

Control and eradication of Foot and Mouth Disease

Paul Suttmoller, Simon S. Barteling, Raul Casas Olascoaga and Keith J. Sumption
Virus research 91 (2003) 101-144

Summary of conclusions

FMD Virus infection

- FMD virus infection often is airborne through the upper and lower respiratory tract.
- FMD virus can also enter the new host through abrasions of the mouth epithelium and of the skin of feet and udder.
- The peak of infectivity is just prior or during the development of lesions. Infectivity is much-reduced 3-4 days after the lesions develop.
- The clinical manifestations of FMD usually are severe, but sequels following initial recovery can seriously impair livestock productivity.

Transmission of FMD virus

- When many susceptible animals are exposed to less than a minimal infective dose of FMD virus, at least one of these animals will likely become infected. One infected animal in the herd or flock will then start an outbreak.
- Cattle produce the greatest total amount of virus of all livestock species and are the major source for the dissemination of FMD.
- FMD is very contagious and spreads in many ways: by direct or indirect contact and through the air by infectious aerosols and fomites.
- Cattle are probably the main source of environmental FMD contamination
- The *total* amount of infectivity from aerosols and lesions together is at least one magnitude higher for cattle than for pigs and is several magnitudes higher for cattle than for sheep.
- Primary infections in FMD free countries have frequently involved pigs; pigs can excrete large quantities of virus (aerosols) before clinical signs develop.
- Excretion of virus by cattle, pigs and sheep often peaks before clinical signs occur.
- Large-scale animal movements create a special hazard regarding the spread of FMD.
- Transport of FMD infected animals and hauling of infected carcasses must be done in sealed containers to prevent escape of virus. Rendering of FMD-infected carcasses must be done under strict bio-safety conditions
- People can be efficient mechanical transmitters of FMD, in particular if they go from farm to farm and carry out clinical examinations.
- Any person (veterinarians, farmers, sanitary and digester personnel etc.) who had contact with infected animals or carcasses must take strict bio-safety measures and refrain from contact with susceptible animals for at least 3-5 days.
- Protective clothes and heavy rubber gloves must be worn when handling contaminated materials, particularly infected animals and cadavers.
- Sanitary disposal of contaminated clothing and gloves is essential.

Airborne diffusion of FMD virus

- Pigs are major producers of virus aerosols. Pigs create the more infectious aerosols than cattle or sheep
- High-pressure sprays used for cleaning infected premises and holding facilities, trucks and equipment to haul cadavers of infected animals can generate large amounts of infectious aerosols.
- Milk trucks collecting milk from infected premises can be an important source mechanical transmission and of infectious aerosols.
- Long distance air-borne spread of the pan-Asian type O strain was not a significant feature of the epidemic during the 2001 outbreak
- Computer models used to predict the airborne spread of FMD can be useful tools, but the results of the simulations must be interpreted with caution.

FMD virus dissemination by wildlife and vermin

- During epizootics, spread of FMD by deer or other susceptible wildlife species must receive serious consideration. However, if these animals are left in their territory (without hunting and chasing) the disease is likely to fade out.
- Vermin might spread FMD from infected premises, particularly when cleaning and decontamination have eliminated normally available feed sources

Persistent infection with FMD virus

- In epidemiological terms a “carrier” is a persistently infected animal able to disseminate that infection, yet remain clinically without symptoms of the disease. The FMD “carrier” does – with the exception of the African buffalo - not fit that definition because so far there is no real prove that it is contagious.
- The carrier state often occurs in FMD convalescent animals, particularly in cattle and the Cape buffalo. The duration of the carrier state depends on the individual animal, animal species, and virus strain. Among the domestic species the largest number of carriers occurs in cattle followed by sheep and goats. Pigs or camelids do not become carriers.
- Vaccination by itself does not cause the carrier state. A vaccinated animal must be exposed to FMD virus to become a carrier. Vaccination suppresses the amount of FMD virus in the environment and thus the (final) number of carriers in the population.
- The risk that carrier animals transmit FMD to susceptible livestock by direct contact is very low. The risk that a carrier animal produces an infectious aerosol is negligible or close to zero.
- There are no indications that vaccinated (carrier) cattle ever caused new outbreaks. Carriers among vaccinated livestock have not caused FMD outbreaks, nor have they hampered FMD eradication efforts.

FMD Vaccination

- In general, oil adjuvant vaccines produce a longer lasting immunity than aluminum hydroxide-saponine vaccines. They protect cattle of different breeds under a variety of epidemiological and ecological, tropical and temperate climatic conditions.
- Swine can also successfully be protected. FMD vaccination can be used strategically in high-risk areas.
- Sheep can be very well protected with FMD oil-adjuvant vaccine and a long lasting immunity has been demonstrated in this species. Vaccination of sheep is not included in South America in systematic vaccination programs.
- FMD was eradicated from Europe by the systematic application of classical aqueous aluminum hydroxide-saponin vaccines.
- Oil-adjuvant vaccines were not used extensively in Europe.
- An extensive FMD outbreak can be controlled and eradicated in a very short time, with minimal disruption of the rural society by vaccination of cattle only, in combination with livestock movement stand-still.
- FMD control and eradication programs in South American countries have applied the systematic vaccination of cattle only, using well-controlled oil-adjuvant vaccines. In several countries this was done with great success resulting in complete eradication of FMD.
- Breaking of the cycle of endemic and active virus niches of the disease can be done by massive and strategic cattle vaccination campaigns.
- Products from vaccinated animals, such as milk and meat, are completely safe for human consumption.

Vaccine banks

- FMD banks of purified and potent antigens and vaccines must be available for immediate use and application.
- FMD antigen stored in (international) vaccine banks can be formulated into oil-adjuvant vaccines of high-potency that can be used to protect all species that are susceptible for FMD.
- Early protection afforded by such FMD vaccines permit their use for (emergency) ring-vaccinations to rapidly control outbreaks.
- To control outbreaks, large stocks of concentrated purified antigens must be available for the rapid preparation of (potent) emergency vaccines.
- After emergency vaccination remaining foci of active virus must be traced by screening (vaccinated) herds for antibodies against non-structural proteins. Therefore, stored concentrated antigens must sufficiently be purified and not induce antibodies against non-structural proteins.

Differentiation between FMD-infected animals and vaccinated non-infected animals

- EITB tests and ELISA measuring a-NSP antibodies are useful serological indicators of current and past infection.

- These tests are not 100% sensitive in individual animals, but perform very well if used for screening on a herd basis; combinations of tests can raise the sensitivity yet further.
- Viral isolation (probang) tests and PCR to detect viral RNA can be used to confirm the presence of persistent infection in individual animals. The significance of the detection of viral RNA by PCR remains to be determined.
- Vaccines prepared from presently available highly purified FMD antigens - like those in vaccine banks - will in combination with tests for antibodies against non-structural proteins perform like a “marker” vaccine. Vaccines prepared from purified antigens will not induce antibody to NSP that interfere with the interpretation of the serological surveys.
- Tests to discriminate between carriers and vaccinated animals have been widely used and the results are, in general, internationally accepted.
- Serological surveillance - after vaccination - for anti-NSP antibodies does not require bio-security laboratories.
- If an FMD outbreak is controlled by vaccination, testing for antibodies against non-structural proteins amongst vaccinated livestock contributes to risk reduction.
- International experience and data from around the world show that, after emergency vaccination, efficient screening programs can be designed to determine the prevalence of a-NSP positive animals. The risk of (vaccinated) carriers not detected by such screening programs is very low.
- A serological survey (for anti-virus antibodies) of the surveillance zone around the vaccination zone may together with the results of the a-NSP test verify a FMD-free status.
- Risk management based on science-based risk assessments must deal with the hypothetical risk of vaccinated carriers. The present zero-risk approach is inappropriate.