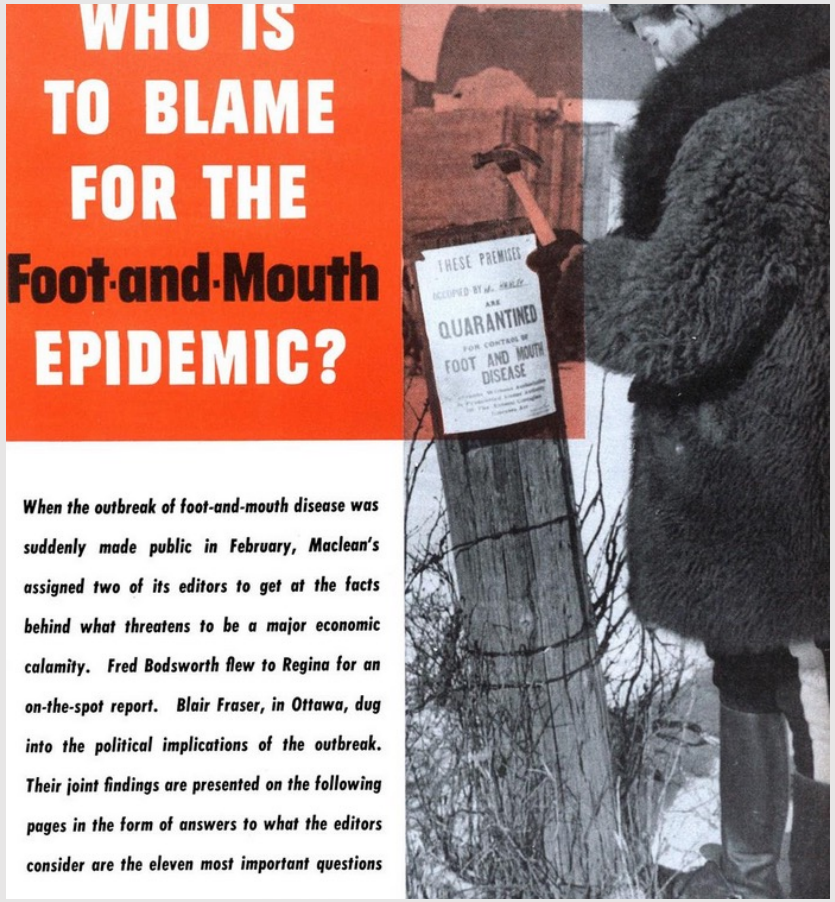






LECTURE 19 - PICORNAVIRIDAE

Russ Fraser, Fall 2023

Picornaviridae: general

Size	22 – 30 nm (small! “pico”)
Morphology	Naked
	• Icosahedral symmetry • Bullet shaped
Genome	• linear, +ve sense ssRNA, 7-8.5 kbp (RNA! “rna”)
Site of Replication	• Cytoplasm
Properties	• Genome is infectious • Large family that includes several reportable diseases, as well as the human common cold and poliomyelitits (polio) • Relatively stable in the environment

Picornaviridae

- At least 30 named genera with animal viruses:
  - Enterovirus
    - Swine vesicular disease virus
  - Cardiovirus
  - Sapelovirus
  - Aphthovirus
    - Foot-and-mouth disease virus
  - Hepatovirus
  - Tremovirus
    - Avian encephalomyelitis virus
  - Parechovirus
  - Erbovirus
  - Kobuvirus
  - Teschovirus
  - Avihepatovirus
  - Megrivirus
  - Senecavirus
    - Seneca Valley virus
  - Aquamavirus A
  - Piscevirus

Picornaviridae: viruses

- Foot-and-mouth disease virus (FMDV)
- Swine vesicular disease virus (SVDV)
- Senecavalley A virus
  - Associated with porcine idiopathic vesicular disease
- Avian encephalomyelitis (AE) virus

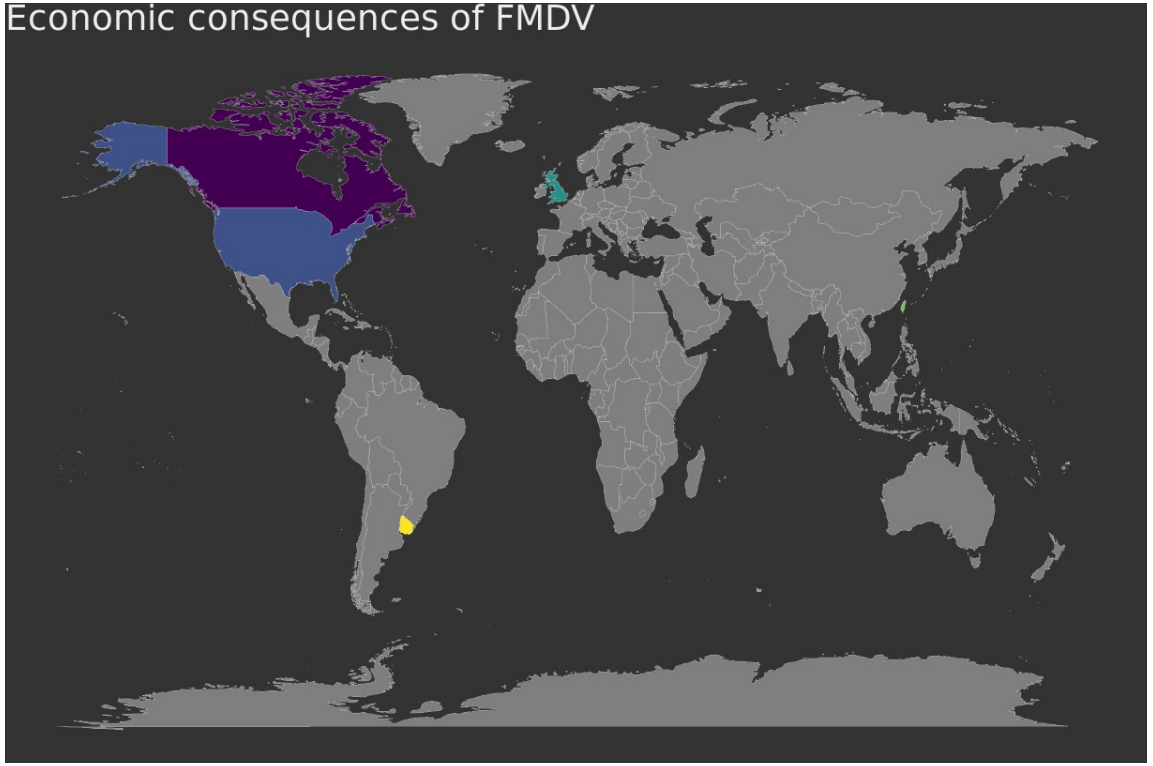


Foot and mouth disease virus

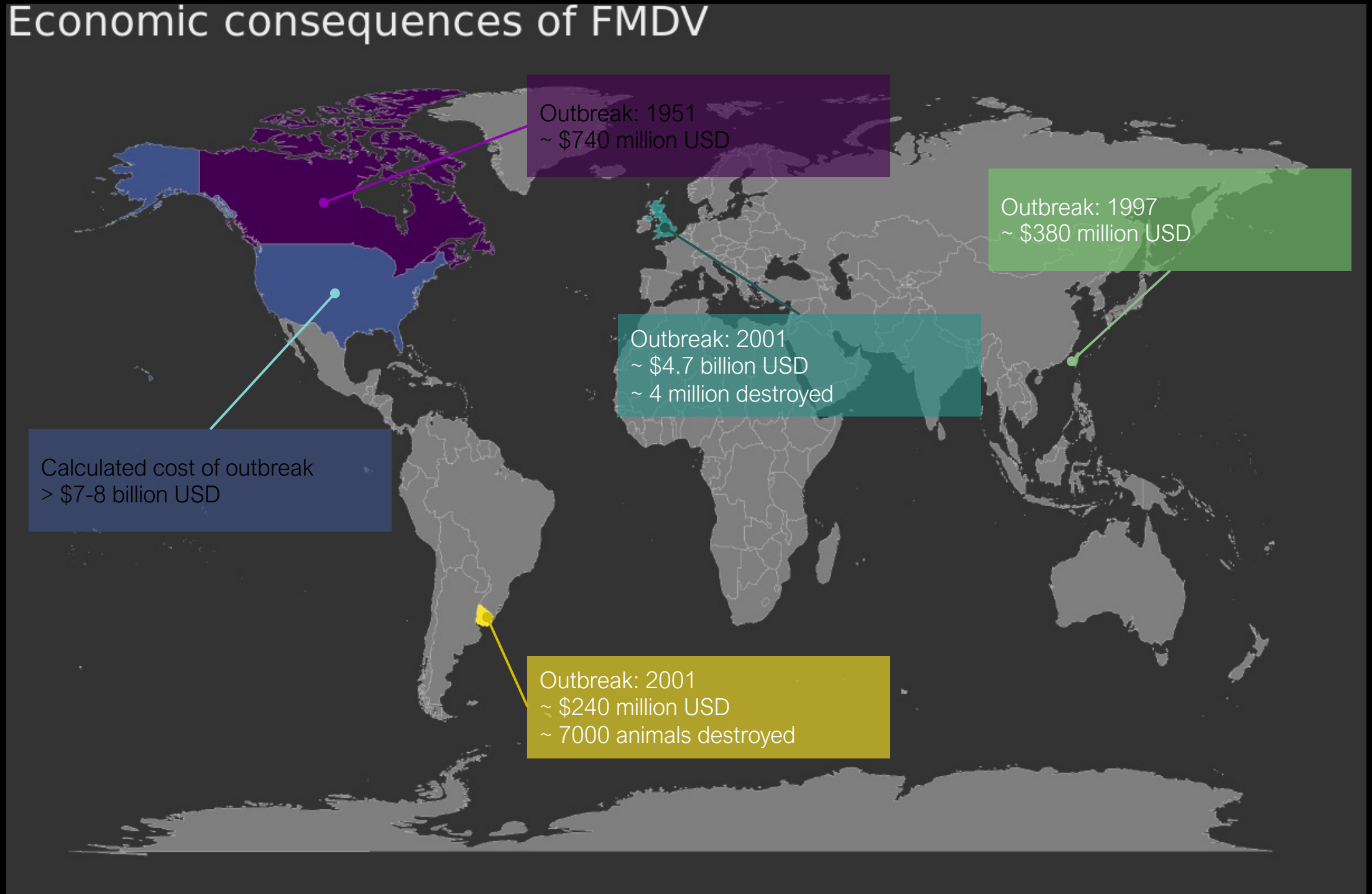
FMDV: significance

- Reportable

- Huge economic consequences
  - Long-term impacts on production
    - Convalescence and shedding are prolonged
    - Permanent ↓ in milk production and growth rates
  - Trade implications
  - Eradication



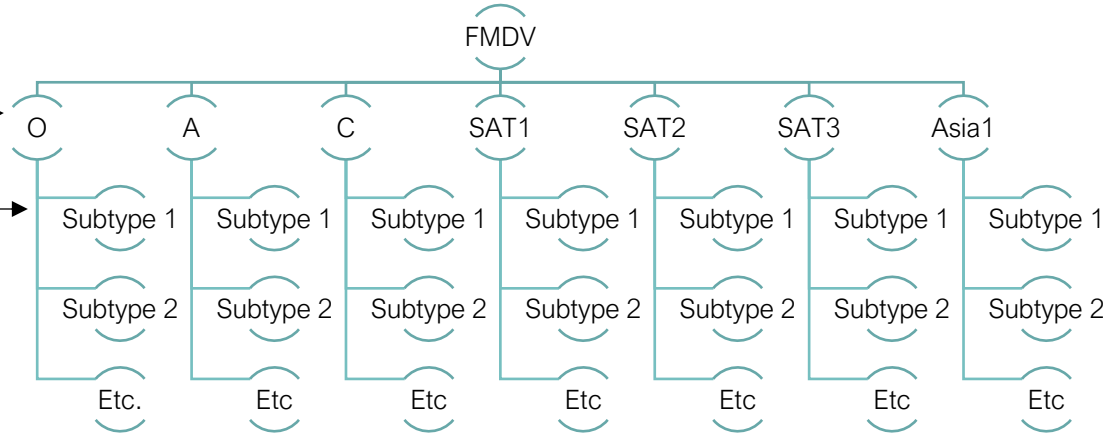
Economic consequences of FMDV



FMDV: general

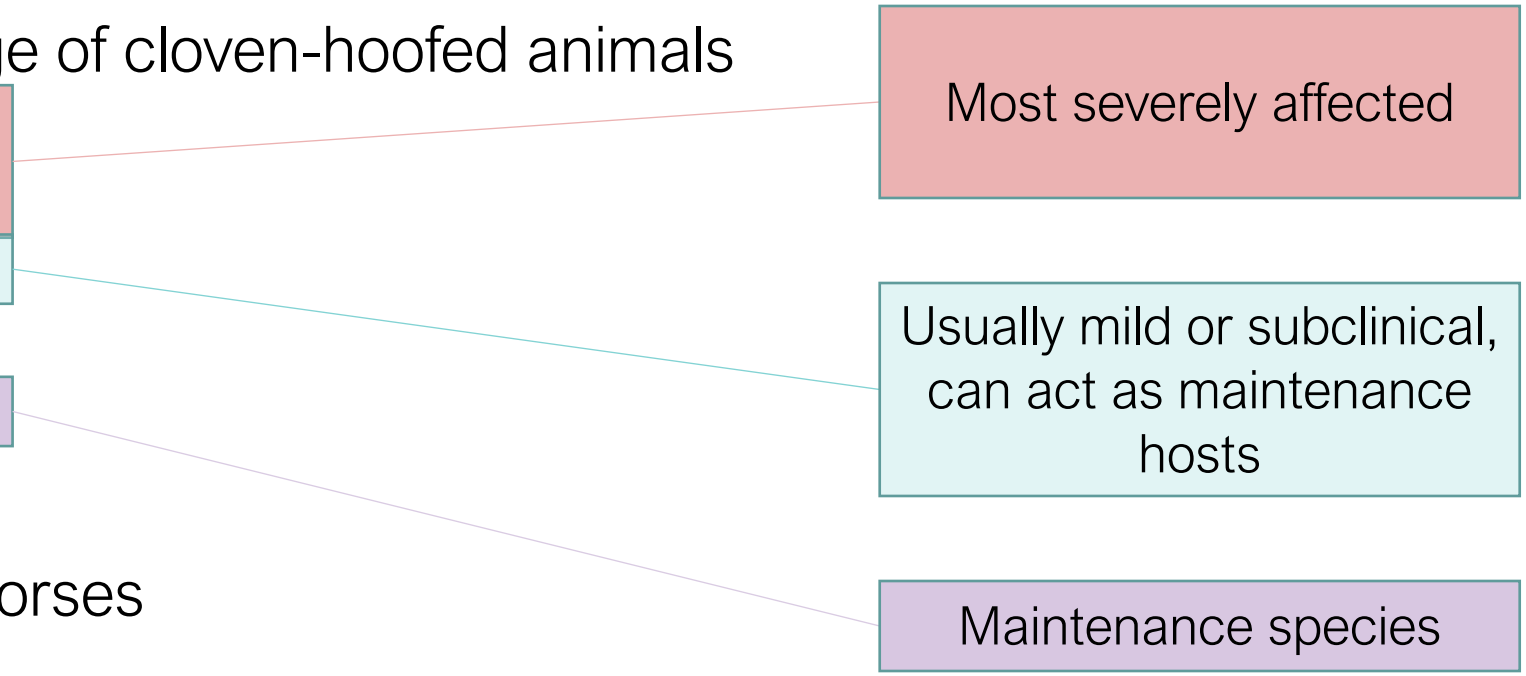
- Highly contagious
  - One of the most contagious viruses known
- Produced in huge quantities during infection
- Resistant to environmental conditions
  - Especially stable in cold conditions
- 7 serotypes
  - Each has many subtypes
  - Undergo antigenic drift
  - Considerable heterogeneity → difficulty with vaccines, and immunity between serotypes





FMDV: general

- Infects a wide range of cloven-hoofed animals
  - Cattle
  - Pigs
  - Small ruminants
  - Llamas, camels
  - African buffalo
- Does NOT affect horses



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Cattle may become persistently infected for up to 2 years (virus isolated and secreted > 28 days PI despite presence of Abs) – potentially important source of transmission in endemic areas

Do not develop persistent infections

FMDV: transmission

- Highly contagious
- Vesicles contain ↑↑ amounts of virus, but all secretions and excretions have virus
  - Pigs act as amplifiers of the virus, excreting 60 – 3000x as much as cattle
- Movement of animals is considered one of the most important sources of spread
- Direct contact between animals
- Contamination of fomites, feed, bedding, etc.
- Spread via equipment (trucks, boots)
- Aerosol and transfer via wind
  - Particularly from pigs → cattle (cattle more susceptible to inhaled route)
- Contaminated meat products (esp. pork)

FMDV: pathogenesis

Viral entry via ingestion or cuts/abrasions on skin or mucosa

Incubation 2-6 days ↓

Replication in MALT of pharynx

↓

Lymph nodes

↓

Bloodstream (viremia) → Myocardium of young animals

↓

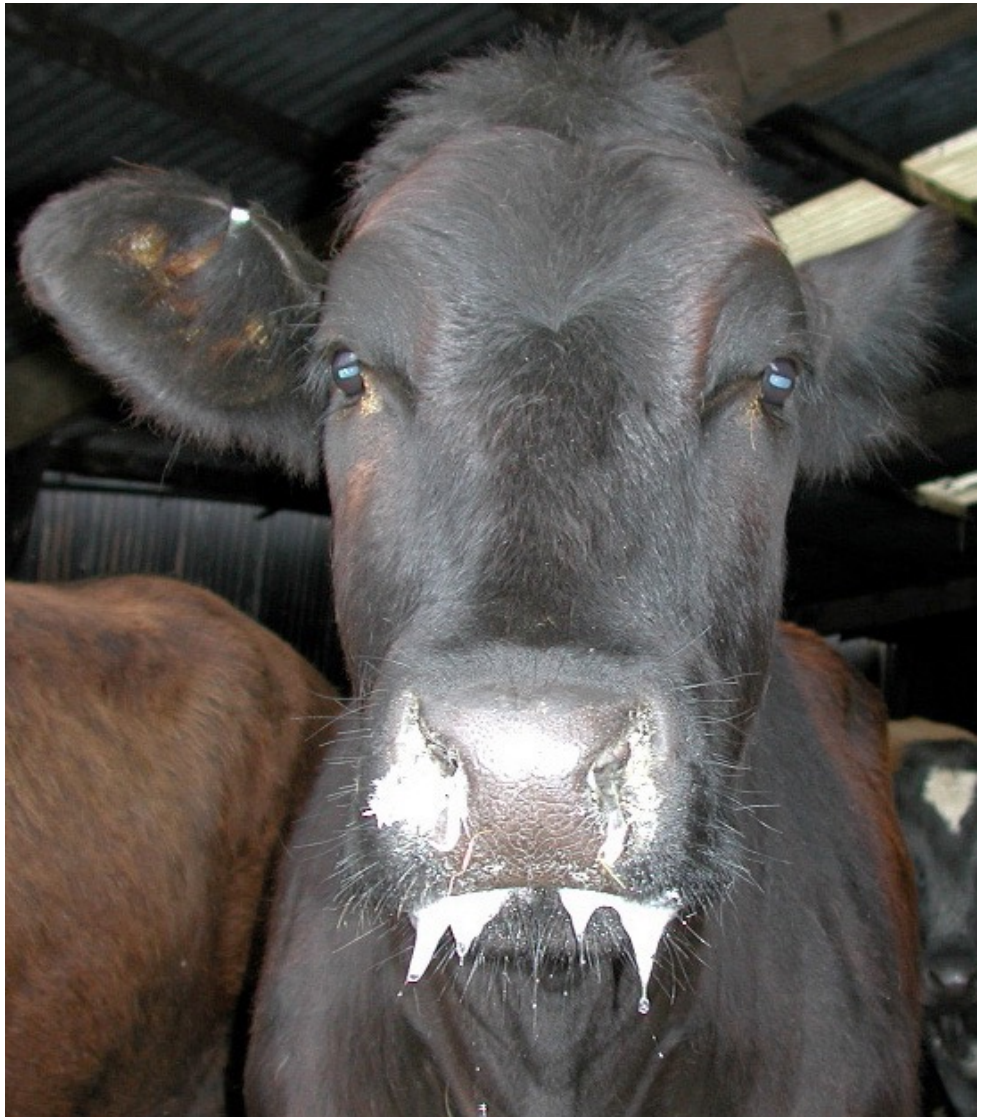
Surface epithelium (stratum spinosum)

↓

Replication and development of vesicles

FMDV: clinical signs

- ↑↑ morbidity, ↓↓ mortality
- Fever, dullness, anorexia
- Hypersalivation and drooling
- Lameness
- ↓ milk production, mastitis



FMDV: physical findings/gross lesions

- Vesicles, ulcers, and crusts in the oral cavity, feet (coronary band), and teats
- ± secondary infections



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FMDV: diagnosis

- FMD is a vesicular disease

VESICULAR DISEASES ARE CLINICALLY INDISTINGUISHABLE

- The vesicular diseases are:
- Foot-and-mouth disease
- Vesicular stomatitis
- Swine vesicular disease
- Vesicular exanthema
- Seneca valley virus disease

FMDV: diagnosis

	Reportable	Disease in pigs	Disease in horses	Disease in cattle
Food and mouth disease	Yes	Yes	No	Yes
Vesicular stomatitis	Yes	Yes	Yes	Yes
Swine vesicular disease	Yes	Yes	No	No
Vesicular exanthema	No	Yes	No	No
Senecavirus A	No	Yes	No	No

FMDV: diagnosis

Vesicular Diseases Reference Chart

	Foot-and-Mouth Disease	Vesicular Stomatitis	Swine Vesicular Disease	Vesicular Exanthema of Swine
Etiology	Aphthovirus	Vesiculovirus	Enterovirus	Calicivirus
Geographic Distribution	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)
Transmission	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
Incubation Period	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
Clinical Signs by Species	**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 indistiguishable from each other, particularly in swine.**			
Notification	**State & Federal Veterinarians should be contacted IMMEDIATELY and informed of suspicions**			
	Disease Indicators			

FMDV: diagnosis

- In cattle, also consider:
  - MCF, BVDV-MD, IBR, bovine popular stomatitis, pseudocowpox, bluetongue, (Rinderpest)
- In small ruminants:
  - Peste-des-petits ruminants, Orf
- In all animals, consider chemical burns, contact dermatitis, photosensitization, laminitis, and trauma

FMDV: diagnosis

- If you suspect a vesicular disease, call your local CFIA (APHIS/USDA) vet
- Positive identification of an index case is based on virus isolation.

> "All vesicular submissions should only be submitted under **Reason for Test** as Disease Investigation or Lab Referral. Under **Disease Category,** choose Foreign Animal Disease – Mammalian. Under **Submission Priority,** select either confirmatory Negative or High Risk. No other choices are acceptable".

- Subsequent cases can be confirmed by PCR.

FMDV: control

- Slaughter of affected and in-contact animals, quarantines, and restrictions on animal movements
- Guided in Canada by the CFIA FMD Hazard Specific Plan
- Historically, vaccination has not been routinely practiced
  - This is changing.

FMDV: vaccination

- High quality inactivated vaccines are now available
- Induce a short-lived humoral immune response (4-6 months)
- Recall that there are several serotypes, each with numerous subtypes, of FMDV
  - Vaccine has to represent the circulating strain
  - May need to be modified if/when virus becomes antigenically modified during prolonged outbreaks
- It is now possible (and recognized by the OIE) to distinguish between vaccinated and infected animals

FMDV: public health

- In theory a zoonotic disease that causes rare human disease
  - 40 cases in total since 1921.
  - Many without good laboratory confirmation

- WHO does not consider it a zoonotic disease.



Swine vesicular disease

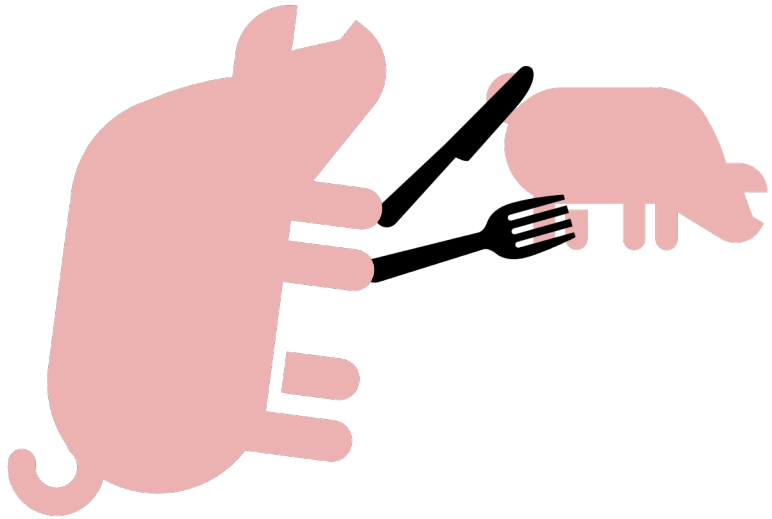
SVDV: general

- Reportable
- Thought to be an anthroponosis
- Endemic in Italy
  - Sporadic in Europe and Asia
- Very resistant to decontamination
  - Hard to decontaminate pig farms
  - Survives in meat for long periods
- Importance is primarily due to its similarity to FMDV
- Affects <u>pigs only</u>



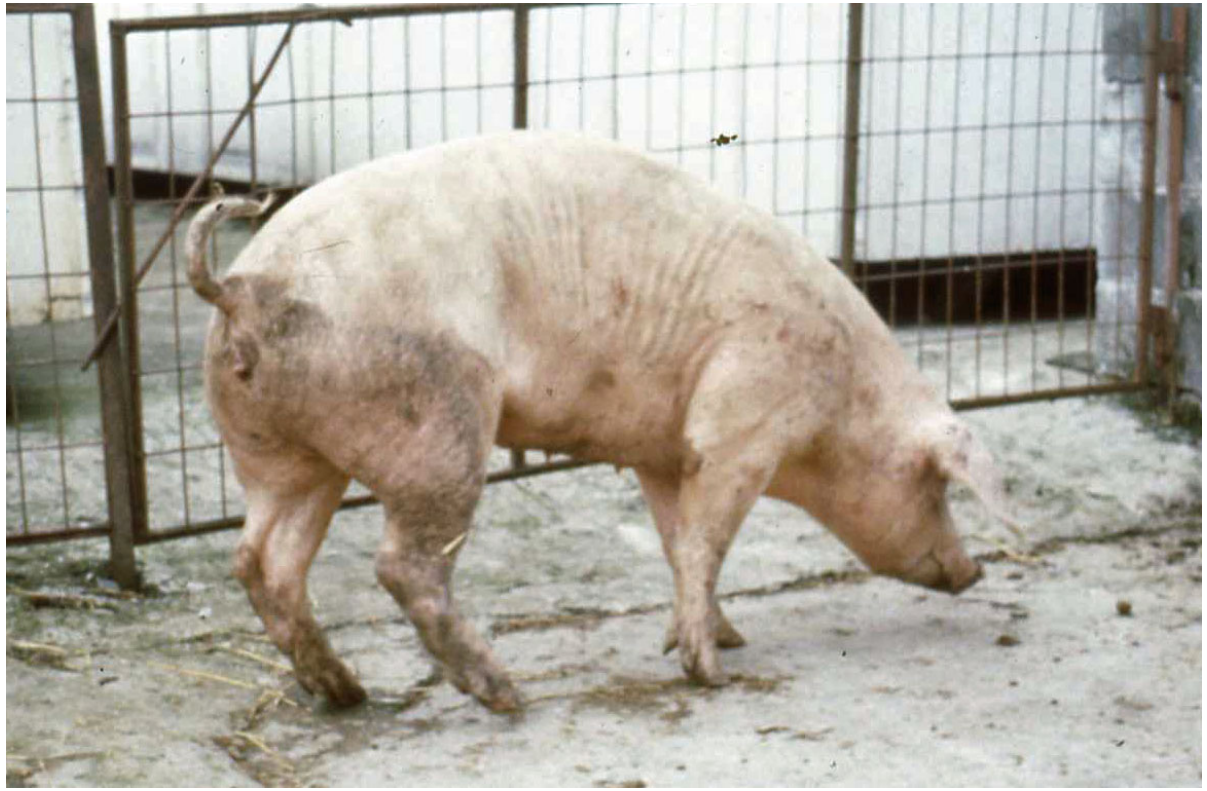
SVDV: transmission

- Feeding of contaminated meat thought to start most outbreaks
- Spread within the farm is then by:
  - Direct contact
  - Feco-oral
  - Entry through skin wounds
- Pathogenesis is similar to FMDV



SVDV: clinical signs

- ↑ ↑ morbidity, ↓↓ mortality
- Fever, anorexia
- Lameness
- Oral lesions ~10% of animals
- Nervous signs (uncommon)
  - Ataxia, circling, convulsions
  - Meningoencephalomyelitis



SVDV: gross lesions

- Vesicles, primarily around the coronary band, and on the hoof
- Also the snout, mouth, lips, tongue



SVDV: gross lesions



SVDV: gross lesions



SVDV: diagnosis and control

- Vesicular disease → call the CFIA
  - Multiplex PCR
  - ELISA
- Control is via slaughter, quarantine, and movement restrictions
- Zoonotic: occasionally causes flu-like symptoms

Senecavirus A

- Cause of Seneca Valley virus disease (formerly known as porcine idiopathic vesicular disease (PIVD))
  - Characterized by formation of non-debilitating ulcers, erosions and vesicles on snout, oral cavity, skin and coronary bands of pigs, lameness, and increased neonatal (< 7 days) mortality.

- Transmission similar to other picornaviruses.

- Strong clinical resemblance to vesicular foreign animal diseases (FMD, VS, VES, & SVD)

- Cases of SVA have been reported in Brazil, New Zealand, Australia, Canada (Manitoba), and USA.

Avian encephalomyelitis

Avian encephalomyelitis virus (AEV)

- Geographical distribution: worldwide.
- Host range: chickens, quail, turkeys, pheasants.
  - Clinical disease in chickens 1-21 days old without maternal antibodies
  - Virus is non-pathogenic in older birds.
- Transmission: horizontally via fecal-oral route (& vertically through the egg during viraemia).
- Target cells: all virus strains are enterotropic; some strains are more neurotropic.
- Clinical disease:
  - Incubation period is 1-7 days.
  - Clinical signs of ataxia, paralysis & prostration;
  - Tremors of head & neck (disease is also called Epidemic tremors);
  - Blindness (recovered birds develop cataracts & impaired vision), &
  - Death (may be >50% in susceptible flock).

Avian encephalomyelitis virus

- Diagnosis:
  - Differentiate from all poultry viruses that cause CNS signs: Newcastle disease, Marek's disease, EEE, WEE, & WNV.
  - Confirm diagnosis by:
    - IFA staining;
    - Virus isolation;
    - Inoculation of chicken embryos & observe clinical signs after hatching;
    - Seroconversion in Layers – particularly if following a drop in egg production.

- Control:
  - Immediately notifiable disease
  - Depopulation or vaccination
  - Inactivated or attenuated vaccines are used in breeders, to pass maternal antibodies via egg yolk to broilers and layers.