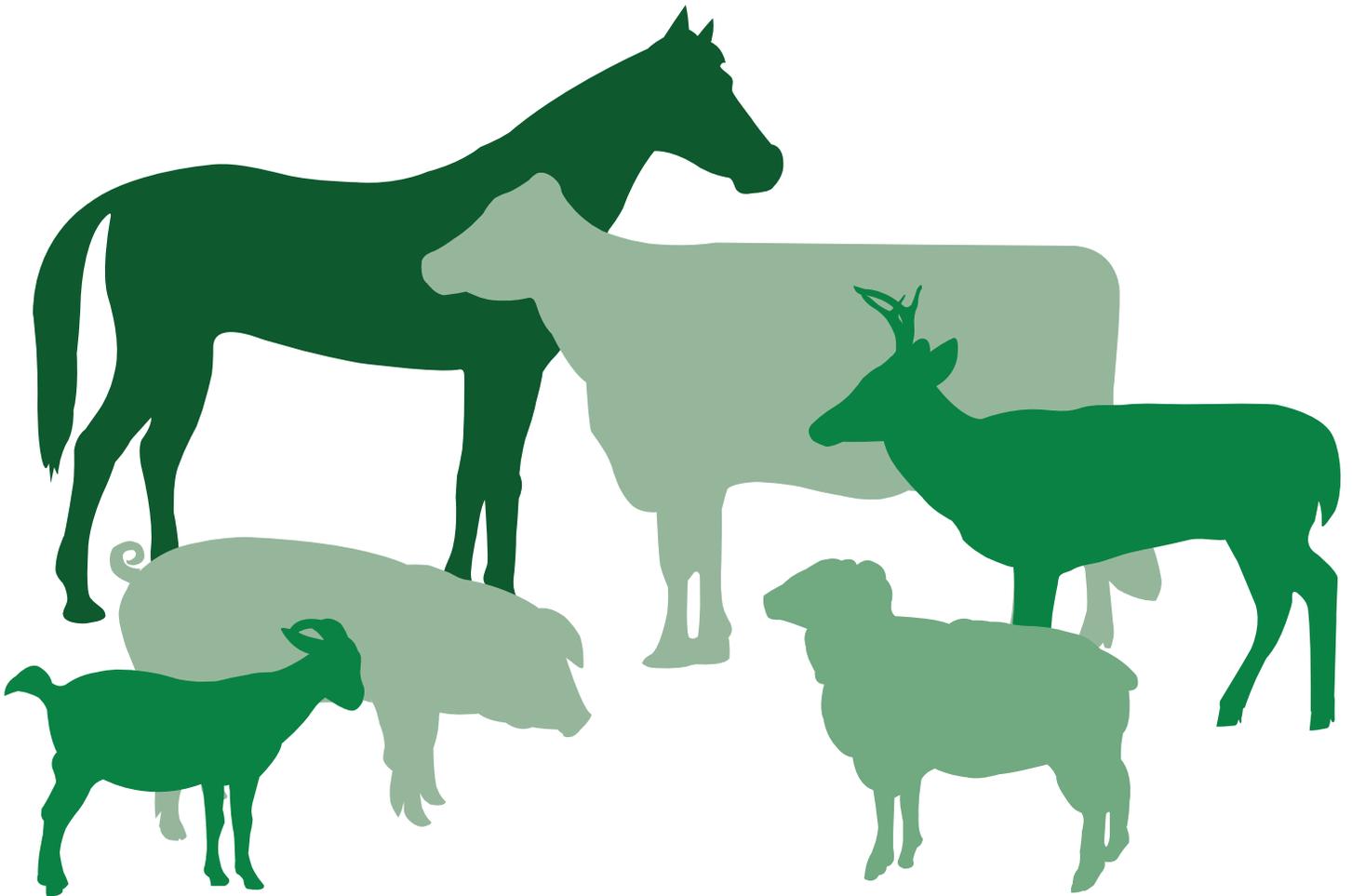


# MODULE 5: VESICULAR DISEASES



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## NATIONAL VETERINARY ACCREDITATION PROGRAM

United States Department of Agriculture • Animal and Plant Health Inspection Service • Veterinary Services

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Approved as one unit of supplemental training for participants in USDA's National Veterinary Accreditation Program

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## Vesicular Diseases

This informational module has been approved expressly to serve as one unit of supplemental training for participants in USDA's National Veterinary Accreditation Program. The module is intended to familiarize accredited veterinarians with animal health regulatory concepts and activities. Information in the module does not supersede the regulations. For the most up-to-date regulations and standards, please refer to the Code of Federal Regulations or contact your local VS Area Office.

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## Vesicular Diseases

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## Vesicular Diseases

### Introduction to Vesicular Diseases

Welcome to the Veterinary Accreditation Vesicular Diseases module.

This module consists of two sections that will prepare you to properly recognize a vesicular disease case. First, you will learn some general information that pertains to vesicular diseases. Then you will apply the introductory information to a fictional but plausible scenario.

Upon completion of this module, you should be able to

- Understand the economic impact of an outbreak;
- Name the four vesicular diseases of importance in the United States;
- Apply biosecurity measures specific for vesicular diseases;
- Recognize the clinical signs associated with each vesicular disease; and
- Know how to report a possible vesicular disease case.

Completion of this module is estimated to take 45 minutes but will vary depending on your familiarity with the diseases and information presented.

### Vesicular Diseases

Vesicular disease is a general term referring to diseases that cause blisters on various body parts of livestock and, in some cases, humans. Included in this category are

- Foot-and-Mouth Disease (FMD);
- Vesicular Stomatitis (VS);
- Swine Vesicular Disease (SVD); and
- Vesicular Exanthema of Swine (VES).

Vesicular stomatitis caused by strains of vesicular stomatitis virus serotype New Jersey and subtype Indiana 1 is the only vesicular disease currently found in the United States.

Introduction of any of the other vesicular diseases (including the other subtypes of VS) would be disastrous to the livestock industry and U.S. economy in general.



### Foot-and-Mouth Disease

#### Direct Economic Impact

An outbreak of FMD in the United States would have a devastating effect on our agricultural industry and economy.

Directly, the disease impacts the productivity of livestock and leads to extensive economic losses to farmers through

- Decreased weight gains;
- Decreased milk production;
- Abortions; and
- Increased mortality in young calves and pigs.

The direct costs incurred during the process of eradicating the disease would cost the producer and the government millions of dollars in the event of a small, controlled outbreak with only regionalized exports banned.

In a larger outbreak, this figure could reach into the billions of dollars. The expenses arise from

- Examining and diagnosing cases;
- Depopulating and disposing of animals;
- Paying producers for depopulated animals;
- Cleaning and disinfecting affected premises; and
- Continued surveillance.

The consequences would be immediate and harsh.

### Indirect Economic Impact

The indirect effects of FMD come into play when countries around the world close their doors to our exports of beef, pork, mutton, dairy products, and live animals.

Based on export data from 2009, the U.S. could lose \$3.08 billion in beef exports, \$4.3 billion in pork exports, and \$27 million in lamb exports (*U.S. Meat Export Federation*). In a 2002 revenue impact analysis of a potential FMD outbreak in the United States, it was estimated that \$6.8 billion would be lost in farm income (*Paarlberg et al., JAVMA, 2002*). Livestock exports would drop \$6.6 billion. Exports and the animal agriculture economy have grown since 2002 and the repercussions could be much higher.

Another indirect effect is consumer fear. Even though FMD is not a risk to humans, consumption of meat and dairy products could be reduced. If consumer purchases go down 10 percent, annual farm income would drop \$14 billion. A 20 percent fall in purchases would lower farm income \$20.8 billion (*Paarlberg et al., JAVMA, 2002*).

Finally, the emotional impact on producers, veterinarians, and the general public could be quite devastating. The destruction of livestock can evoke strong emotions in their owners and the veterinarians charged with disposal. The mental health and psychosocial impact needs to be considered and prepared for in the event of a devastating FMD outbreak.

### International Economic Impact

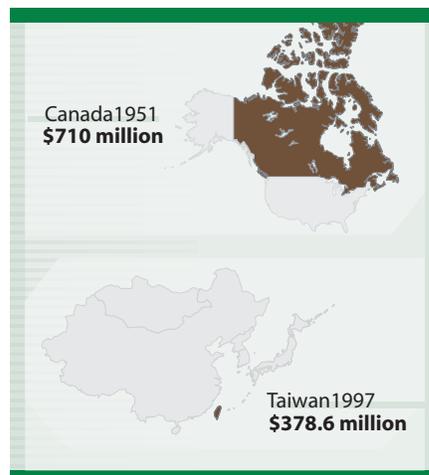
Fortunately, there has not been a case of FMD in the United States since 1929. Looking at FMD-caused economic losses from other countries, we can get a feel for how overwhelming and far reaching this disease could be.

**Canada** - The 1951 outbreak cost approximately \$710 million USD plus one year's loss of livestock and livestock product trade. (*Sellers RF, Daggupaty SM, Canadian Journal of Veterinary Research, 1990*)

**Taiwan** - A 1997 outbreak of FMD cost the country roughly \$378.6 million USD. (*Yang P.C. et al, Veterinary Record, 1999*)

**United Kingdom** - Total estimates of economic losses from the 2001 outbreak were approximately \$4.7 billion USD (3.1 billion pounds). (*Thompson, D. et al., Rev Sci Tech OIE 2002*)

- Indemnities paid to farmers for slaughtered livestock were estimated at around \$1.7 billion USD (£1.1 billion).
- More than 4 million animals were slaughtered to control this disease and an additional 2.5 million were slaughtered under the Livestock Welfare Disposal Scheme. The true costs may never be known.



**Uruguay** - Total cost of the 2001 epidemic was approximately \$243.6 million USD. (*Sutmoller, P. et al., Virus Research 2003; Sutmoller, P. and*

*Casas Olascoaga, R. Presentation at Evidence for the Temporary Committee on Foot-and-Mouth Disease of the European Parliament, 2002)*

- Approximately \$6.1 million USD was paid in compensation to farmers and for cleaning/disinfection and operating expenses.
- This FMD outbreak resulted in the slaughter of less than 7,000 animals with 28.5 million doses of vaccine used to help control the spread.

It is thought that, despite economic estimations, the cost of an FMD outbreak in the United States could far exceed preliminary calculations.

### Global Economic Impact

The agricultural industry is a large sector of our economy, but there are other industries that will be indirectly affected if an FMD outbreak were to occur in our country.

In the United Kingdom, for example, the **tourism industry** suffered great losses because people were restricted in where they could go and what they could do. Tourism in 2001 there lost between \$4.1 and \$4.8 billion USD (£2.7 to 3.2 billion pounds).

**Sporting and fund-raising events** were canceled, **national elections** were postponed, and people generally stayed home. It was estimated that sports-related sales and activities alone lost \$1.3 billion USD in the United Kingdom.

### Knowledge Review #1

**If an outbreak of foot-and-mouth disease were to occur in the United States, what impacts might result?**

**Please select the one best answer below.**

- A.** Consumer fear
- B.** Loss of export dollars
- C.** Loss of tourism
- D.** Economic loss to farmers
- E.** Costs of eradication
- F.** All of the above

**Answers are found in the appendix.**

### Clinical Signs of Vesicular Diseases

Now that we have reviewed the economic impact of an FMD outbreak, it is important to discuss the clinical signs of all four diseases.

Vesicular diseases are **CLINICALLY INDISTINGUISHABLE** from each other.

All vesicular diseases produce vesicles that progress to erosions in the mouth, nares, muzzle, teats, and feet. Although the four diseases produce similar clinical lesions, the species they affect and the severity of lesions can differ.

The next section will briefly describe aspects of each disease. Please review the vesicular disease chart in the appendix for more detailed information regarding foot-and-mouth disease (FMD), vesicular stomatitis (VS), swine vesicular disease (SVD), and vesicular exanthema of swine (VES).

### Foot-and-Mouth Disease

**Etiology**—Foot-and-mouth disease virus in the genus *Aphthovirus* within the family *Picornaviridae*

**Distribution**—Endemic in Asia, Africa, the Middle East, and parts of South America. The United States has been free of FMD since 1929.

**Species Affected**—Cattle, pigs, sheep, goats, and cloven-hooved wild and domestic animals (horses are NOT affected).

#### Clinical Signs

- **Cattle:** Oral and hoof lesions, salivation, drooling, lameness, and abortions
- **Pigs:** Severe hoof lesions, lameness, hoof sloughing, snout vesicles, and oral lesions less severe than in cattle
- **Sheep and Goats:** Mild signs, if any
- **Horses:** Not affected
- **Cervidae:** Mild to inapparent signs but can act as a viral reservoir for domestic animals

**Morbidity/Mortality**—Morbidity 100 percent. Mortality less than 1 percent, but more severe in young animals.

#### Vesicular Stomatitis

**Etiology**—Vesicular stomatitis virus in the genus *Vesiculovirus* within the family *Rhabdoviridae*

**Distribution**—North and Central America, northern part of South America

**Species Affected**—Horses, mules, donkeys, cattle, pigs, sheep, and goats

#### Clinical Signs

- **Cattle:** Vesicles in oral cavity, mammary gland, coronary bands and interdigital space
- **Pigs:** Same as cattle
- **Sheep and Goats:** Rarely show signs
- **Horses:** Show severe lesions with oral and coronary band vesicles, drooling, rubbing mouths on objects, and lameness
- **Cervidae:** Have only been affected experimentally

**Morbidity/Mortality**—Morbidity varies, up to 90 percent. Mortality is low.

#### Swine Vesicular Disease

**Etiology**—Swine vesicular disease virus in the genus *Enterovirus* within the family *Picornaviridae*

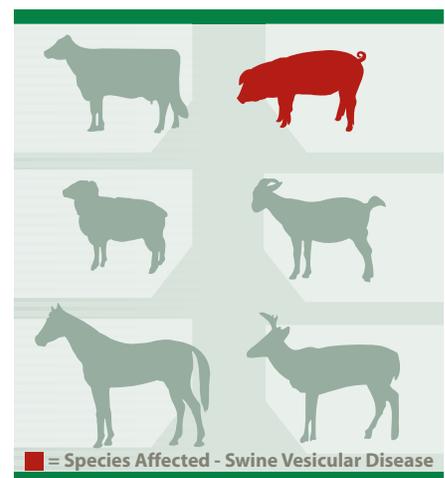
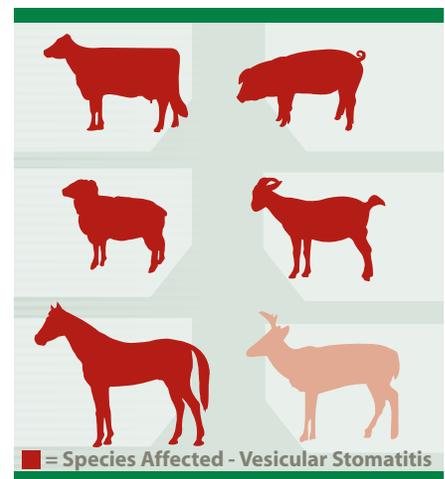
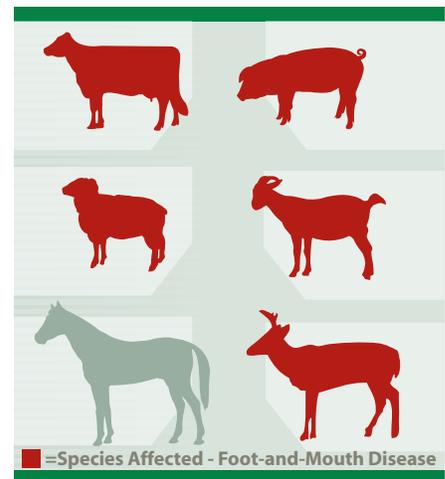
**Distribution**—Many European countries

**Species Affected**—Pigs

#### Clinical Signs

- **Cattle:** Not affected
- **Pigs:** Severe signs in animals housed on concrete, lameness, salivation, and neurological signs. Younger animals more severely affected.
- **Sheep and Goats:** Not affected
- **Horses:** Not affected
- **Cervidae:** Not affected

**Morbidity/Mortality**—Morbidity is low; lesions are less severe than in other vesicular diseases. Mortality is generally not a concern.



## Vesicular Exanthema

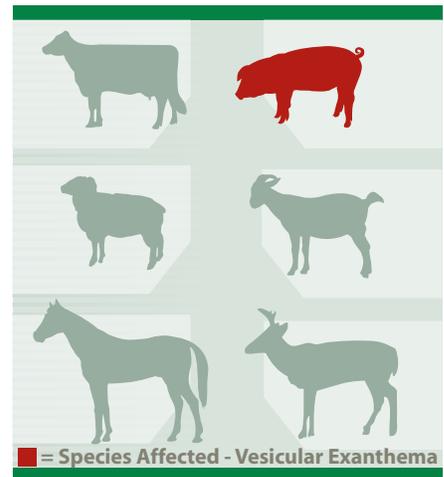
**Etiology**— Vesicular exanthema of swine virus in the genus *Vesivirus* within the family *Caliciviridae*

**Distribution**—Has only been found in the United States but was eradicated in 1956.

**Species Affected**—Pigs

### Clinical Signs

- **Cattle:** Not affected
- **Pigs:** Deep lesions with granulation tissue formation on the feet
- **Sheep and Goats:** Not affected
- **Horses:** Not affected
- **Cervidae:** Not affected



**Morbidity/Mortality**—Morbidity varies, up to 100 percent. Mortality is low.

## Knowledge Review #2

We have just reviewed the various vesicular diseases and the animals that are susceptible to each. Please choose the correct statement listed below.

- A.** Horses are susceptible to FMD.
- B.** The clinical signs of vesicular diseases present differently enough that it's easy to distinguish them from one another.
- C.** Vesicular stomatitis is the only vesicular disease present in the United States.
- D.** Vesicular diseases naturally result in high mortality among affected species.

Answers are found in the appendix.

## Clinical Signs by Animal Species

It is important to review the clinical signs of vesicular diseases as they are all similar and can only be differentiated through diagnostic tests. The next pages contain pictures and descriptions of some common lesions of vesicular diseases.

## Cattle



- A.** Ruptured vesicle on the dental pad and gingiva due to FMD
- B.** Ulceration of dental pad, excessive salivation due to Vesicular Stomatitis
- C.** Excessive salivation and drooling
- D.** Unruptured vesicles on the tongue
- E.** Ruptured vesicles on the tongue and gingiva
- F.** Ruptured vesicles on the rumen pillars
- G.** Unruptured vesicles on the teat
- H.** Lameness common due to coronary band lesions
- I.** Ruptured vesicle in the interdigital space
- J.** Gray streaking in the myocardium due to degeneration and necrosis (also known as "tiger heart" lesions)

Excessive salivation is not common. Piglets may not want to nurse due to mouth lesions.

Fever may occur with any of the vesicular diseases

- A.** Vesicles on snout from FMD
- B.** Vesicle on top of snout from FMD
- C.** Ruptured vesicle on coronary band; claw is starting to peel away
- D.** Blanched coronary band and ruptured vesicle from SVD infection
- E.** Granulation tissue formation during healing from VES infection
- F.** Coronary band erosions are common with all four diseases



- A. Ruptured vesicle visible on the nostril
- B. Extensive erosion of the lip at the mucocutaneous junction
- C. Ruptured vesicle on tongue
- D. Erosions are visible along the coronary band of the hoof

## Biosecurity, Cleaning, and Disinfection

### Prior to Farm Visit

In the event of a suspected vesicular disease case, biosecurity, cleaning, and disinfection are of the utmost importance. The vesicular diseases are spread easily, and improper protocols can disseminate the diseases to other animals and/or properties quickly.

When going to a call where you suspect a vesicular disease, complete these general biosecurity preparations upon arrival:

1. Roll up your vehicle window.
2. Put on clean coveralls and boots.
3. Prepare water and disinfectant.
  - Disinfectants are listed in the Vesicular Disease Chart in the appendix.
4. Wash your boots.
5. Take all necessary equipment with you, including a cooler, disposable gloves, syringes, and sample collection materials.
6. Prepare for your visit. Examine the healthier/younger animals first, then the sicker/older ones to minimize disease spread.



### Reporting Your Suspicions

When you suspect a possible vesicular disease outbreak, it is important that you notify the authorities **immediately**. Before taking samples and especially before leaving the farm, contact the local VS Area Office or the State Animal Health Official (SAHO). Due to your exposure, you may need to remain on the suspect farm until the authorities arrive or advise you otherwise. If you are in a group practice, notify your own veterinary clinic of the pending situation, even before making a final diagnosis. This is also important because neighboring farms may need to be quarantined, and your colleagues at the clinic may be involved.

In the event that you identify a vesicular disease, you may be required to stay on the farm and help carry out specific disinfection protocols based on recommendations of the Foreign Animal Disease Diagnostician (FADD) and the APHIS Area Veterinarian-in-Charge (AVIC).

### End of Farm Visit

Complete these biosecurity activities at the end of the visit:

1. Using a virucidal disinfectant, clean all sides, tops, bottoms, and handles of the cooler and bag.
2. Follow that up with an acetic acid rinse.
3. Place the cooler with samples and bag in the vehicle immediately.
4. Clean and disinfect all other equipment used to restrain and examine animals and collect samples.
5. Clean and disinfect your boots.
6. Remove your coveralls and put them in a bag that can be sealed.

### Laboratory Submissions

Diagnosis of a vesicular disease requires laboratory testing at the USDA National Veterinary Services Laboratories (NVSL). The NVSL is composed of 4 testing laboratories, three of which are located in Ames, Iowa. The fourth laboratory is the Foreign Animal Disease Diagnostic Laboratory which is located on Plum Island, New York.

In general, the Area Veterinarian-in-Charge (AVIC) authorizes submissions of United States-origin samples to the NVSL. All vesicular disease samples (except from horses) and other highly contagious diseases are sent to Plum Island, NY. The world reference laboratory for initial cases of foot-and-mouth disease occurs at the Pirbright Laboratory in Surrey, England.



## Case Scenario

As a veterinarian in a mixed-animal practice, you receive a call from Oink International, one of your purebred swine clients, regarding some lame pigs.

The site manager informs you that some of the pigs in the **grower** barn are **lame** and **off feed**. Management has not purchased any animals recently.

You were planning on bleeding pigs for swine influenza in a few days, but due to the high volume of animals that Oink International ships each week, you decide to do a walk-through today.

## Case History

You ask the grower-barn manager a few more questions during this initial phone call.

**Q: Besides pigs in the grower barns, are any other pigs or sows affected?**

**A:** No, not really. Everything else looks fine so far.

**Q: How long have these pigs been in the grower barn?**

**A:** They were moved in last week.

**Q: Were you able to clean out the barn and disinfect it before the new group moved in?**

**A:** Yes, we were able to clean and disinfect the barn as usual. We used the hot water power washer and used a bleach solution. We let the barn dry and sit empty for 2 days before we moved these pigs in.

**Q: Have any animals died?**

**A:** Not from this group. We did have to put down some nursery pigs that weren't eating.

**Q: Have there been any management changes lately?**

**A:** No, not really. We have been using the same feed and vaccinations as always. The only difference is that we were 2 weeks late getting the grower pigs vaccinated because two of our international employees were delayed getting back after spending a holiday in their home country.

**Q: Do the lame animals have a fever?**

**A:** Yes, they ranged from 103°F to 106°F.

**Q: Have you tried treating any pigs?**

**A:** Not yet. We do have 100 g/ton of chlortetracycline in the feed, but no water medications or individual treatments in this group.

## Equipment and Supplies

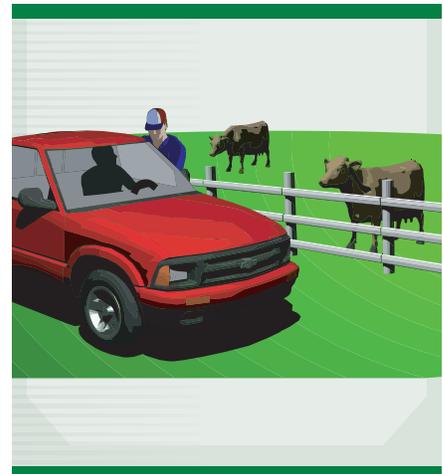
In the event of investigating a potential foreign animal disease outbreak, specific equipment will be needed. However, as a veterinarian, you do not always have the luxury of knowing what disease will be encountered on the next farm visit.

A checklist of items that should be carried in the event of a foreign animal disease investigation is provided in the appendix (see *Items Needed for Disease Investigation*). This can be used as a reference for you and your office staff.

## Driving to the Farm

It's a beautiful fall day and on your way to the lame-pig farm call, you pass by one of your clients, Mr. Johnson, who lives just down the road from Oink International. You have a few minutes, so you stop to see how his cows are doing. "The cows got out this morning," Mr. Johnson states. "We had our hands full, but thanks to our neighbors and their hired help, we got them all back in the pasture."

You wish him well and proceed to the next farm.



## Arriving at the Farm

You arrive at Oink International and stop by the office to meet with the manager. Because of the biosecurity protocols at this farm, you are not allowed to drive your vehicle from one barn to another. Therefore, you gather all the necessary supplies from your truck (making sure to remember the biosecurity preparations discussed earlier) and proceed with the manager to the barns.

The manager informs you that they had to put down three more piglets from the nursery since he talked with you this morning, and he wonders if that barn might be affected as well. Besides the grower and the nursery, pigs at the other barns appear fine.

## Walk-Through

It is important to establish a proper sequence when looking at different groups of animals in order to minimize the chances of spreading disease within the farm.

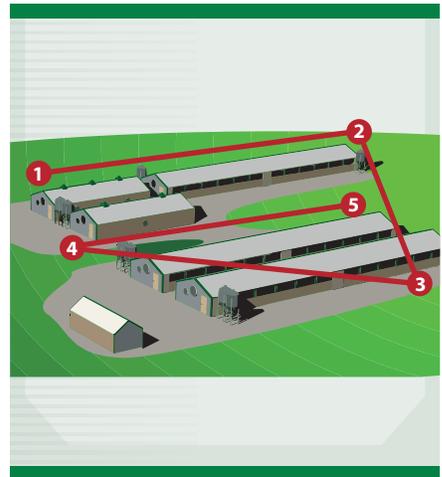
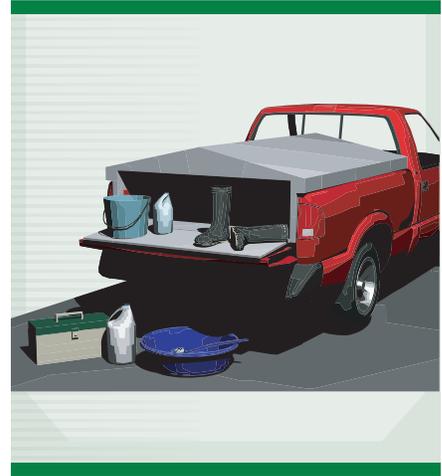
Start with the **healthy** animals and save the **sickest** group (or suspect group) for last. Also, go from **youngest** (most susceptible) to **oldest** (less susceptible and probably most exposed due to age).

Let's review what order you should examine this farm (the numbers below correspond with the graphic).

1. Start in the **farrowing** house. Baby pigs are the youngest and most susceptible population. Also, sows ready to farrow should be protected from possible disease exposure.
2. Next, the **gestating** barn (**sows**) should be visited. Disease exposure should be minimized to this older group due to their pregnancy status.
3. The **finishing** barn should be visited next. Even though these pigs are older, they currently appear to not be affected and should be seen next. It may be tempting to go to the closest building next (Building 4—nursery), but doing so could allow further spread of disease.

Now that all presumed healthy animals have been examined, you can evaluate the sick animals. Save the group with the worst signs of illness for last (also follow the rule of youngest to oldest).

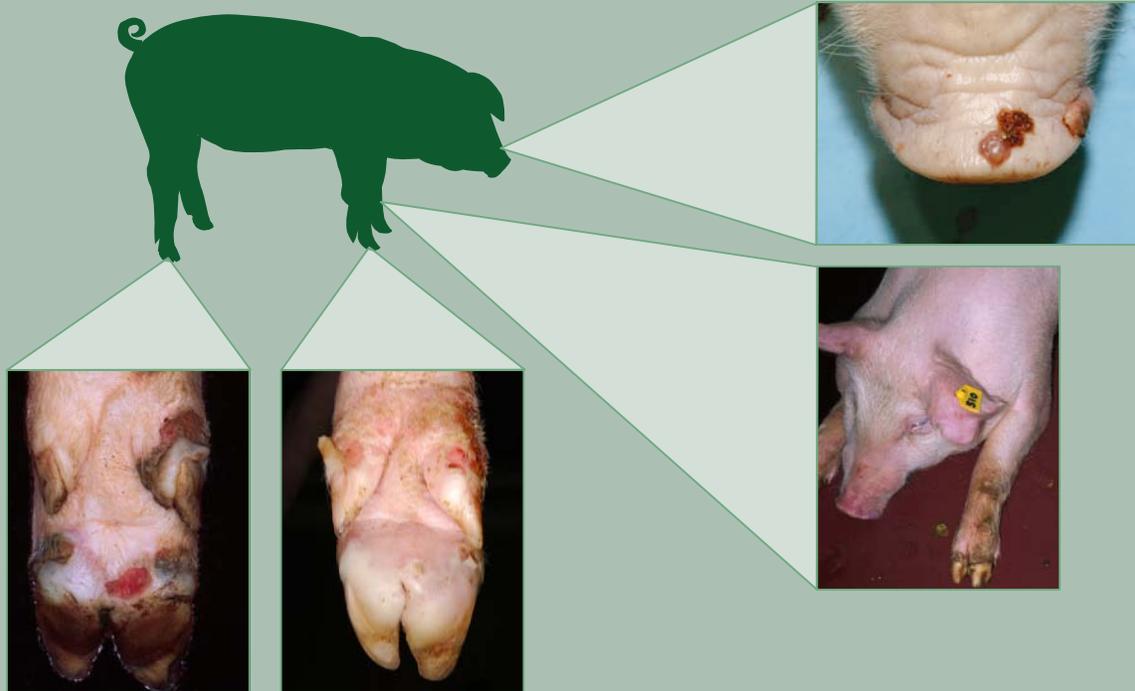
4. In this scenario, the **nursery** group would be the next group evaluated.
5. Finally, the **grower** pigs can be visited.



## Clinical Signs

### Knowledge Review #3a

The following clinical images were seen in the nursery and grower barns:



Additionally, the pigs had temperatures ranging from 103 to 106°F, lameness was noted in a few pigs, and some of the young animals had oral erosions.

Based on the images and physical exam findings, mark all observed clinical signs.

- |   |   |
|---|---|
| <input type="checkbox"/> Fever            | <input type="checkbox"/> Heel blanching         |
| <input type="checkbox"/> Vesicles (snout) | <input type="checkbox"/> Coronitis              |
| <input type="checkbox"/> Vesicles (feet)  | <input type="checkbox"/> Lameness               |
| <input type="checkbox"/> Oral necrosis    | <input type="checkbox"/> Sloughing of claw wall |
| <input type="checkbox"/> Oral erosions    | <input type="checkbox"/> Teat lesions           |
| <input type="checkbox"/> Erosions (feet)  |   |

Answers are found in the appendix.

### Knowledge Review #3b

Based on the images and physical exam findings in the nursery and grower pigs, which of these vesicular diseases should you suspect? Select ALL that apply.

- A. FMD
- B. SVD
- C. VS
- D. VES

Answers are found in the appendix.

## Next Steps

**At this point you should contact the SAHO or APHIS AVIC regarding your suspicions of a vesicular disease in the grower pigs.**

Be prepared to explain to them the **history** and **clinical signs** observed and provide **directions to the farm** for additional investigation. You may be advised to remain on the farm until they arrive or follow strict biosecurity exit steps and go directly home without any animal contact.

You should also contact your veterinary clinic as you cannot visit any other farms due to your potential exposure.

## Additional Investigations

Once the SAHO and/or AVIC are contacted, they may decide to call in a Foreign Animal Disease Diagnostician (FADD) to perform additional diagnostic procedures. In the event of an outbreak of vesicular diseases, you may be involved with sample collection or explanations to your clients about what is occurring. Review the table below to learn what equipment is needed to collect various samples for diagnostic testing.

Diagnostic procedures	Supplies needed	Samples to collect
Necropsy a dead pig	Necropsy kit, formalin, gel packs, cooler, marker, specimen container and bags, sterile swabs, and transport media	Examine all organ systems and note lesions. Collect tissue samples (lymph nodes, thyroid, adrenal gland, kidney, and heart in formalin) for further testing.
Sacrifice a live, untreated pig showing clinical signs of vesicular disease	Euthanasia solution, needle, syringe, necropsy kit, formalin, gel packs, cooler, marker, specimen containers and bags, sterile swabs, and transport media	Select a pig with unruptured vesicles to collect 1 gram of epithelium and vesicular fluid for virus isolation. Collect antemortem blood samples. Examine all organ systems and note lesions. Collect tissue samples (lymph nodes, thyroid, adrenal gland, kidney, and heart in formalin) for further testing.
Blood samples	Needles, syringes, red top and purple top tubes, cooler, test tube rack, marker, and paint stick	Collect 5-mL sample with anticoagulant; collect 10-mL sample for serum for ELISA and virus neutralization testing.
Collect some fluid from the vesicles	Needles, syringes, cap for syringe, cooler with gel packs, marker, sample bag, and paint stick	Aseptically obtain a sample from an unruptured vesicle using a needle and syringe, cap it, and freeze it for virus isolation.
Throat swab	Snare, tranquilizer, sterile swabs, and transport media	Snare and tranquilize an animal showing clinical signs. Aseptically swab the pharyngeal region and place swab in labeled culturette.

## Knowledge Review #4

Suspect vesicular disease diagnostic samples require special handling, packaging, and labeling. **It is important that all samples be sent under secure conditions and only to an authorized laboratory to prevent spread of the disease.** The APHIS AVIC and State Animal Health Official will have specific guidelines to follow for sample submission, but it is important to know which laboratories can handle the diagnosis of a vesicular disease.

Which of the following would be an appropriate diagnostic laboratory to receive suspected vesicular disease samples?

- A. Plum Island Animal Disease Center in New York
- B. State veterinary diagnostic laboratory
- C. National Veterinary Services Laboratories in Ames, IA
- D. Private veterinary diagnostic laboratory with state-of-the-art equipment

Answers are found in the appendix.

## Final Diagnosis

The Oink International scenario resulted in the first FMD outbreak in the United States since 1929.

After additional history collection, it was discovered that one of Oink's international employees had brought some hand-cured meats from home; a country that has endemic FMD in pigs. As he prepared to vaccinate animals after lunch one day, he dropped the last bite of his sandwich in a pen of grower animals. They ate it up faster than he could retrieve it, and he thought nothing of it at the time.

The virus was suspected to be in the meat, and **pigs can become infected 1 to 3 days after ingestion.**

## Follow-up

Once you suspect the presence of a vesicular disease, various follow-up procedures need to occur quite rapidly. Listed below are some things that need to be done regarding the Oink International production facility and other operations in the area.

**Producer Education**—The farm owners/managers need to understand the implications of an FMD outbreak. You now have the tools to provide them with technical information and to explain the economic implications of this disease.

**Neighboring Properties**—Due to the highly contagious nature of FMD, managers at neighboring properties with susceptible animals will need to be notified. You recall your visit with Mr. Johnson on your way to this operation and how he had help from Oink International to gather his cows. His operation is at high risk because cattle are very susceptible to FMD. Federal authorities also need to be notified of the potential exposure.

**Quarantine**—Animals on this premises have been diagnosed with FMD, but the State Animal Health Official could have implemented a quarantine before or after a definitive diagnosis. Animals on neighboring farms will also be quarantined, especially Mr. Johnson's cattle due to their contact with personnel from Oink International.

**Restricted-Movement Orders**—Due to the highly contagious nature of FMD and the high consequences of trade embargoes, State or Federal authorities will likely implement a restricted-movement order. No animals should be moved off farm, livestock markets may shut down, milk shipments may cease, and all but authorized movements into and out of the area around the infected premises may halt temporarily.



**Destroy Infected and Exposed Animals**—All infected or exposed cloven-hooved animals are potential carriers of this disease and, on the order of State and Federal authorities, may be depopulated and properly disposed of following the diagnosis of FMD. As the herd veterinarian, **you do not have to be involved** in this step unless you so choose.

**Disinfection of the Farm**—Once animals have been destroyed and disposed of, it is necessary to disinfect all potentially contaminated areas. Because this is an FMD outbreak, virucidal products should be used:

- 2-percent sodium hydroxide (lye)
- 4-percent sodium carbonate (soda ash)
- 6-percent sodium hypochlorite (household bleach)
- 5-percent acetic acid

**Restocking the Operation**—Depending on the severity and extent of the outbreak and the decisions made by the State and Federal authorities, Oink International may **remain idle** for a period of time. Eventually, **sentinel animals** will be permitted on the premises and monitored for signs of the disease. Only after this time is the operation eligible to restock with swine.

## Summary

Now that you have completed this module, you should

- Have a better understanding of the economic importance of vesicular diseases;
- Be able to recognize clinical signs of the various vesicular diseases;
- Realize the importance of biosecurity, cleaning, and disinfection protocols to prevent disease spread; and
- Know how to report a suspicious vesicular disease.

## Supplemental Training

The content in this module has been approved expressly to serve as one unit of supplemental training for participants in USDA's National Veterinary Accreditation Program. Please ensure you complete, sign, and retain the certificate that was issued with this document stating that you have read the contents of this module. This certificate will be your only proof of having completed this module, and will need to be produced should APHIS audit your accreditation supplemental training records in the future. Contact your VS Area Office for more details on accreditation renewal.



## Acknowledgments

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The content of this module has been reviewed and approved by USDA-APHIS Legislative and Public Affairs.

## Photo and Illustration Credits

- Page 1** Various animal species are susceptible to vesicular diseases including cattle, pigs, sheep, goats and horses. *Photo sources: Cattle- USDA; Swine- Iowa State University Veterinary Diagnostic and Production Animal Medicine (VDPAM); Sheep- Danelle Bickett-Weddle, Iowa State University; Goat- Pam Zaabel, Iowa State University; Horse- Danelle Bickett-Weddle, Iowa State University*
- Page 2** **(Top)** This graphic shows the potential U.S. economic losses to FMD. *Graphic illustration by: Clint May, Iowa State University*  
**(Middle)** This graphic shows economic losses to FMD in Canada and Taiwan. *Graphic illustration by: Clint May, Iowa State University and Katlyn Harvey, Iowa State University*  
**(Bottom)** This graphic shows economic losses to FMD in the UK and Uruguay. *Graphic illustration by: Clint May, Iowa State University*
- Page 4** **(Top)** This graphic shows species affected by foot-and-mouth disease. *Graphic illustration by: Clint May, Iowa State University*  
**(Middle)** This graphic shows species affected by vesicular stomatitis. *Graphic illustration by: Clint May, Iowa State University*  
**(Bottom)** This graphic shows species affected by swine vesicular disease. *Graphic illustration by: Clint May, Iowa State University*
- Page 5** This graphic shows species affected by vesicular exanthema of swine. *Graphic illustration by: Clint May, Iowa State University*
- Page 6** This graphic shows the clinical signs of vesicular diseases in cattle. *Graphic illustration by: Katlyn Harvey, Iowa State University; Photo sources: Visual Information Services, Plum Island Animal Disease Center (PIADC) (A,B,D,E,H,I,J); USDA (C,F,G)*
- Page 7** This graphic shows the clinical signs of vesicular diseases in swine. *Graphic illustration by: Katlyn Harvey, Iowa State University; Photo sources: USDA (A,C,D,F); FMD Pocket Guide – USDA/Center for Food Security and Public Health/American Association of Swine Veterinarians/National Pork Board (B); Visual Information Services PIADC (E)*
- Page 8** This graphic shows the clinical signs of vesicular diseases in horses. *Graphic illustration by: Katlyn Harvey, Iowa State University; Photo sources: USDA (A,C,D); Visual Information Services PIADC (B)*
- Page 9** **(Top)** This graphic shows clean boots and overalls as well as prepared water and disinfectant. *Graphic illustration by: Clint May, Iowa State University*  
**(Bottom)** This graphic shows biosecurity activities to complete at the end of a visit. *Graphic illustrations by: Clint May, Iowa State University*
- Page 10** This graphic shows the neighboring property housing cattle. *Graphic illustration by: Clint May, Iowa State University*
- Page 11** **(Top)** This graphic shows the equipment needed for farm calls. *Graphic illustration by: Clint May, Iowa State University*  
**(Bottom)** This graphic shows the proper sequence to follow on farm when looking at different groups of animals at Oink International. *Graphic illustration by: Clint May, Iowa State University*
- Page 12** Knowledge review 3a: Images of clinical signs of a vesicular disease in pigs. *Graphic illustration by: Katlyn Harvey, Iowa State University. Photo sources: Left and middle right – USDA; middle left – FMD Pocket Guide – USDA/Center for Food Security and Public Health/American Association of Swine Veterinarians/National Pork Board; and right – Visual Information Services PIADC*
- Page 14** This graphic depicts Oink International’s property under a quarantine due to the diagnosis of FMD. *Graphic illustration by: Clint May, Iowa State University and Katlyn Harvey, Iowa State University*
- Page 15** This photo depicts the cleaning and disinfection that needs to occur on infected farms after the animals are depopulated and disposed. *Photo source: Darin Madson, Iowa State University*

## Knowledge Review Answers

### Knowledge Review #1

If an outbreak of FMD were to occur in the United States, what impacts might result? Please select the one best answer below.

- A. Consumer fear
- B. Loss of export dollars
- C. Loss of tourism
- D. Economic loss to farmers
- E. Costs of eradication
- F. All of the above

**The correct answer is F, all of the above.** All of these impacts would be felt in the United States if FMD were to occur.

### Knowledge Review #2

We have just reviewed the various vesicular diseases and the animals that are susceptible to each. Please choose the correct statement listed below.

- A. Horses are susceptible to FMD.
- B. The clinical signs of vesicular diseases present differently enough that it's easy to distinguish them from one another.
- C. Vesicular stomatitis is the only vesicular disease present in the United States.
- D. Vesicular diseases naturally result in high mortality among affected species.

A is not correct because horses are not susceptible to FMD. The only vesicular disease horses are affected by is **vesicular stomatitis**.

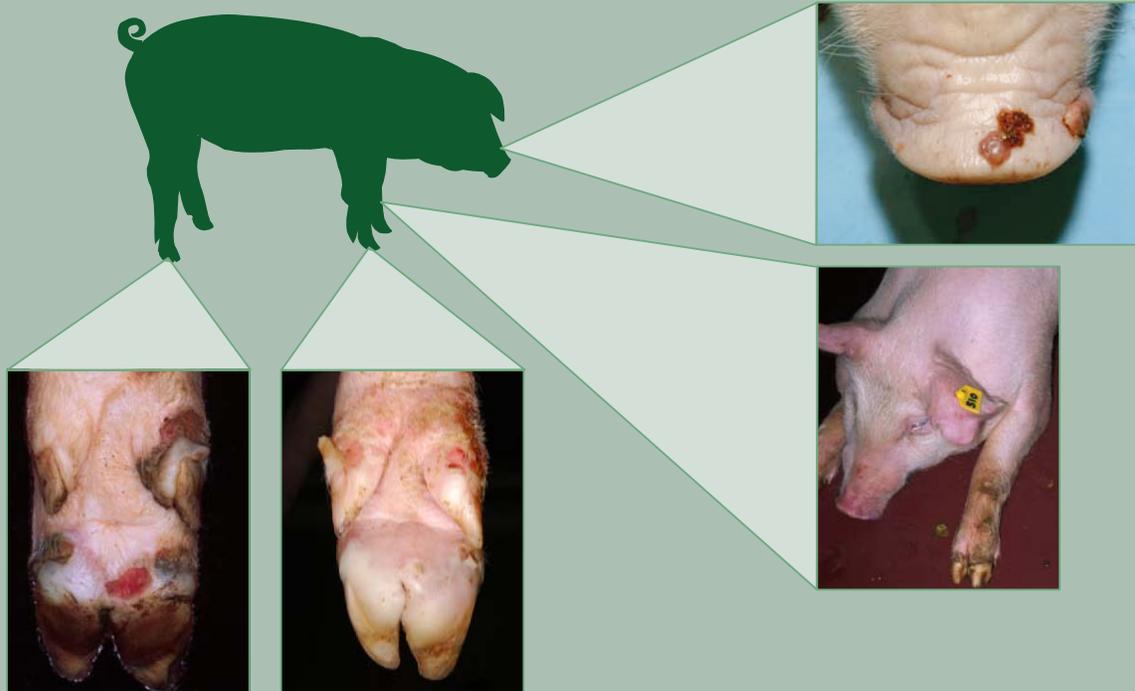
B is not correct because the clinical signs of vesicular diseases are **clinically indistinguishable** from one another.

**C is the correct answer** because the United States has been free of FMD since 1929, vesicular exanthema was eradicated in 1956, and swine vesicular disease has never been diagnosed here.

D is not correct because vesicular diseases generally result in high morbidity and **low mortality**. Eradication efforts often include massive depopulation of affected and exposed animals, but that is due to the contagious nature of the viruses and the need to control the infection.

### Knowledge Review #3a

The following clinical images were seen in the nursery and grower barns:



Additionally, the pigs had temperatures ranging from 103 to 106°F, lameness was noted in a few pigs, and some of the young animals had oral erosions.

Based on the images and physical exam findings, mark all observed clinical signs.

- |  |   |
|--|---|
| <input checked="" type="checkbox"/> Fever            | <input type="checkbox"/> Heel blanching         |
| <input checked="" type="checkbox"/> Vesicles (snout) | <input type="checkbox"/> Coronitis              |
| <input checked="" type="checkbox"/> Vesicles (feet)  | <input checked="" type="checkbox"/> Lameness    |
| <input type="checkbox"/> Oral necrosis               | <input type="checkbox"/> Sloughing of claw wall |
| <input checked="" type="checkbox"/> Oral erosions    | <input type="checkbox"/> Teat lesions           |
| <input checked="" type="checkbox"/> Erosions (feet)  |   |

Based on the images and physical exam findings you should have checked fever, vesicles (snout), vesicles (feet), oral erosions, erosions (feet), and lameness.

### Knowledge Review #3b

Based on the images and physical exam findings in the nursery and grower pigs, which of these vesicular diseases should you suspect? Select ALL that apply.

- A. FMD
- B. SVD
- C. VS
- D. VES

You should have selected **all four** of these vesicular diseases. If you suspect one, you should suspect them all as their clinical signs are indistinguishable.

### Knowledge Review #4

Suspect vesicular disease diagnostic samples require special handling, packaging, and labeling. **It is important that all samples be sent under secure conditions and only to an authorized laboratory to prevent spread of the disease.** The APHIS AVIC and State Animal Health Official will have specific guidelines to follow for sample submission, but it is important to know which laboratories can handle the diagnosis of a vesicular disease.

Which of the following would be an appropriate diagnostic laboratory to receive suspected vesicular disease samples?

- A. Plum Island Animal Disease Center in New York
- B. Local State veterinary diagnostic laboratory
- C. National Veterinary Services Laboratories in Ames, IA
- D. Private veterinary diagnostic laboratory with state-of-the-art equipment

A is the correct answer because Plum Island Animal Disease Center is the only laboratory in the United States equipped to handle highly infectious vesicular diseases.

B, C, and D are incorrect because those labs are not equipped to handle highly infectious vesicular diseases.

# Vesicular Diseases Reference Chart

	Foot-and-Mouth Disease	Vesicular Stomatitis	Swine Vesicular Disease	Vesicular Exanthema of Swine
<b>Etiology</b>	Aphthovirus	Vesiculovirus	Enterovirus	Calicivirus
<b>Geographic Distribution</b>	Endemic in Asia, Africa, Middle East, parts of South America; U.S. free since 1929	North & Central America, northern South America	Many European countries	U.S. only (eradicated in 1956)
<b>Transmission</b>	Respiratory aerosols; oral consumption; direct and indirect (fomite) contact	Insect vectors (sand flies & black flies); contact, aerosol in humans	Ingestion of contaminated meat; contact with animals, feces	Ingestion of uncooked garbage contaminated with pork
<b>Incubation Period</b>	Ingestion 1-3 days, Exposure 3-5 days	Animals 3-5 (up to 21) days, Humans 24-48 hours	Ingestion 2-3 days, Exposure 2-7 days	18-72 hours
<b>Clinical Signs by Species</b>	All vesicular diseases produce a fever with vesicles that progress to erosions in the mouth, nares, muzzle, teats, and feet. These 4 diseases are clinically indistinguishable from each other, particularly in swine.			
<b>Notification</b>	State & Federal Veterinarians should be contacted IMMEDIATELY and informed of suspicions			
<b>Cattle</b>	<b>Disease Indicators</b> Oral & hoof lesions; salivation, drooling; lameness; abortions; death in young animals; "panthers"	Vesicles in oral cavity, mammary glands, coronary bands, interdigital space	Not affected	Not affected
<b>Pigs</b>	<b>Amplifying Hosts</b> Severe hoof lesions; hoof sloughing; snout vesicles; less severe oral lesions	Same as cattle	Severe signs in animals housed on concrete; lameness; salivation; neurological signs; more severe in young	Deeper lesions with formation of granulation tissue on the feet
<b>Sheep &amp; Goats</b>	<b>Maintenance Hosts</b> Mild signs if any	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
<b>Humans</b>	Not common	Flu-like signs, headache, rare oral blisters	Not affected	Seroconversion and mild meningitis in one lab worker
<b>Clinical Summary</b>	Salivation and lameness with vesicles; Equidae not affected	Horses are affected; less contagious so spread is slower; lesions in one area of body	Pigs only; mild lesions; no mortality	Pigs only; deeper lesions; low mortality

This information was developed by staff veterinarians at the CFSPH for use as training materials for the USDA APHIS National Veterinary Accreditation Program.



## Vesicular Diseases Reference Chart- Additional Information

	<b>Foot-and-Mouth Disease</b>	<b>Vesicular Stomatitis</b>	<b>Swine Vesicular Disease</b>	<b>Vesicular Exanthema of Swine</b>
<b>Morbidity &amp; Mortality</b>	Morbidity 100%; Mortality less than 1%, severe in young	Morbidity varies, up to 90%; Mortality low; death in young less common	Morbidity is low; lesions less severe; Mortality not a concern	Morbidity varies, up to 100%; Mortality is low
<b>Differentials</b>	<b>Rinderpest, bovine herpes virus 1 (IBR), BVD, bovine papular stomatitis, malignant catarrhal fever, bluetongue, contagious ecthyma, lip and leg ulceration, foot rot, chemical and thermal burns</b>			
<b>Post-Mortem Lesions</b>	Single or multiple vesicles, ruptured vesicles with demarcation line, "dry" lesions in pig oral cavity, coronitis, hoof wall separation, "Tiger heart" lesions, rumen pillar lesions	Similar to FMD, but without heart and rumen lesions	Similar to FMD	Similar to FMD
<b>Sample Collection</b>	<b>Before collecting or sending any samples, the proper authorities should be contacted. Samples should only be sent under secure conditions to authorized laboratories to prevent spread.</b>			
<b>Prefer</b>	<b>Epithelium from unruptured or recently ruptured vesicles in proper medium</b>			
<b>Additional Samples/ Tissues</b>	Esophageal-pharyngeal fluid (cattle) or throat swab (pigs), 5ml blood with anticoagulant; 10ml for serum, lymph nodes, thyroid, adrenal gland, kidney, heart in formalin	Vesicular fluid collected aseptically and frozen	Vesicular fluid collected aseptically and frozen; unclotted whole blood from febrile animals; fecal and serum samples from infected and noninfected animals	Vesicular fluid collected aseptically and frozen; unclotted whole blood from febrile animals; fecal and serum samples from infected and noninfected animals
<b>Sample Packaging</b>	Caution with dry ice as carbon dioxide will inactivate the virus	Virus inactivated by 1% formalin		
<b>Disinfection</b>	2% sodium hydroxide (lye), 4% sodium carbonate, 5% acetic acid; 6% hypochlorite; Resistant to iodophores, quaternary ammonium compounds, and phenol, especially with organic matter present.	2% sodium hydroxide (lye), 4% sodium carbonate, 2% iodophores, chlorine dioxide	10% formalin, 2% sodium hydroxide (lye), iodophores, chlorine dioxide	Organic matter: 1% sodium hydroxide combined with detergent No Organic Matter: oxidizing agents and iodophores with detergents
<b>Prevention &amp; Control</b>	Destroy litter and susceptible animal products	Control insects, no movement of animals from farm for 30 days		

# Items Needed for Disease Investigation

Check	<b>Clothing and Safety</b>
	Coveralls- multiple pairs
	Disposable gloves
	Mask
	Ear / eye protection
	Rubber boots / gloves

Check	<b>Cleaning and Disinfection</b>
	Brush and pail
	Long-handled brush
	Water
	Virucidal disinfectants and acetic acid
	Soap / detergent
	Cotton towels
	Paper towels
	Large plastic bags
	Duct and electrical tape
	Spray insecticide

Check	<b>Restraint Equipment</b>
	Ropes / Halters
	Tranquilizers
	Snare

Check	<b>Clinical Supplies</b>
	Blood-collection needles
	Blood-collection tubes
	Blood tubes with anticoagulant
	Test-tube rack
	Cooler / carrier
	Syringes and hypodermic needles
	Thermometer and stethoscope
	Paint stick

Check	<b>Necropsy</b>
	Clipboard
	Lead pencil
	Permanent markers
	Masking tape
	Euthanasia solution
	Necropsy kit
	Tweezers and hemostats
	Formalin
	Specimen containers and bags
	Sterile swabs and transport media
	Gel packs and cooler

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