This document provides a brief overview of the FMD *Standard Operating Procedure (SOP): Overview of Etiology and Ecology*. It is intended to be an easy to use reference for responders at all levels and provide a common basis for understanding FMD. Please see the SOP or *FMD Response Plan: The Red Book* for details on any aspect of this guide.

Introduction

FMD is a highly contagious viral disease affecting both domestic and wild cloven-hoofed animals. FMD is endemic in many areas of the world, and introduction into the United States is a serious concern. The disease is characterized by fever, vesicular (blister-like) lesions, and ulcers of the mouth, tongue, nostrils, muzzle, feet, and teats. FMD is not a threat to public health.

Etiology

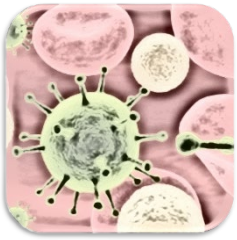
The FMD virus (FMDV) is a single stranded RNA virus of 25–30 nm diameter with icosahedral symmetry. The virus belongs in the genus Aphthovirus in the family Picornaviridae. There are more than 65 strains within 7 serotypes of the disease (O, A, C, Asia-1 and South African Territories (SAT) 1, SAT 2, and SAT 3); these vary by geographic region. Type O is the most prevalent worldwide.

Vaccination against one serotype of FMDV does not cross-protect against the other serotypes. Within a serotype, vaccination against one strain may not cross-protect against other strains, depending on the antigenic similarity of the strains.

Ecology

FMD is currently found in parts of Africa, Asia, Eastern Europe, the Middle East, and South America. There has not been an outbreak in the United States since 1929.

Cattle, pigs, sheep, and goats are all susceptible to FMD, as are wildlife species such as deer, bison, and elk. Different strains of FMDV may be more likely to infect one species over another.



The following are examples of how FMDV can be transmitted:

♦ *Animal to animal contact*: FMDV is shed in all secretions and excretions, including saliva, milk, semen, feces, urine, and fluid from ruptured vesicular lesions. Pigs are considered key amplifiers of the disease, as they produce 30 to 100 times the quantity of FMDV in respiratory secretions as cattle or sheep. The amount of virus in excretions also varies by serotype and strain of FMDV.

♦ *Air/Windborne*: Airborne FMDV is usually caused by a concentration of infected pigs creating a plume. The virus may able to travel up to 300 km, but more commonly, spread may be up to 20 km downwind. Cattle are most frequently infected by the aerosolized virus due to their large respiratory volume.

♦ *Fomites*: FMDV is easily transmitted by objects and may persist on the item for an extended period of time. Items such as vehicles, equipment, boots, and clothing must be cleaned and disinfected.

♦ *Feed*: FMD can be introduced to a naïve population by feeding contaminated meat, milk, or garbage.

♦ *Personnel*: Responders should wait between 24–72 hours before moving between infected and unknown or uninfected premises to avoid the possibility of transmitting FMDV to uninfected animals. With appropriate biosecurity and cleaning and disinfection measures, extended waiting periods are of decreased necessity.

♦ *Wildlife*: Though many wildlife species are susceptible to FMD, it is unclear what role they may play in transmission. Deer were not implicated in the transmission of FMDV in the 2001 outbreak in the United Kingdom.

FMD has a typical incubation period of 2–14 days. The World Organization for Animal Health (OIE) recognizes the incubation period as 14 days. The viral dose, susceptible species, and route of infection all influence the speed with which signs of illness appear. It is possible for an animal to shed FMDV before showing clinical signs.

Morbidity and Mortality

The animal species and FMDV strain affect the rates of illness and death in a population. Morbidity can be up to 100 percent, but mortality in adults is typically 1–5 percent. Younger animals are more likely to die from FMD, often due to inflammation of the heart. Clinical signs commonly occur in the following manner:

♦ Cattle: Typically present with fever, anorexia, and reduction in milk production; excessive salivation can often occur. After 2–3 days, lesions can be observed on mucous membranes, interdigital spaces, and on the coronary band; these will rupture after approximately 1 day. Recovery comes after 8–15 days.

♦ Pigs: Severe lesions occur on feet and also may be on the snout, udder, hock, and elbow.

♦ Sheep and goats: Signs are fewer or less obvious, but can include lesions on mouth, heel bulbs, and coronary bands.

Environmental Persistence

Persistence

FMDV is reasonably stable in the environment but vulnerable to high temperatures and acidic or alkaline conditions.

Action	Resistance
Temperature	Preserved by refrigeration and freezing. Progressively inactivated by temperatures above 50 °C. Heating animal products to a minimum core temperature of 70 °C for at least 30 minutes inactivates the virus.
pH	Quickly inactivated by pH <6.0 or >9.0.
Disinfectants	Inactivated by sodium hydroxide (2%), sodium carbonate (4%), citric acid (0.2%), acetic acid (2%), sodium hypochlorite (3%), potassium peroxymonosulfate/sodium chloride (1%), and chlorine dioxide. Resistant to iodophores, quaternary ammonium compounds, and phenol, especially in the presence of organic matter.
Survival	Survives in lymph nodes and bone marrow at neutral pH, but destroyed in muscle at pH <6.0, i.e. after rigor mortis. Survives in frozen bone marrow or lymph nodes. Residual virus survives in milk and milk products during regular pasteurization, but is inactivated by ultra high-temperature pasteurization. Survives drying but may persist for days to weeks in organic matter under moist and cool temperatures. Can persist in contaminated fodder and the environment for up to 1 month, depending on the temperature and pH conditions.

Source: OIE Technical Disease Card for FMD, 2013.

Virus Inactivation

Some organic materials (including hay, hair, feces, and animal products) can prolong the persistence of FMDV in the environment. To inactivate FMDV that may be present in animal products, the OIE recommends the following actions (OIE *Terrestrial Animal Health Code*, Chapter 8.8, www.oie.int, 2019):

- Milk and dairy: Pasteurization processes do not inactivate FMDV, and milk/milk products can infect naïve animals if not treated. For human consumption, milk and cream should be sterilized by the ultra high temperature process (UHT; heating to 132 °C for 1 second) or the high temperature-short time method (HTST; 72 °C for 15 seconds). If milk has a pH of 7.0 or over, apply HTST twice. For animal consumption, milk can be treated by HTST twice or employing either HTST or UHT in combination with either maintaining a low pH for 1 hour or additional heating to 72 °C and desiccation.
- Meat: Chilling and freezing preserve the virus, so it can remain in beef, liver, and the blood of slaughtered animals. Meat can be treated with high heat (70 °C internal temp) for at least 30 minutes through canning or cooking methods to inactivate the virus. Deboned, salted meat can be completely dried as long as it is not allowed to deteriorate at room temperature.
- Wool and hides: These can harbor FMDV for various lengths of time, ranging from a few days to almost a year depending on the humidity and temperature of storage and any processing done on the products. Industrial washing, scouring, depilation, fumigation, or controlled temperature storage can eradicate FMDV from wool and hair.

Further Information

For more details please see the *FMD SOP: Overview of Etiology and Ecology* and the *FMD Response Plan: The Red Book*, available at http://www.aphis.usda.gov/fadprep.