

S  
l  
i  
d  
e  
  
1

**Foot and Mouth Disease**

*Fiebre Aftosa*

S  
l  
i  
d  
e  
  
2

**Overview**

- Organism
- Economic Impact
- Epidemiology
- Transmission
- Clinical Signs
- Diagnosis and Treatment
- Prevention and Control
- Actions to take



Center for Food Security and Public Health, Iowa State University, 2011

In today's presentation we will cover information regarding the organism that causes foot and mouth disease and its epidemiology. We will also talk about the economic impact the disease has had in the past and could have in the future. Additionally, we will talk about how it is transmitted, the species it affects (including humans), clinical and necropsy signs seen, and diagnosis and treatment of the disease. Finally, we will address prevention and control measures for the disease, as well as actions to take if foot and mouth disease is suspected. [Photos: (Top) Cow. Source: Wikimedia Commons; (Middle) Sheep. Source: Danelle Bickett-Weddle/CFSPH; (Bottom) Pig. Source: Dave Gunn/Flickr-Creative Commons]

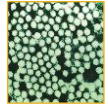
S  
l  
i  
d  
e  
  
3

**THE ORGANISM**

S  
l  
i  
d  
e  
  
4

**The Virus**

- Picornaviridae, *Aphthovirus*
  - 7 distinct serotypes
  - Not cross protective
- Cloven-hoofed animals
  - Two-toed
- Inactivation
  - pH below 6.5 and above 11
- Survives in milk, milk products, bone marrow, lymph glands



Center for Food Security and Public Health, Iowa State University, 2011

Foot and mouth disease virus (FMDV) is in the family Picornaviridae, genus *Aphthovirus*. There are 7 immunologically distinct serotypes which do not cross protect. There are over 60 subtypes; these subtypes develop spontaneously making effective vaccination difficult. FMDV primarily affects cloven-hoofed domestic and wild animals such as cattle, sheep, goats, pigs, deer, and water buffalo. It can also affect hedgehogs, armadillos, nutrias, elephants, capybaras, rats and mice. African buffalo are the maintenance host for the SAT serotype in Africa. Wildlife, other than African buffalo, do not seem to maintain the FMD viruses and usually only become infected after contact with infected livestock. FMDV is inactivated at a pH below 6.5 or above 11 (acidic or very basic conditions). The pH drop that occurs in muscle tissue post-mortem will inactivate the virus. It can survive in milk and milk products, frozen bone marrow, and lymph glands with stability increasing at lower temperatures. It can remain active on surfaces for days to weeks and survives drying if it is in serum. [Photo: Electronmicrograph of the foot and mouth disease virus. Source: FBI Laboratory via Wikimedia Commons]

S  
l  
i  
d  
e  
  
5

**IMPORTANCE**

S  
l  
i  
d  
e  
  
6

**History**

- 1929: Last case in U.S.
- 1953: Last cases in Canada and Mexico
- 1993: Italy
- 1997: Taiwan
- United Kingdom
  - 1967-68, 1981
  - 2001, 2007



Center for Food Security and Public Health, Iowa State University, 2011

Prior to 1929, FMD was present in several U.S. states, generally due to the importation of infected animals or their products. In 1929, restrictions were imposed on imported animals and products from infected countries. An outbreak in Canada in 1953 was quickly controlled; Mexico was also endemic with FMD until the 1950s. The North American continent has been free of FMD since 1953. Internationally, many countries have endemic FMD. FMD outbreaks may have a large economic impact. Italy's 1993 outbreak cost over \$130 million, and the 1997 Taiwan outbreak cost roughly \$15 billion. Great Britain documented outbreaks in 1967-68, 1981, 2001, and 2007. The 2001 UK outbreak is estimated to have cost over 3.1 billion pounds from losses in agriculture and the food chain, plus an addition 2.7 to 3.2 billion pounds from lost tourism (roughly 10 billion U.S. dollars total).\*

\*Rev Sci Tech. 2002 Dec;21(3):675-87.

[Photo: Map of the United Kingdom. Source: worldtravels.com]

S  
l  
i  
d  
e  
  
7

**Economic Impact**

<ul style="list-style-type: none"> <li>• Direct costs                             <ul style="list-style-type: none"> <li>- Economic losses to farmers and producers</li> <li>- Eradication costs</li> <li>- Millions to billions of dollars lost</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>• Indirect costs                             <ul style="list-style-type: none"> <li>- Exports shut down</li> <li>- \$14 billion in lost farm income</li> <li>- \$6.6 billion in livestock exports</li> <li>- Consumer fear</li> </ul> </li> </ul>
---	--

**Economically Devastating**

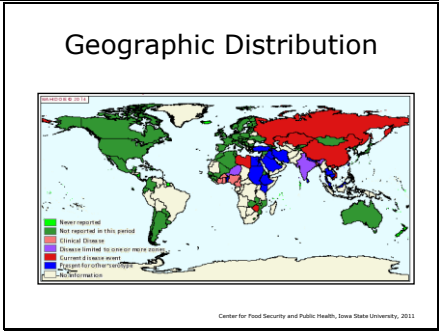
Center for Food Security and Public Health, Iowa State University, 2011

FMD is considered by many to be the most economically devastating livestock disease virus in the world--it is highly transmissible; results in economic losses in animal production; and depopulation, the most effective means of control, would cost producers and the government millions or even billions of dollars. Indirect costs of FMD are due to lost exports of beef, pork, mutton, dairy products, and live animals; the U. S. has the potential to lose \$3.1 billion in beef exports and \$1.3 billion in pork exports each year. In the event of a U.S. FMD outbreak, Paarlberg and others estimated that \$14 billion would be lost in farm income and livestock exports would drop \$6.6 billion.\* Consumer fear could cause additional indirect losses. Even though FMD is not a risk to humans, consumption of red meat and dairy products could be reduced. Estimates include a 20% decline in consumer purchases, causing a loss to farm income of \$20.8 billion. \*JAVMA. 200;220(7):988-992.

S  
l  
i  
d  
e  
8

**EPIDEMIOLOGY**

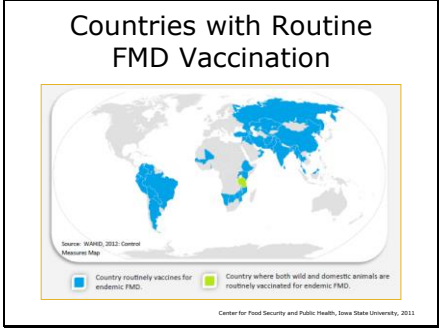
S  
l  
i  
d  
e  
9



FMD was found worldwide after WWII and the last outbreak in the United States was in 1929. Endemic areas include Asia, Africa, the Middle East and parts of South America. Epidemics have occurred in Taiwan, South Korea, Japan, Mongolia, Britain, France, and the Netherlands. Most parts of Europe, North and Central America, Australia, New Zealand, Greenland, and Iceland have been free of FMD for many years. Recently, outbreaks of FMD have occurred in Russia, Mongolia, and Korea. This map shows the worldwide FMD distribution from July to December 2010. Light green indicates FMD never reported, dark green indicates FMD not reported in this period, dark pink indicates FMD infection, light pink indicates clinical disease, purple indicates FMD limited to one or more zones, red indicates a current FMD event, and blue indicates other FMD serotypes are present.

[Photo: Map depicts foot and mouth disease events reported to the OIE (Jan-Jun 2013). Source: World Organization for Animal Health (OIE) WAHID]

S  
l  
i  
d  
e  
10



The World Organization for Animal Health (formerly known as the Office of International Epizootics, OIE) has a list of Member Countries that are FMD free countries where vaccination is not practiced. The map depicts the countries that vaccinate and those that do not.

[Photo: Map showing countries worldwide with routine vaccination for foot and mouth disease. Source: USDA Foot and Mouth Disease Response Ready Reference Guide at [www.aphis.usda.gov/animal.../fmd\\_rrg\\_freedom\\_and\\_vaccination.pdf](http://www.aphis.usda.gov/animal.../fmd_rrg_freedom_and_vaccination.pdf); data from OIE World Organization for Animal Health World Animal Health Information Database (WAHID)]

S  
l  
i  
d  
e  
11

**Morbidity/ Mortality**

- Morbidity 100% in susceptible animal population
  - U.S., Canada, Mexico, others
- Mortality less than 1%
  - Higher in young animals and highly virulent virus strains
  - Animals generally destroyed to prevent spread

In a susceptible animal population, like those found in the U.S., morbidity can reach 100%. However, mortality is generally less than 1%. Younger animals and highly virulent strains of the virus cause mortality to increase. Because of the economic impact of this disease, animals are generally destroyed to prevent further spread.

S  
I  
d  
e  
  
1  
2

**TRANSMISSION**

S  
I  
d  
e  
  
1  
3

**Animal Transmission**

- Respiratory aerosols
  - Travel long distances
  - Proper temperature and humidity
- Direct contact
  - Vesicular fluid
  - Ingestion of infected animal parts
- Indirect contact via fomites
  - Boots, hands, clothing

Center for Food Security and Public Health, Iowa State University, 2011

Transmission primarily occurs via respiratory aerosols and direct or indirect contact with infected animals and contaminated fomites. Aerosol transmission requires proper temperature and humidity; the virus may travel long distances. Virus is also found in large quantities in vesicle fluid and peak transmission usually occurs when vesicles rupture. Direct contact with vesicular fluid and contaminated animal parts (such as meat, milk, bones, glands, and cheese that are fed to animals) can also spread the disease. Contact with contaminated fomites such as boots, hands, or clothing can also be a source of infection. Other sources include artificial insemination, and contaminated biological, and hormone preparations.

S  
I  
d  
e  
  
1  
4

**Animal Transmission**

Species	Host	Carrier
Sheep Goats	Maintenance	Pharyngeal tissue 4-6 months
Pigs	Amplifier	No
Cattle	Indicator	Pharyngeal tissue 6-24 months

Center for Food Security and Public Health, Iowa State University, 2011

Sheep and goats are considered maintenance hosts for FMD; they have mild signs which delay diagnosis and allow for aerosol, contact spread, and environmental contamination. Sheep can carry the virus in their pharyngeal tissue for 4-6 months. Pigs are amplifying hosts; they produce large quantities of aerosolized virus, but shed for a short time and are not long-term carriers. Cattle are indicator hosts because they are often the first species to demonstrate clinical signs. Lesions quickly progress and become severe. Cattle can carry the virus in their pharyngeal tissue for 6-24 months once infected with FMD. Vaccination can protect from clinical signs but does not prevent development of the carrier state.

S  
I  
d  
e  
  
1  
5

**Human Transmission**

- Clinical disease rare
  - Infected by direct contact, ingestion of unprocessed milk/dairy products
  - Type O, C, rarely A
- Transmit virus to animals
  - Rarely harbor virus in respiratory tract for 1-2 days
    - Low risk of prolonged carriage
  - Contaminated boots, clothing, vehicles

Center for Food Security and Public Health, Iowa State University, 2011

Humans normally do not acquire FMD, but the serotypes that have been isolated include O (most commonly), C and rarely A. Direct contact may result in infection, as well as ingestion of unprocessed milk or dairy products from infected animals (extremely rare). Importantly, humans may serve as fomites and transmit FMD to other animal species. Humans may rarely harbor FMD virus in their respiratory tract for 1-2 days. Recent evidence suggests that the risk of prolonged carriage is very rare.\* Also, if boots, clothing or vehicles become contaminated humans can spread the virus to susceptible animals.

\*Vet Rec. 2010 Dec 11;167(24):928-31.

S  
I  
D  
E  
  
1  
6



S  
I  
D  
E  
  
1  
7

**Clinical Signs**

- Incubation period: 2 to 14 days
- Fever and vesicles
  - Feet, mouth, nares muzzle, teats
  - Progress to erosions
- Lameness, reluctance to move, sloughing of hooves
- Abortion
- Death in young animals



Center for Food Security and Public Health, Iowa State University, 2011


The incubation period for FMD is 2 to 14 days. Animals that are in contact with infected animals will generally develop signs in 3 to 5 days. Fever and vesicles (blisters) on the feet, mouth, nares, muzzle and teats are the characteristic lesions of FMD. These will eventually progress to erosions which cause the affected animal to have clinical signs associated with the lesioned area. Pain and discomfort from the lesions leads to a variety of symptoms including depression, anorexia, excessive salivation, lameness and reluctance to move or rise. Lesions on the coronary band may cause growth arrest lines on the hoof. In severe cases, the hooves may be sloughed. Abortion can occur in adults and death in young animals without any other clinical signs. Animals generally recover in two weeks but secondary infections can lead to longer recovery time.

[Photo: Large clefts at the coronary bands of this pig foot precede sloughing of the claws. Source: Dr. D. Gregg, Noah's Arkive, Plum Island Animal Disease Center/CFSPH]

S  
I  
D  
E  
  
1  
8

**Clinical Signs: Cattle**

- Oral lesions (vesicles)
  - Tongue, dental pad, gums, soft palate, nostrils, muzzle
  - Excess salivation, drooling, nasal discharge
- Lethargy, loss of body condition



Center for Food Security and Public Health, Iowa State University, 2011


Clinical signs in cattle include oral lesions such as vesicles on the tongue, dental pad, gums, soft palate, nostrils or muzzle. This leads to excess salivation, drooling, and nasal discharge. Affected animals become lethargic and lose condition rapidly.

[Photo: There are multiple large mucosal erosions and ulcers on this tongue. Source: Plum Island Animal Disease Center/CFSPH]

S  
I  
D  
E  
  
1  
9

**Clinical Signs: Cattle**

- Teat lesions
  - Decreased milk production
- Hoof lesions
  - Interdigital space
  - Coronary band
  - Lameness
  - Reluctant to move



Center for Food Security and Public Health, Iowa State University, 2011


Teat lesions can occur and cause a decrease in milk production. Hoof lesions in the interdigital space and on the coronary band are also common leading to lameness and a reluctance to move.

[Photo: There is a ruptured vesicle on the end of the teat. Source: Plum Island Animal Disease Center/CFSPH]

S  
I  
d  
e  
2  
0

### Clinical Signs: Pigs

- Hoof lesions
  - More severe than in cattle
    - Very painful
    - Coronary band, heel, interdigital space
  - Lameness
- Snout vesicles
- Oral vesicles less common



Center for Food Security and Public Health, Iowa State University, 2011

Pigs have more severe hoof lesions than cattle with vesicles on the coronary band, heel and interdigital space. The lesions may become so painful that pigs crawl rather than walk. The horns of the digits are sometimes sloughed. Vesicles are often seen on the snout but oral lesions are not as common or less severe than in cattle if they do occur. Drooling is rare in pigs because of this.

[Photo: There is a ruptured vesicle of the caudal-lateral coronary band, with undermining of the heel of this pig foot. Source: Plum Island Animal Disease Center/CFSPH]

S  
I  
d  
e  
2  
1

### Clinical Signs: Sheep and Goats

- Mild, if any
  - Fever
  - Lameness
  - Oral lesions
- Makes diagnosis and prevention of spread difficult



Center for Food Security and Public Health, Iowa State University, 2011

Since sheep and goats are maintenance hosts, fever, oral lesions and lameness occur but are very mild and sometimes are not detected. This makes it difficult to diagnose and prevent the spread of disease to other species.

[Photo: Oral lesions on the tongue of a sheep. Source: Institute for Animal Health, UK at <http://www.bbsrc.ac.uk/news/food-security/2011/110505-pr-better-understanding-of-foot-and-mouth.aspx>]

S  
I  
d  
e  
2  
2

	Foot & Mouth Disease	Vesicular Stomatitis	Swine Vesicular Disease	Vesicular Exanthema of Swine
<b>Clinical Signs by Species</b>	<b>All vesicular diseases produce a fever with vesicles that progress to erosions in the mouth, nares, muzzle, teats, and feet</b>			
<b>Cattle</b>	Oral & hoof lesions, salivation, drooping, lameness, abortions, death in young animals, "painter's", <b>Disease Indicators</b>	Vesicles in oral cavity, mammary glands, coronary bands, interdigital space	Not affected	Not affected
<b>Pigs</b>	Severe hoof lesions, hoof sloughing, snout vesicles, less severe oral lesions: <b>Amplifying Hosts</b>	Same as cattle	Severe signs in animals housed on concrete, lameness, salivation, neurological signs, younger more severe	Deeper lesions with granulation tissue formation on the feet
<b>Sheep &amp; Goats</b>	Mild signs if any: <b>Maintenance Hosts</b>	Rarely show signs	Not affected	Not affected
<b>Horses, Donkeys, Mules</b>	Not affected	Most severe with oral and coronary band vesicles, drooling, rub mouths on objects, lameness	Not affected	Not affected

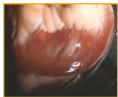
Center for Food Security and Public Health, Iowa State University, 2011

Clinically, all vesicular diseases produce a fever with vesicles that progress to erosions in the mouth, nares, muzzle, teats and feet. Vesicular diseases are clinically indistinguishable from one-another, especially in swine as this chart shows. Any disease with vesicles and fever should be reported to a state or federal veterinarian.

S  
I  
d  
e  
2  
3

### Post Mortem Lesions

- Single or multiple vesicles
- Various stages of development
  - White area, 2mm-10cm
  - Fluid filled blister
  - Red erosion, fibrin coating
- Dry lesions
- Sloughed hooves
- Tiger heart



Center for Food Security and Public Health, Iowa State University, 2011

FMD lesions consist of single or multiple vesicles from 2mm to 10cm in size in various stages of development. They start out as a small white area and progress to a fluid filled blister. Once they rupture, they leave a red eroded area that is covered by a gray fibrinous coating, that eventually is replaced with new epithelium and a demarcation line. Dry lesions are common in the pig oral cavity and occur when the fluid escapes through the epidermis and appear more necrotic than vesicular. Pigs can lose their hoof in severe cases of coronary band lesions. Yellow or gray streaking leaves "Tiger heart" lesions (photo) on the myocardium caused by degeneration and necrosis. The rumen pillars may also have vesicular lesions.

[Photo: there is a pale area of myocardial necrosis visible from the epicardial surface of this sheep heart. Source: Dr. D Gregg, Noah's Arkive, Plum Island Animal Disease Center/CFSPH]



S  
I  
d  
e  
2  
4

### Differential Diagnosis

- Swine
  - Vesicular stomatitis
  - Swine vesicular disease
  - Vesicular exanthema of swine
- Cattle
  - Rinderpest, IBR, BVD, MCF, Bluetongue
- Sheep
  - Bluetongue, contagious ecthyma

Center for Food Security and Public Health, Iowa State University, 2011

Differential diagnosis in swine includes vesicular stomatitis, swine vesicular disease, vesicular exanthema of swine, foot rot, and chemical and thermal burns. In cattle, oral lesions later in the disease can resemble rinderpest, infectious bovine rhinotracheitis (IBR), bovine virus diarrhea (BVD), malignant catarrhal fever (MCF), and bluetongue. In sheep, the lesions can be confused with bluetongue, contagious ecthyma, and lip and leg ulceration.

S  
I  
d  
e  
2  
5

### Sampling

- Before collecting or sending any samples, the proper authorities should be contacted
- Samples should only be sent under secure conditions and to authorized laboratories to prevent the spread of the disease


Center for Food Security and Public Health, Iowa State University, 2011

Before collecting or sending any samples from animals with a suspected foreign animal disease, the proper authorities should be contacted. Samples should only be sent under secure conditions and to authorized laboratories to prevent the spread of the disease.

S  
I  
d  
e  
2  
6

### Clinical Diagnosis

- **Vesicular diseases are clinically indistinguishable!**
- Suspect animals with salivation or lameness and vesicles
- Tranquilization may be necessary
- Laboratory testing essential



Center for Food Security and Public Health, Iowa State University, 2011

Clinically, vesicular diseases are indistinguishable from one another. However, if salivation and lameness are present with vesicular lesions, FMD should be considered a differential. Fever is often the first clinical sign; that should prompt examination of the mouth and feet for early lesions. Tranquilization may be necessary for a thorough exam as vesicles may be hard to identify initially. Laboratory confirmation is necessary, as all vesicular diseases have almost identical clinical signs.

[Photo: Several healing vesicles on this bovine tongue have yellow-tan margins. Source: Dr. D. Gregg, Noah's Arkive, Plum Island Animal Disease Center/CFSPH]

S  
I  
d  
e  
2  
7

### Laboratory Diagnosis

- Initial diagnosis
  - Virus isolation
  - Virus identification
    - ELISA, RT-PCR, complement fixation
- Serology
  - ELISA and virus neutralization
- Notify authorities and wait for instructions before collecting samples


Center for Food Security and Public Health, Iowa State University, 2011

For initial diagnosis of an outbreak in a region, virus isolation and identification must be performed on vesicular fluid or the epithelium covering vesicles. In cell culture, FMDV is identified by ELISA, RT-PCR, or complement fixation. ELISA and virus neutralization tests can detect antibody in serum. Contact the authorities if you are suspicious of a vesicular disease. Samples must be properly obtained, securely packaged, and sent to authorized laboratories for diagnosis. Call before sampling as a Foreign Animal Disease Diagnostician (FADD) is trained to handle exotic diseases.

S  
I  
d  
e  
2  
8

### Treatment

- No treatment available
- U.S. outbreak could result in:
  - Quarantine
  - Euthanasia
  - Disposal
- Vaccine available
  - Ramifications are many
  - See section "prevention and control"



Center for Food Security and Public Health, Iowa State University, 2011

Currently there is no treatment recommended for FMD. Due to the grave economic impact, animals will be quarantined, euthanized, and disposed of if they are infected. Vaccines are available for use in some countries and this will be discussed under prevention and control.

[Graphic: Do Not Enter sign. Source: Center for Food Security and Public Health]

S  
l  
i  
d  
e  
  
2  
9

**DISEASE IN HUMANS**

S  
l  
i  
d  
e  
  
3  
0

- Disease in Humans**
- Very low incidence
    - 40 cases since 1921
      - Most reports ended when FMD was eradicated in Europe
    - NOT a public health concern
  - Incubation period: 2 to 6 days
  - Clinical signs
    - Mild headache, malaise, fever
    - Tingling, burning sensation of fingers, palms, feet prior to vesicle formation
- Center for Food Security and Public Health, Iowa State University, 2011


FMD has zoonotic potential, but incidence is very low. Only 40 cases of human FMD have been reported since 1921. Most human reports ended after mass vaccination eradicated FMD in animals in Europe and other countries. FMD is **NOT** a public health concern. Humans with FMD generally have an incubation period of 2 to 6 days prior to clinical disease manifestation. Initial onset includes fever, mild headache, malaise, oral dryness, muscle pain, and a tingling, burning sensation of fingers, palms, and feet prior to vesicle formation.

S  
l  
i  
d  
e  
  
3  
1

- Clinical Signs: Humans**
- Vesicles
    - Fluid-filled, 2 mm to 2 cm in diameter
    - Tongue, palate
      - Painful
      - Interfere in eating, drinking, talking
    - Vesicles dry up in 2 to 3 days
  - Diarrhea
  - Recover within one week of last blister appearing
- Center for Food Security and Public Health, Iowa State University, 2011

Aphthae, or vesicles, may be pin head to 2cm in diameter and fluid filled initially. Vesicles or blisters in the mouth, generally on the tongue and palate, are the most painful and interfere in eating, drinking, and talking. Most blisters dry up in 2 to 3 days and the skin sloughs and heals by first intention. Diarrhea often accompanies these lesions. Recovery usually occurs within a week of the last blister appearance.

S  
l  
i  
d  
e  
  
3  
2

- Diagnosis and Treatment**
- Clinically FMD in humans resembles:
    - Coxsackie A group viruses
      - Hand, foot, and mouth disease
      - Herpangina
    - Herpes simplex virus
    - Vesicular stomatitis
  - Virus isolation or antibody identification required for diagnosis
  - Treatment is supportive care
- 
- Center for Food Security and Public Health, Iowa State University, 2011

Clinically, FMD resembles Coxsackie A group viruses (including hand, foot, and mouth disease and herpangina) as well as Herpes simplex virus and vesicular stomatitis virus . To definitively diagnose FMD in humans, the virus must be isolated and identified as it is in animals. Treatment consists of supportive care, such as parenteral nutrition, intravenous fluids, and antibiotics if there is a risk of secondary infection.

[Photo: Child with hand-foot-and-mouth disease. This is **NOT** the same as foot-and-mouth-disease in animals, but resembles it. Note the lesions on the palms. Source: CDC Public Health Image Library]

S  
l  
i  
d  
e  
  
3  
3

**PREVENTION AND CONTROL**



S  
I  
d  
e  
3  
4

**Prevention**

- Strict import restrictions
  - Prohibit live ruminants, swine, and their products from FMD-affected countries
  - Heat-treatment of swill (garbage) fed to pigs
    - Swine Health Protection Act
  - Travelers, belongings monitored at ports of entry



Center for Food Security and Public Health, Iowa State University, 2011

The USDA has upgraded the safeguarding measures in place to prevent introduction of FMDV into the U.S. USDA APHIS has strict import restrictions in place to prohibit importations of live ruminants, swine, and their products from FMD-affected countries. Heat-treatment of all swill (garbage) fed to pigs reduces the risk of an outbreak. In the U.S., the Swine Health Protection Act (SHPA) regulates food waste containing any meat products fed to swine. Government officials at ports of entry continue to monitor travelers and their belongings that have returned from an FMD area.

[Photo: Sow with piglets. Source: USDA ARS]

S  
I  
d  
e  
3  
5

**Prevention**

- Suspicious lesions investigated
- State planning/training exercises
- Federal response plans
- Biosecurity protocols for livestock facilities

Center for Food Security and Public Health, Iowa State University, 2011

There are 450 foreign animal disease diagnosticians (FADD) employed to investigate suspicious lesions and other unusual symptoms that private veterinary practitioners alert them to. Several states have also been involved in training exercises regarding actions to take if FMD is introduced. Additionally, APHIS has a federal response plan in place should FMD occur on U.S. soil. Producers should implement and follow strict, complete biosecurity protocols on U.S. livestock production facilities as their best means of prevention.

S  
I  
d  
e  
3  
6

**Recommended Actions**

- Notification of Authorities
  - Federal Area Veterinarian in Charge (AVIC)  
[http://www.aphis.usda.gov/animal\\_health/area\\_offices/](http://www.aphis.usda.gov/animal_health/area_offices/)
  - State Veterinarians  
[www.usaha.org/stateanimalhealthofficials.aspx](http://www.usaha.org/stateanimalhealthofficials.aspx)
- Quarantine



Center for Food Security and Public Health, Iowa State University, 2011

Due to the economically devastating nature of this disease, state and federal veterinarians should be notified immediately of any suspicious cases of FMD. While waiting for the authorities or a confirmed diagnosis, all suspect animals should be quarantined.

[Photo: Quarantined farm that was FMD positive in the UK in 2001. Source: Katie Steneroden/CFSPH]

S  
I  
d  
e  
3  
7

**Recommended Actions**

- Confirmatory diagnosis
- Depopulation
  - Must properly destroy exposed cadavers, litter, animal products



Center for Food Security and Public Health, Iowa State University, 2011

Should FMD be confirmed by diagnosis, depopulation may occur. Depopulation protocols include plans for the infected premises, contact exposed premises, and contiguous premises. Proper destruction of all exposed cadavers, litter and animal products is required.

[Photo: A burning pyre of animal carcasses. Source: www.bbc.co.uk]

S  
I  
d  
e  
3  
8

**Disinfection**

- Products:
  - 2% sodium hydroxide (lye)
  - 4% sodium carbonate (soda ash)
  - 5.25% sodium hypochlorite (household bleach)
  - 0.2% citric acid
- Areas must be free of organic matter for disinfectants to be effective

Center for Food Security and Public Health, Iowa State University, 2011

Proper disinfection of all contact premises and infected materials is also required. Preparing disinfectants for the farm entrance, vehicles, and people is imperative in preventing the spread. Some of the effective disinfectants include: 2% sodium hydroxide (lye), 4% sodium carbonate (soda ash), 5.25% sodium hypochlorite (household bleach), and 0.2% citric acid. FMD is resistant to various compounds such as iodophores, quaternary ammonium, hypochlorite and phenol. Make sure the areas are free of organic matter for any of the disinfectants to be effective.

S  
I  
d  
e  
3  
9

**Vaccination**

- Killed vaccine, serotype specific
- North American Foot-and-Mouth Vaccine Bank
  - Plum Island, NY
- Monitor disease outbreaks worldwide
- Stock active serotypes and strains
- Essential to isolate virus and identify the serotype to select correct vaccine

Center for Food Security and Public Health, Iowa State University, 2011

FMD vaccines are killed, serotype specific preparations and available to members (U.S., Mexico, Canada) of the Vaccine Bank. The North American Foot-and-Mouth Vaccine Bank (NAVB) is housed at the USDA Foreign Animal Disease Diagnostic Laboratory (FADDL) at Plum Island Animal Disease Center. The scientists at this biosafety-3 level lab monitor outbreaks worldwide to stock the NAVB with the FMD antigens from the most active serotype or strains of the virus. Since FMD has 7 different serotypes and more than 60 subtypes and there is no universal vaccine. It is essential to isolate the virus and identify the serotype to select the correct vaccine. A decision to vaccinate during an outbreak would be made by USDA officials in consultation with state, and local officials.

S  
I  
d  
e  
4  
0

**Vaccination**

- Currently U.S. has no need to vaccinate
- But, vaccine may be used in an outbreak
- Vaccination issues
  - Annual re-vaccination required
    - Costly, time consuming
  - Does not protect against infection, but reduces clinical signs
    - Spread infection to other animals
  - International trade status harmed

Center for Food Security and Public Health, Iowa State University, 2011

In the U.S. there is no need to vaccinate against an eradicated disease. However, vaccination may occur during an outbreak for disease containment. The vaccination process is complex. First, annual re-vaccination would be required to maintain immunity; this is very costly and time consuming. It would be necessary to vaccinate against all 7 serotypes of the virus. Second, the FMD vaccine does not protect against infection, but it lessens the severity of clinical manifestations. If a vaccinated animal came in contact with the virus, it could harbor it for months or years in its respiratory tract and shed it to others. This false sense of security of “vaccinated animals” could do more harm than good. Finally, if the U.S. does vaccinate, international trade status would be in jeopardy as the country could no longer claim FMD-free status. To earn FMD-free status, the OIE health code requires a 3-month waiting period after slaughter of the last positive animal, given ongoing surveillance through serological testing has occurred throughout the disease monitoring process.

S  
I  
d  
e  
4  
1

**Additional Resources**

- World Organization for Animal Health (OIE)
  - [www.oie.int](http://www.oie.int)
- U.S. Department of Agriculture (USDA)
  - [www.aphis.usda.gov](http://www.aphis.usda.gov)
- Center for Food Security and Public Health
  - [www.cfsph.iastate.edu](http://www.cfsph.iastate.edu)
- USAHA Foreign Animal Diseases (“The Gray Book”)
  - [http://www.aphis.usda.gov/emergency\\_response/downloads/nahems/fad.pdf](http://www.aphis.usda.gov/emergency_response/downloads/nahems/fad.pdf)

Last reviewed: May 2011

S  
I  
d  
e  
4  
2

**Acknowledgments**

Development of this presentation was made possible through grants provided to the Center for Food Security and Public Health at Iowa State University, College of Veterinary Medicine from the Centers for Disease Control and Prevention, the U.S. Department of Agriculture, the Iowa Homeland Security and Emergency Management Division, and the Multi-State Partnership for Security in Agriculture.

**Authors:** Danielle Bickett-Weddle, DVM, MPH; **Co-authors:** Anna Rovid Spickler, DVM, PhD; Kristina August, DVM  
**Reviewers:** James A. Roth, DVM, PhD; Bindy Comito, BA; Heather Sanchez, BS; Glenda Dvorak, DVM, MPH, DACVPM; Kerry Leedom Larson, DVM, MPH, PhD