poor weight gain, poor quality 'staring' coat, and a large proportion of cattle will go on to become persistently infected carriers of FMDV (AVIS, 2002).
Pigs: The end of the incubation period is followed by a marked phase of pyrexia, anorexia and lethargy. Pigs become extremely lame, are reluctant to move and adopt a hunched gait if forced to stand. The severity of lesions on the limbs depends on the conditions under which the pigs are kept. Lesions are pronounced in animals kept on hard floors. Vesicular lesions appear rapidly on the snout, mouth, coronary band, accessory digits and possibly the pressure points on the limbs. Mortality in un-weaned piglets due to myocarditis can be up to 100% and can precede any other signs of the disease (for example, vesicles on the teats of lactating sows). Lesions age at a rate similar to that in cattle. Lesions are frequently subject to secondary infection. Pigs do not become carriers of FMDV (AVIS, 2002).

Notes
Parts of Europe, North and Central America, Pacific nations and the Caribbean are considered free of FMDV (EUFMD, 2004).

Lifecycle Stages
Russell Kightley Media (UNDATED) outlines the life cycle of the FMD virus: \"Virus particles \"dock\" with the cell membrane at receptor molecules. The genetic material of the FMD virus is then introduced into the cell. The viral RNA associates with ribosomes to produce viral proteins. Viral RNA also travels to the smooth endoplasmic reticulum where it forms replication complexes. Such replication complexes are associated with new vesicles that form from the smooth endoplasmic reticulum. Here, new viral RNA is produced. Some will associate with ribosomes (to make more viral protein) and some will form the genomes of new virus particles (capsid assembly). The new virus particles collect together in large arrays (aggregation of new virus). Eventually, the cell is destroyed (cell lysis) causing a release of new virus particles.\"

Habitat Description
FMDV is transmitted by animal-to-animal contact, and by animals coming into contact with infected meat, meat products, or people and equipment very recently contaminated with FMDV. The virus can also spread considerable distances through the air. The virus has a remarkable capacity for remaining viable in carcasses, in animal byproducts, in water, in such materials as straw and bedding, and even in pastures (FIWG, 2003; and Ministry of Agriculture and Forestry, 2002).

General Impacts
FMDV rarely kills animals; however, affected animals do not normally regain lost flesh for many months. It causes abortions, deaths among young animals, and (in some animals) permanent adverse effects such as reduced milk yields, sterility, and lameness. FMDV very rarely affects humans, and the meat from infected animals can be eaten safely. Death from FMDV occurs most often in newborn animals (FIWG, 2003; and Ministry of Agriculture and Forestry, 2002).
In some countries wild populations of deer, swing, and other wildlife could become infected and remain as reservoirs of infection and require depopulation. Productivity losses of 10-20 percent are commonly reported with FMDV. Owners would have to cull herds, and Meat, milk, and other livestock products would not be allowed into the food chain. Premises would have to be cleaned and disinfected, and there would be a waiting period of at least 30 days before restocking could begin. There would be no production income during that period and only a reduced income while rebuilding herds. In an area seriously affected by an outbreak, it may be prohibitively difficult to purchase replacement stock, and prices would increase as supplies of replacement livestock were depleted(FIWG, 2003).
Meat plants and dairy factories could be forced to close due to economic loss. There are many businesses that supply various farm products and services like fertilizers, fencing, and equipment, among others that would lose business and might potentially have to close. Any closures would result in an unknown number of unemployed. Certain restrictions on travel would have to be initiated. Countries that rely on tourists may face loses in the tourism industry due to negative publicity. Outbreak means governments must spend hundreds of millions of dollars compensating farmers and costs related to disease control (Ministry of Agriculture and Forestry, 2002).

Management Info
Due to its highly infectious nature, FMDV is one of the most difficult animal diseases to control. There is a vaccine, but it is not available in the United States, and countries using the vaccine are not allowed to export vaccinated animals because there is no way to differentiate between vaccinated and infected animals. Control is based on quarantine and slaughter and widespread slaughter of infected animals is seen internationally as the best method to contain the spread of disease (Ministry of Agriculture and Forestry, 2002; and NJDA, 2001).
AVIS (2002) report that, \"The objective of carrying out a slaughter policy is to eliminate the source of FMD virus. Rapid and complete elimination is essential to prevent further spread of disease and to prevent completely the possibility of recurrence or recrudescence of FMDV in the future. Ruminants infected with FMDV can become persistently infected carriers of the virus. Vaccination does not prevent the establishment of carriers. There are currently no entirely reliable diagnostic tests to detect carrier animals and there is no method of 'curing' the carrier state. For these reasons, slaughter of animals is the only way of ensuring complete elimination of the virus.\"
Preventative measures: 5M Enterprises (2005) reports that in endemic and high risk areas routine vaccination may be practiced to protect the breeding stock. Unfortunately vaccination is problematical. This is because protection is short-lived lasting only about six months. It is also partly because there are seven serotypes of FMDV and protection against one leaves animals susceptible to the others. Vaccines must be multivalent (several serotypes) in most endemic regions. Since FMDV is largely a winter disease, vaccination should be carried out in the autumn. Inactivated vaccines have been successfully used in many parts of the world and although protected against disease, vaccinated animals are not totally resistant and can still become infected and shed virus. Resistance falls fairly quickly, so animals must be revaccinated at regular intervals (4-6 months) to maintain immunity (5M Enterprises, 2005; and EU FMD, 2004).
Countries in free and fringe areas apply strictly enforced national preventative measures against the introduction of infection. The main features of these measures are control over the importation of cloven-hoofed animals and of meat from such animals from counties in which FMDV occurs. Unfortunately, preventative measures cannot stop the windborne spread of FMDV. Infected pigs can produce huge quantities of infective virus as aerosols. In dry weather the wind does not carry infective aerosols very far. In humid overcast weather with a steady light wind blowing over flat countryside infective virus may survive long enough to infect other herds up to 60km (36 miles) distant. Strong winds, hills and objects such as high buildings and trees create turbulence and disperse the plume of airborne virus as they would a plume of smoke from a bonfire. Over water, given the same climatic conditions, infective virus has been shown to travel up to 300km (180 miles) (5M Enterprises, 2005).
The United States has an extravagant strategy for preventing FMDV outbreaks. Diseases in foreign animals are monitored worldwide outside U.S. borders by the government. U.S. borders and other ports of entry are regulated and inspected. Any potential animal products that could carry animal diseases are intercepted and quarantined. Within the borders of the U.S. a strong animal health infrastructure is maintained that includes self-surveillance and monitoring. An emergency response capacity has been established and is maintained. Despite the significant time and monetary investment of the United States into these preventative strategies, it is understood that there are still weaknesses in the system and certain areas still require further attention and addressing (FIWG, 2003).

Pathway
Live animals (zoo, breeding livestock). Edible animal products (fresh, frozen, chilled meat/dairy products). The most likely entry pathway of FMDV into New Zealand would be by illegally imported infected meat(Ministry of Agriculture and Forestry, 2002). Military movement. Contraband (prohibited meat products carried by passengers/in cargo containers/sent by mail/courier, black market). Illegal transshipments (products from other than stated point of origin). Garbage (commercial ships/planes). Legal human movements (civilian) from foreign countries. Animal germplasm. Other animal-related products (straw, hay, packing material, crop movements, feed, farm equipment, shipping containers)

Principal source: *AVIS FMD 2002* AVIS, 2002
Ministry of Agriculture and Forestry, 2002. Case Study 7 Preparedness for an Outbreak of Foot-and-mouth disease

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ALIEN RANGE

[1] NEW ZEALAND
[1] UNITED STATES

[1] NORTH AMERICA

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