

## **African Horse Sickness**

This is a non-contagious disease of horse, mules and donkeys.

Aetiology: African horse sickness virus (AHSV), an orbivirus. The African horse sickness subgroup is made up of nine serotypes of AHSV and they are distinguishable by neutralization tests.

African horse sickness is endemic in subtropical and tropical Africa. Outbreak have also been reported in some parts of Asia (Middle East, India, Pakistan) and Europe (Spain and Portugal)

Transmission: AHS is transmitted by haematophagous insects. The major vector is *Culicoides imicola* (a species of Afro-Asian midge). *Culicoides imicola* once infected remains infected for life. The warm climate of Africa supports the multiplication of the midge and endemic disease occurs only in regions where *C. imicola* is constantly present. Outbreak occurs in regions outside the warm climate when wind blows the midge for up to 700km to those regions. Outbreaks occurs majorly during the warm humid season (summer). The virus may be isolated from clinically normal maintenance hosts such as the zebra and African donkey.

Clinical signs:

Four clinical forms of AHS are recognized:

1. A peracute pulmonary form characterized by depression, nasal discharge with rapid progression to severe respiratory distress. Mortality is close to 100%
2. a subacute cardiac form manifesting as conjunctivitis, abdominal pain and progressive dyspnoea  
subacute oedematous swelling of the head and mouth are most obvious in the supraorbital fossae, palpebral conjunctiva and intermandibular space. Mortality rate is p to 70%
3. A combination of pulmonary and cardiac features
4. a mild or subclassical form termed horse sickness fever observed in zebra and donkeys

Diagnosis:

- characteristic clinical signs and postmortem findings
- samples: blood, lymph nodes, spleen

- virus isolation in embryonated eggs or cell culture as well as intracerebral inoculation of newborn mice
- identification of isolated virus by immunofluorescence and typing by virus neutralization with monovalent antiserum or competitive ELISA
- reverse-transcriptase (RT)-PCR can be used for detection of viral RNA
- serological test by CFT, AGID, ELISA and serum neutralization tests

Control:

- vector control, quarantine and vaccination
- attenuated vaccines both monovalent and polyvalent containing up to four serotypes are available, vaccines do not prevent viraemia. Vaccine virus can revert to virulence and be transmitted by vectors. Vaccinated animals can not be differentiated serologically from those with foal infection
- inactivated vaccines based on serotype 4 are effective in preventing both clinical disease and viraemia
- a polyvalent vaccine must be used if there is a risk of exposure to different serotypes
- protective immune response may be generated using recombinant expressed structural proteins as subunit vaccines. Such vaccines should be safe and permit differentiation of vaccinated from infected animals

## Picornaviridae

- Consists of the smallest RNA viruses.
- They are naked, positive sense and single-stranded.
- There are six genera, four of which contain pathogens of veterinary importance.

### Viral Characteristics

- The picornaviruses are small (22 - 30 nm), naked, icosahedral viruses
- Replication takes place in the cytoplasm and the picornaviral RNA itself is infectious.
- Most can be propagated in cell culture producing a characteristic and rapid cytopathic effect. Exceptions are some rhinoviruses, which require a lower temperature and can be cultured *in vitro* in very few cell types such as human fetal tracheal cells.
- Most are host specific.
- They are able to survive in the environment for some time. They have been demonstrated to be infectious for several hours to one year, depending upon conditions.
- They are resistant to ether, chloroform and alcohol. They are susceptible to radiation, phenol, and bleach (chlorination). They are highly resistant to most disinfectants. However, 0.2% citric acid, 0.4% sodium carbonate, or acid-containing iodophore disinfectants are effective.

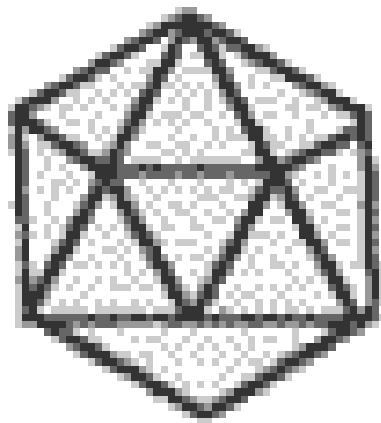


Figure 2. Picornaviridae (22 - 30 nm). Small, naked, icosahedral virions.

### Classification

Picornaviridae contains five genera, *Enterovirus*, *Aphthovirus*, *Teschovirus*, *Cardiovirus*, and *Hepatovirus*. The significant veterinary diseases and viruses in each genus are as follows:

- *Enterovirus*

- Teschen and Teschen-like diseases
- Swine vesicular disease
- Porcine enteroviruses
- Bovine enteroviruses
- Avian enteroviruses
- ***Aphthovirus***
  - Foot-and-mouth disease virus
- ***Cardiovirus***
  - Encephalomyocarditis virus
- ***Hepatovirus***
  - Avian encephalomyelitis-like virus: a tentative species in this genus.
  - Human hepatitis A virus
- ***Parechovirus***: Cause gastrointestinal and respiratory illness in humans.
- ***Rhinovirus***
  - Three species of equine rhinoviruses.
  - Bovine rhinoviruses 1, 2 and 3.
  - More than 100 human rhinoviruses. They are widespread and cause usually mild respiratory infections.

### ***Aphthovirus***

#### **Foot-and-Mouth Disease**

##### Cause

- Foot-and-mouth disease virus (FMDV).
  - Seven different serologic types are known, namely FMDV-A, FMDV-O, FMDV-C, FMDV-ASIA1, FMDV-SAT1, FMDV-SAT2 and FMDV-SAT3.
  - Types A, O, C are often referred to as European types because they were first isolated in Europe (France and Germany), although they do occur in other countries like Argentina, Brazil etc.
  - The SAT types were first isolated in "Southern African Territories" and are restricted to Africa.
  - The Asia type has only been reported in various parts of Asia.
- No serological/protection cross-reaction occurs between different types.

##### Occurrence

- All cloven-footed animals including swine, sheep, goats, deer and water buffalo are susceptible.
- Guinea pigs, rabbits, mice and some other species can be infected experimentally.
- Contact with infected animals rarely results in infection of humans, which is characterized by development of vesicular lesions on the hands, feet, and in the mouth.
- Foot-and-mouth disease (FMD) is widespread, occurring in South America, Africa, Europe, the Middle East and Asia. North America, New Zealand, Australia, and the United Kingdom are free at present.
- Most South American countries are in the process of eradication with only a few small outbreaks in the last few years. Effective continental strategies of control and eradication have been implemented.

### Transmission

- Spread is mainly by contact, fomites, and migratory birds.
- The mode of infection is by inhalation and ingestion.
- Airborne transmission has been reported and attributed to a combination of winds and humidity.
- The virus is considered particularly infectious and transmissible.

### Clinical Features

- Morbidity is very high; mortality is low.
- Lameness and marked loss of condition are frequent sequelae.
- Affected animals may recover in one to two weeks. Some may become carriers but their role in transmission is controversial.

### Diagnosis

#### Clinical specimens:

- Vesicular fluid, affected mucous membranes, pharyngeal and esophageal fluid, blood and serum.
- Diagnosis is based upon detection of FMDV in the aforementioned clinical materials. ELISA and complement fixation procedures are used.
- A mouse inoculation test is widely used to demonstrate virus. Suckling mice are inoculated intraperitoneally with liquid from vesicles and macerated tongue/foot lesions. If the material is positive, mice die in a few days. Several passages are made before the material is considered negative. This test is usually performed along with a serological test.
- The FMD virus can be isolated in a variety of cell cultures. Viral growth with accompanying cytopathology occurs best in primary cell cultures. Identification is accomplished by virus neutralization and complement fixation tests.
- A test for virus infection associated antigen detects antibody against the viral polymerase, which is considered present only during infection and not upon vaccination. It is used to distinguish active infection from vaccination with inactivated antigen.
- Real time PCR has been used to rapidly detect virus.

### Prevention

- FMD is the most important economic disease of cattle and thus is reportable in many countries. Regulatory officials should be contacted if the disease is suspected. Confirmed outbreaks are dealt with in many countries by strict quarantine and slaughter. The difficulty of eradicating the disease once established was strikingly evident in the recent outbreak in Britain.
- In areas where the disease is endemic, vaccination is practiced using killed vaccines, of cell culture origin, containing the appropriate serotypes of virus for the region. The most effective vaccines in current use contain inactivated virus with an oil- adjuvant. Although

requiring periodic revaccination, this type of vaccine has been quite effective and has contributed markedly to eradication in a number of countries.

### ***Hepatovirus***

#### **Avian Encephalomyelitis**

(Epidemic tremor)

#### Cause

- Avian encephalomyelitis virus of which there are 15 serotypes.

#### Occurrence

- Avian encephalomyelitis is an important, frequently occurring disease with worldwide distribution. It affects chickens, pheasants, turkeys, and quail.

#### Transmission

- Transmission is via the egg and by the oral/fecal route.

#### Clinical & Pathologic Features

- Signs in young birds include tremor of the head, in-coordination, and leg weakness with loss of condition followed frequently by prostration and death. Average mortality rate is about 20%.
- Some infections are asymptomatic and are only diagnosed by the finding of brain lesions.
- The lesions in the brain and spinal cord consist of loss of neurons and perivascular cuffing that is mainly observed in the cerebellum, medulla, and pons. Diffuse lymphoid nodular hyperplasia is observed in the proventriculus, spleen, pancreas, and liver.

#### Diagnosis

Clinical specimens:

- Brain and spinal cord.
- A presumptive diagnosis can be made clinically. Finding the typical microscopic lesions is supportive.
- Definitive diagnosis depends upon the demonstration of the virus by the intracerebral inoculation of day-old susceptible chicks. If virus is present, epidemic tremor develops in 10 - 12 days, and the brains can be harvested for histopathologic examination.
- Another diagnostic method is the inoculation of brain suspension into chicken embryos via the yolk sac; signs of encephalomyelitis infection in the chicks are observed after hatching. Tissues from these birds should be examined histologically after the signs appear.
- The virus can be cultivated in primary whole embryo cell cultures.
- Antibodies can be demonstrated by means of neutralization tests in chicken embryos employing an embryo-pathogenic strain of the virus.
- A commercial ELISA is available for the serologic monitoring of chicken flocks.

### Prevention

- A live virus vaccine is administered in the drinking water to 10 - 16 week-old birds.
- Killed vaccines are used to revaccinate breeders with poor antibody response. These vaccines are administered by the wing-web stick method.

## **Papillomaviridae**

- Double-stranded DNA viruses
- Once included with polyomaviruses in the discontinued family Papovaviridae.
- The myriad papilloma viruses cause papillomas (warts) of the skin and mucous membranes of most domestic animals and a wide variety of other mammals and birds.

### **Viral Characteristics**

- Viruses are nonenveloped, circular dsDNA viruses with icosahedral symmetry.
- The genome consists of a single, circular molecule of double stranded DNA. The dsDNA serves as a template for transcription of mRNAs and progeny genomes by host enzymes.
- Replication and virion assembly occur in the nucleus and virions are released by destruction of the nuclear and cell membranes.
- Papillomaviruses replicate in the nucleus and new virions are released with the lysis of the cell.
- Because papillomaviruses grow poorly if at all in cell culture, it has taken significantly longer to understand how they replicate. Much has been learned recently by the study of bovine papillomavirus-1 (BPV-1).
- Papillomaviruses produce diagnostically significant koilocytotic (vaculated) cells while replicating.
- Viruses are resistant and remain viable for long periods of time on contaminated premises.
- Transmission is mainly by direct contact and fomites.
- Viruses are host species-specific.
- Papillomaviruses target squamous epithelial cells of the skin and mucous membrane.
- The many papillomatoses are common and occur worldwide.
- Immune response to papillomaviruses associated with the spontaneous regression of warts is mediated by both cellular and humoral immune responses.
- Some papillomaviruses cause neoplastic transformation of cells and have been implicated in the cause of bovine and human cancers.

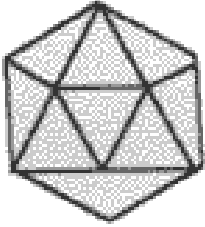


Figure 3. Papillomaviridae (~55 nm). Illustration of the icosahedral capsid.

### **Classification**

This family has a single genus, *Papillomavirus*.

The papillomaviruses, which are species-specific, infect many animals including humans, chimpanzee, monkeys, cattle, deer, dog, horse, sheep, elephant, elk, opossum, rabbit and birds. The genus consists of a number of antigenically distinct papillomaviruses:

- six types occur in cattle,
- three types in dogs,
- two in rabbits and more than 100 in humans.

Types are largely distinguished by the characteristic restriction endonuclease cleavage of their genome.

### **Bovine Papillomatosis**

(Common warts of cattle)

#### Cause

- Six types of papillomavirus cause bovine papillomatosis.

#### Occurrence

- Bovine papillomatosis occurs frequently worldwide, mainly affecting young cattle. They occur with greater frequency in stabled cattle.

#### Clinical & Pathologic Features

Papillomas develop as small nodular growths of the skin or mucous membrane. They initially grow slowly, but then more rapidly and eventually become larger, horny, pendulant and sometimes cauliflower in shape. They ultimately necrose and fall off.

The most common sites affected are the head (particularly around the eyes), neck, and shoulders. They may occur on the penis of the bull and in the vaginal mucosa of the female, resulting in breeding difficulty.

After about a year there is usually spontaneous recovery.

The recognized six types of bovine papillomaviruses are associated with particular sites as follows:

- Types 1 and 2: head, neck and shoulders; penis and vaginal mucosa.
- Type 3: persistent papillomas of the skin.
- Type 4: papillomas in the alimentary tract; malignant transformation associated with concomitant bracken fern ingestion has been reported.



- Type 5: "rice-grain type" papillomas of the teat.
- Type 6: flattened (frond-like) papillomas of the teat.

### Diagnosis

- This is usually based on characteristic gross appearance. Laboratory diagnosis is not usually sought.
- Definitive diagnosis requires histological examination for the presence of koilocytes.
- Although not employed for diagnosis, types 1 and 2 bovine papillomaviruses can be cultivated in cell cultures and on the chorioallantoic membrane of chicken embryo.

### Prevention

- Commercial wart vaccines and autogenous wart vaccines, both consisting of finely ground warts, are used. Formalin is often used to kill the virus and a preservative is added. Their value is questionable.
- To prevent spread, affected animals should be isolated.

The BPV-1 is currently being investigated as a potential shuttle vector for moving genes into animals. In addition to BPV-1, human papillomavirus (HPV)-6b, -11, -16, -18, and -31 are also being investigated for use in this manner.

### **Bovine Papilloma Virus 2 and 4**

The combined action of bracken fern and BPV 2 or 4 are thought to produce tumors in the upper digestive track of cattle.

Enzootic hematuria due to ingestion of bracken fern occurs in cattle worldwide. The hematuria results from hemorrhages caused by tumors in the bladder wall. Studies suggest that the oncogenesis is due to the combined action of bracken compounds and BPV 2.

## **Flaviviridae**

- Enveloped, positive-sense single-stranded RNA viruses.
- There are three genera, two of which include important veterinary pathogens. One of these, *Flavivirus*, has more than 50 species, many of which are mosquito and tick-borne.

### **Viral Characteristics**

- Flaviviridae are similar to each other in virion morphology, genome organization, and replication strategy, but lack serological cross-reactivity across the family.
- Envelope contains at least two viral envelope proteins that are thought to be involved in receptor-mediated endocytosis. However, the target receptor has not yet been identified.

- Once the genome has entered the cytoplasm, it is translated by host ribosomes into a large polyprotein (a polypeptide comprised of several proteins). The polyprotein is then cleaved by viral and host proteases into approximately ten individual proteins.
- A great deal about the replication strategy is currently unknown. This has unfortunately limited vaccine and antiviral drug development.



Figure 6. Flaviviridae ( 40 - 60 nm). Complex virion structure, enveloped, nucleocapsid has icosahedral/polyhedral symmetry.

### **Classification**

- The Flaviviridae consists of three genera, *Flavivirus*, *Pestivirus*, and *Hepacivirus*.

#### ***Flavivirus***

- Consists of more than 50 antigenically related viruses.
  - Some are mosquito-borne, some tick-borne and others have not been associated with any arthropod.
  - A number cause disease in animals and humans. Some have been recovered from bats, marsupials, rodents and birds.
- Louping ill virus
  - West Nile virus
  - Japanese B encephalitis virus
  - Wesselsbron virus
  - St. Louis encephalitis virus: The host is birds. Transmitted by mosquitoes. Causes human encephalitis in the Americas.

#### ***Pestivirus***

- Viruses of this genus are not related antigenically to the viruses of the other genera.
- Bovine viral diarrhea virus
  - Swine fever virus
  - Border disease virus

## *Hepacivirus*

- Hepatitis C virus: A major cause of hepatitis in humans.

## *Pestivirus*

- **Bovine Viral Diarrhea**  
(Mucosal disease)
- **Border Disease**  
(Hairy shaker disease)
- **Swine Fever**  
(Hog Cholera)

## **Swine Fever** (Hog Cholera)

### Cause

Swine fever virus.

### Occurrence

- Has been mostly eradicated in countries like United States , Canada, UK, New Zealand, Australia, Iceland, and Switzerland.
- disease still occurs in South America, outbreaks are infrequent to rare.

### Transmission

- Saliva, nasal secretions, faeces, blood, and urine.
- Spread is by direct and indirect contact.
- Pigs are infected by ingestion or inhalation;
- birds and haematophagous arthropods may be mechanical vectors.
- The disease has been spread by consumption of uncooked pork scraps.

### Diagnosis

Clinical specimens:

Kidney, spleen, tonsil, lymph nodes, brain, and blood.

- Diagnosis is based on clinical signs, gross and microscopic lesions, and laboratory tests.
- Fluorescent antibody (FA) test on frozen sections of spleen, tonsil, and lymph nodes is the simplest and most reliable means of diagnosis.
- Virus can be cultivated in cell cultures of swine origin but grows without discernible CPE. Cell culture cover slips are stained with specific FA to confirm the presence of virus.
- Reverse transcription (RT)-PCR can also be used to detect swine fever virus in clinical specimens. This method converts viral RNA to DNA and allows for specific

amplification of swine fever virus nucleic acid. This method is rapid and highly sensitive, but has yet to be accepted for routine clinical diagnostic use.

- Virus-specific monoclonal antibodies are used to distinguish the viruses of swine fever, BVD and border disease. Virus characterization in this manner confirms any antigen detection or virus isolation tests that may be performed.

### Prevention

- Countries free of hog cholera have strict importation and quarantine requirements to prevent entry of the disease.
- Live attenuated virus vaccines are used in countries where the virus is endemic. Such vaccines are inappropriate where eradication is being attempted in that the virus may continue to circulate subclinically in vaccinates.
- A marker vaccine (gene-deleted vaccine) has been developed that doesn't express one of the viral glycoproteins. Thus the vaccinated animals can be differentiated from infected (wild type virus) by the lack of an antibody response to the viral glycoprotein. Marker vaccines are not yet widely used in eradication programs.