Food and Agriculture Organization of the United Nations

eufmd
european commission for the control of foot-and-mouth disease

EuFMD TRAINING

More than 600 veterinarians and 50 countries have benefitted from our training courses since the establishment of the programme in 2009

Real Time Training: field experience, clinical diagnosis, lesion ageing, epidemiology, biosecurity - Online FMD Emergency Preparation Course - FMD Modelling as a Decision Support Tool - FMD Laboratory Techniques - FMD Vaccination - Introductory Epidemiology - e-Learning - Multi-lingual training - Tailored courses.

#eufmd

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Complete reports from all previous Real Time courses, with timelines and photos are available on the Eufmd e-learning space: https://eufmd.rvc.ac.uk/ in the 'Resources' section. All presentations given during the training will be uploaded to your course page on the e-Learning web site.

Information is also available on the the EuFMD main web site: www.fao.org/ag/eufmd/training

Introduction to Real Time Training (RTT)

The Real Time Training courses are intensive, 5 day courses in the clinical recognition, diagnosis and investigation of foot and mouth disease (FMD). They include training on laboratory testing, outbreak investigation and biosecurity. The objectives are to train veterinarians and stakeholders from FMD free countries in the skills required to undertake clinical and epidemiological enquiries in the event of an FMD outbreak. Courses take place in countries where FMD is endemic and have been held in Turkey, Kenya and Nepal. Courses are run in close collaboration with the host country veterinary services, and veterinarians from the host country are trained alongside the visiting trainees. Crucially, the Real Time courses provide invaluable experience of seeing actual cases of FMD 'first hand' along with experience of how to apply knowledge of biosecurity, laboratory testing and outbreak investigation in a practical way.

Teamwork and Roles –Real-Time FMD Training Course

- ***Welcome***

Welcome to the Nakuru Real Time Training Course. We hope you will enjoy this opportunity to learn so much about FMD, here in Kenya. Remember, the more you put into the training, the more you will benefit!

- ***Expectations***

All participants, both international and local, are expected to work together throughout the RTT course. All individuals are required to help to plan field work, to be proactive during field visits, to take the appropriate biosecurity measures, and to analyse and report results. The staff from the Department of Veterinary Services will help to answer questions on the local FMD situation, and provide demographics and animal movement information/data where possible. At the end of the course the participants will produce a collaborative report.

- ***Teams***

The RTT group will be divided into two teams for the field exercises and report writing:
Please note that the members of both teams will have the opportunity to clinically examine cases, and to experience the collection and testing of diagnostic samples.

Clinical investigation and diagnostics team

Prior the field visit this team should:

- Design clinical signs and sample recording forms, prepare for sampling on Day 2 (selecting materials and equipment), and plan for the cataloguing of photographs.
- The team must liaise with the Epidemiological Team.

On farm this team should:

- Select animals for clinical examination, estimate the age of the lesions, collect the appropriate diagnostic samples, perform penside test(s), and take probang samples.
- Keep records of and photograph the evidence of clinical and test findings. Link each case with the photo and samples.
- Make sure appropriate biosecurity measures are taken on entry and exit from the farm.

Outputs:

- Summarize the evidence of FMD infection (clinical and lab).
- Taking appropriate samples and testing in the field (penside tests).
- Photographic evidence taken and catalogued, with links to animal identification.
- Immediate verbal presentation (to group), and written sections of the final report.

Team roles include: Team Leader, reporter, logistics, photographer, biosecurity officer.

Epidemiology/Tracing Team:

Prior the field visit this team should:

- Collate epidemiological information of recent relevant outbreaks in the region, gather appropriate information regarding demographics/movement patterns, and any other relevant epidemiological information.
- Design a pragmatic epidemiological questionnaire; to investigate the outbreak and to assess the impact of the disease
- This team must liaise with the Clinical Team

On farm this team should:

- Undertake group and, where required, individual interviews to identify risk factors for entry and spread of FMD, identify recent and longer term FMD events, and identify dangerous contacts.
- Survey the premises (and wider village if necessary) to identify boundaries and entrance(s); identify animal groups in the village that may be at a different level of risk

Outputs:

- In liaison with the clinical team construct a time-line for the entrance and spread of FMD to the premises/village
- Identify the possible and mostly likely source(s) of infection; identify other holdings at risk and assess the impact of the disease in the farm.
- Recommend follow-up actions for the farm/village/area
- Immediate verbal presentation (to group), and written sections of the final report

Team roles include: Team Leader, reporter, interviewer & recorders (at field site), mapper (of field site) and GIS (for report), photographer.

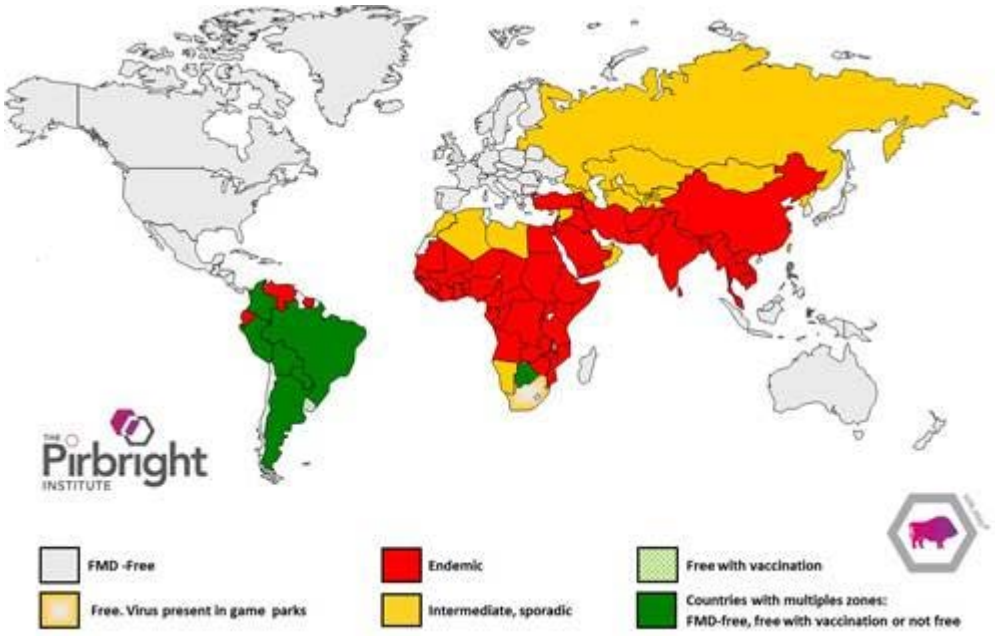
FMD Overview

- ***1-Introduction to Foot-and-mouth disease***

Foot and mouth disease (FMD) is a highly contagious, acute viral disease affecting cloven hooved animals, including pigs, cattle, sheep and goats.
The disease is characterized by the formation of vesicles and erosions inside the mouth, and on the nose, teats and feet. Mortality is low in adult animals, but can be common in young piglets, calves and lambs.
Foot and mouth disease causes severe economic losses. These can be direct, for instance a drop in milk production, or in an FMD free country, through the cost of animals slaughtered. Losses may also be indirect, for instance through loss of trade. The FMD virus is a small non-enveloped RNA virus. (Family Picornoviridae, genus Aphthovirus)
The virus is very resistant and able to survive well in the environment, due to its non-enveloped structure.
The virus is susceptible to inactivation at low or high pH, so acid or alkali disinfectants can be effective.
RNA viruses show frequent spontaneous mutation. This means that new lineages of the virus frequently emerge, allowing the evolution and origin of strains to be tracked. There are 7 immunologically distinct serotypes of FMD virus: O, A, C, Asia1, SAT-1, SAT-2, SAT-3 (SAT stands for Southern African Territories). Within each serotype there are many constantly evolving strains. Infection with one serotype does not give immunity to infection with a different serotype. In many endemic countries more than one serotype is circulating at once. It is therefore often necessary for animals to vaccinated for multiple FMD virus serotypes

- ***2. Conjectured status for FMD (2013)***

Europe, North and Central America, the Pacific nations and the Caribbean are officially recognized by the OIE as free of FMD without vaccination.
The disease is endemic in many countries in Africa, the Middle East, Asia and South America, although significant improvements have been made in South America and South East Asia in recent years.



Reproduced courtesy of Dr Jef Hammond, OIE/FAO FMD World Reference Laboratory, Pirbright Institute

- ***3. Susceptible species***

The main domestic species susceptible to FMD are cattle, sheep, pigs and goats.
Alongside these key domestic species, over 70 other animal species are known to be susceptible. Wildlife species including buffalo, wild pigs, antelope and yaks can become infected, although infections in many species are usually subclinical. Camelids such as llamas and alpacas can also be infected, although, again, the disease in these species is often subclinical.

- ***4. Routes of Infection***

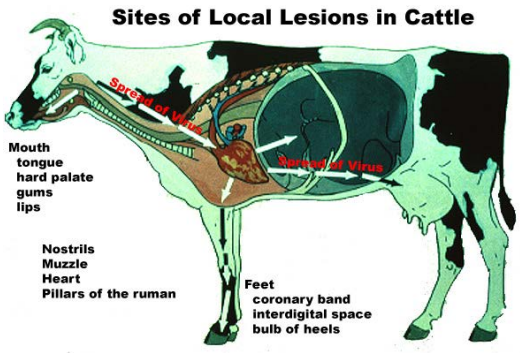
The route of infection can be direct or indirect contact with infected animals, contaminated animal products, or by airborne virus.
The major route of virus entry in ruminants is the respiratory system, where very low doses of virus can initiate infection. Pigs require approximately 80 times more FMD virus than ruminants to be infected by the respiratory route. Pigs are frequently infected by the oral route while in ruminants oral infection is uncommon.
All species could be infected through skin and mucosae

Estimated minimum doses* for various species and routes of exposure

Species	Inhalation	Intradermal	Intramuscular	Nasal instillation	Oral
Cattle	10	100	10^4	10^4-10^5	10^5-10^6
Sheep	10	100	10^4	10^4-10^5	10^5-10^6
Pigs	>800	100	10^4	Unknown	10^4-10^5

From Alexandersen S. *et al.* 2003

* Estimated minimum doses reported to cause clinical disease in TCID50



- ***5. Virus spread in the infected animal***

The usual route of FMD virus entry is via the mucosa and lymphoid tissues of the pharyngeal or tonsillar region.
Initially the virus replicates at the site of entry, usually in the mucosa and associated lymphoid tissues of the upper respiratory tract. Virus can be detected in the oropharynx 1-3 days before the onset of viraemia and clinical signs.
Following this initial replication the virus enters the blood stream in which it may circulate for 3-5 days. Animals often have a fever during this viraemic phase.
A secondary phase of replication then occurs in the main predilection sites: the non-haired skin of the coronary band, between the digits of the feet, the tongue, dental pad, teats and other areas such as the mammary gland, and in young animals, the heart.
During the acute phase of disease all body secretions and excretions of infected animals are infectious.

- ***6. Incubation periods***

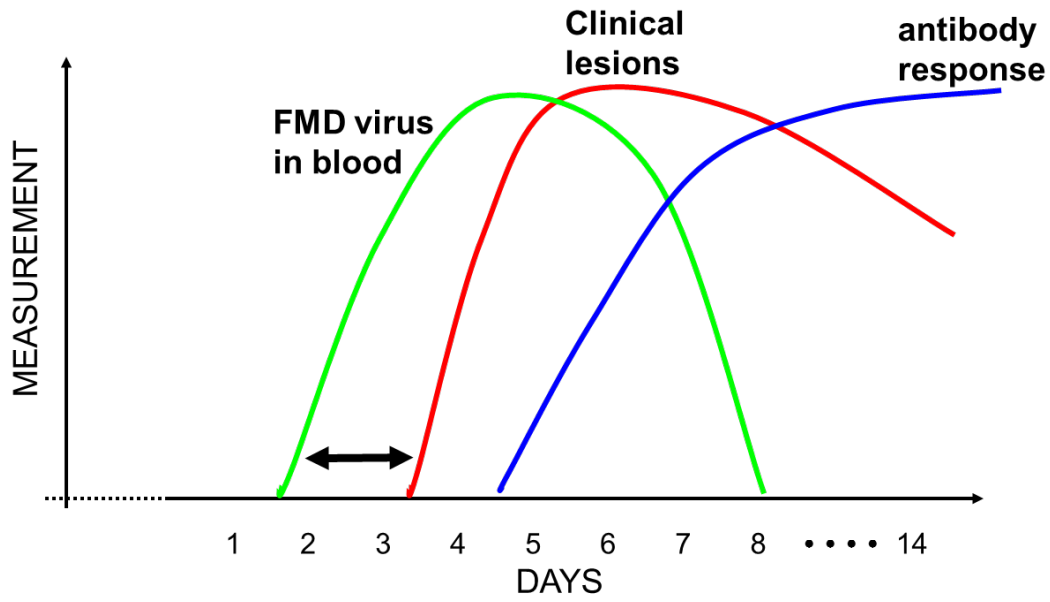
The incubation period of the disease, which represents the time from infection to disease, is usually 1-14 days, but may be as short as 24 hours. The incubation period is dependent upon the infectious dose; the higher the infectious dose, the shorter the incubation period. It also depends on the FMD strain, any pre-existing immunity from vaccination or prior exposure, and physiological status.

- ***7. Virus excretion:***

Virus excretion usually begins up to a day prior to the appearance of clinical signs, but virus can be detected in milk up to 4 days before the appearance of clinical signs. Virus excretion usually ceases about 4-5 days after the appearance of vesicles, except in the oesophageal-pharyngeal fluid.
Virus is present in fluid from ruptured vesicles and in almost all secretions and excretions including serum, oral and pharyngeal fluid, urine, faeces, semen and milk. It can also be detected in bone marrow and lymph nodes of carcass meat. Large quantities of virus are released in expired air, particularly in pigs. An infectious pig can produce up to 400 million infectious doses (TCID50) per day, ruminants excrete a maximum of 120,000 infectious doses per day.
For this reason, pigs are seen as important amplifiers of FMD, with the potential to produce vast quantities of airborne virus.

- ***8. Development of immunity against FMDV***

Immunity to FMD is primarily mediated by antibodies. Three to five days from the first appearance of clinical signs, circulating antibodies are detected by ELISA. High levels of antibodies are reached 2 to 4 days later.
The antibody titre normally stays at a relatively high level for many months after infection and may remain detectable for several years in ruminants. In pigs, especially in fast-growing young animals, antibodies may only be detectable for a few months.



Representative "in contact" cattle data from Alexandersen et al., 2003 and unpublished data from Pirbright Institute

Antibodies appear rapidly and clear virus from most sites; FMD virus can persist to 28 days and beyond in the oropharynx of ruminants but not pigs. Up to 50% of ruminant animals become persistently infected after clinical recovery. The length of persistence is species-dependant: Cattle up to 3.5 years, sheep up to 9 month, goats up to 4 months, African buffalo at least 5 years. Virus excretion is intermittent, low level and declines over time.

The significance of persistently infected o carrier animals in disease transmission is controversial: transmission of disease from carrier cattle to other cattle has not been shown experimentally. Transmission from carrier African (cape) buffalo to cattle has been shown to occur. FMD-free trading partners adopt the precautionary principle and maintain embargoes because of carriers and their potential risk.

Clinical Diagnosis

- ***1. Conducting a clinical examination***

It is important to have a systematic approach to examining animals suspected of foot and mouth disease. It is also important to write down your findings as you examine animals. A prepared form may help you do this efficiently.
Firstly, take a clinical history from the farmer: What clinical signs has he noticed? When did the signs start? Which animals have been affected?
Next, observe the animals from a distance: General demeanour, salivation, lameness, etc. Finally examine the individual animal. FMD is a painful condition. It is important to ensure that animals are adequately restrained before you begin examination. Start off by taking the animal's temperature. Then, check the mouth and ensure you have looked at the outer muzzle, the inside of the lips and cheeks, the dental pad, underneath the tongue and the full length of the tongue. Stroking or scratching the tongue can help you identify early vesicles which are just forming. Take care when holding the tongue to examine it, FMD lesions are painful, and in severe cases the entire surface of the tongue can slough.
Finally check the feet; you will probably need to wash the dirt from the feet in order to examine them properly. It is important to lift feet and examine in the interdigital cleft by splitting apart the claws, and also the underside of the foot. In female animals the udders should also be examined.

- ***2. - FMD Clinical Signs***

Diagnosis of FMDV based on epidemiologic and clinical findings. Clinical signs of FMD include: Depression, anorexia, fever, lameness, milk drop, salivation, vesicles and ruptured lesions on the muzzle, inside the mouth, on feet and teats FMD in cattle is often severe, with marked depression, anorexia, and possibly recumbency. In milking cows, milk drop often occurs before the onset of other clinical signs. Salivation can be profuse and affected animals may "chomp" and grind their teeth due to mouth pain.
There may also be sudden death in calves, due to myocarditis, and pregnant cows may abort.

- ***3. - Differential Diagnosis***

Swine vesicular disease, Vesicular stomatitis, vesicular exanthema of swine (calicivirus), Bluetongue, Peste des petits ruminants, BVD/mucosal disease, Bovine papular stomatitis, ORF (parapoxvirus), Bovine ulcerative mammilitis, Pseudocowpox, Malignant catarrhal fever, Contagious ecthyma ('scabby mouth'), Infectious bovine rhinotracheitis, Dermatophilosus infection, photosensitization, Phytophotodermatitis-contact with plants containing furocoumarins; Trauma, footrot.

Ageing of Lesions

Lesion ageing is important for epidemiological investigations. Lesion ageing allows you to establish a likely time period in which clinical signs first appeared, and from this, the likely time period in which infection took place. This is important for tracing possible sources of infection. Similarly, you can also estimate when viral shedding would have begun, allowing tracing of further spread of the virus.
When carrying out lesion ageing in order to determine the likely date of infection of a group of animals, it is important to examine all animals, looking for the oldest lesions. This will allow identification of the approximate time period that the first animal in the group became infected.
Similarly, it is not uncommon to find lesions of different ages present in the same animal. Again, it is important to look carefully for the oldest lesion in order to determine when the animal was infected

Estimating the age of lesions

Day of Clinical disease	**Appearance of lesions**
Day1	Blanching of epithelium followed by formation of fluid filled vesicles
Day2	Freshly ruptured vesicles characterized by raw epithelium, a clear edge to the lesion and no deposition of fibrin
Day3	Lesions start to lose their sharp demarcation and bright red colour. Deposition of fibrin starts to occur.
Day4	Considerable fibrin deposition has occurred and regrowth of epithelium is evident at the periphery of the lesion
Day7	Extensive scar tissue formation and healing has occurred. Some fibrin deposition is usually still present.

Lesions photography library can be found in the EuFMD e-Learning Resources section:
https://eufmd.rvc.ac.uk/mod/data/view.php?id=472

Diagnostic and Sampling Procedures for FMD

1. Diagnostic tests for FMD

Laboratory diagnosis can be used to confirm a clinical diagnosis of FMD. It also provides further information which is useful for epidemiological investigations, such as the serotype and strain of virus present.
Laboratory testing does not replace the need for an accurate clinical diagnosis of disease. In particular, clinical diagnosis and lesion ageing are vital in directing which diagnostic tests are likely to be appropriate, according to the stage of the disease process.
In general, diagnostic tests can be used to detect either the virus itself, or anti-viral antibodies.

2. Laboratory testing scenarios

Laboratory testing is likely to be used in one of four scenarios:

a) **Active surveillance for pre-clinical cases**
   Given virus is present in serum 1-2 days prior to the appearance of clinical signs, testing for viral RNA can be used to detect infected animals prior to the clinical phase of disease. This can be very resource intensive, as a PCR test is required.
b) **Clinical lesions are present**
   In this scenario, laboratory testing is used to confirm that suspicious lesions found are indeed due to FMD, and to identify the serotype of the virus.
   Viral antigens can be detected in an epithelium sample or vesicular fluid. The virus is removed from the blood as antibodies appear, approximately 3-4 days after the start of clinical signs.
   Antibody titre begins to rise from around 4 days after the appearance of clinical signs, and so in animals showing older lesions it may also be appropriate to test for antibodies.
c) **Sero-surveillance for previously infected animals**
   Previously infected but recovered animals can be detected by testing for antibody. Virus may also be isolated from the pharyngeal region of carrier animals by sampling with a probang cup.
d) **Post-vaccination sero-surveillance**
   If vaccination is used to control an FMD outbreak, sero-surveillance can be carried out. The laboratory tests used must be able to differentiate infected from vaccinated animals (or DIVA for short).

3. Testing for FMD virus presence

Live virus isolation
Live virus can be isolated by cell culture. It will require a well-equipped laboratory. The time to report results is between 1 and 4 days
Antigen ELISA
Viral antigen is detected either by antigen ELISA in a laboratory or using a penside lateral flow device. The time to reports results is around 4 hours
Penside lateral flow device. (LFD)
These devices have the advantage that they allow very rapid penside testing for viral antigen. They are highly specific and have a similar sensitivity to the lab based antigen ELISA.
There are currently three types of antigen LFD's available: Pan serotype (tests for all known serotypes, although sensitivity varies according to serotype), Specific LFD's are also available for serotypes SAT-2 and ASIA-1.The time to report results is around 10-30 minutes.

Reverse Transcription Polymerase Chain Reaction (RT-PCR)
Viral RNA can be detected by RT PCR, 1-2 days prior to the development of clinical signs. This can be either conventional RT-PCR or real time RT-PCR. Results can be obtained within 4-5hours.

4. Antibodies to FMD

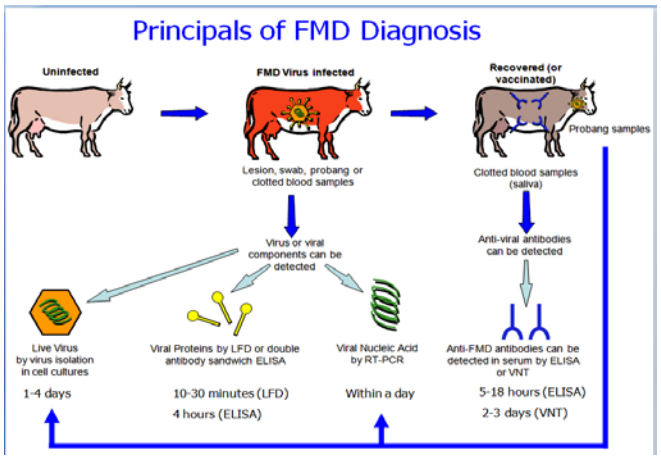
Antibodies to FMD virus are induced against structural (SP) and non-structural proteins (NSP).

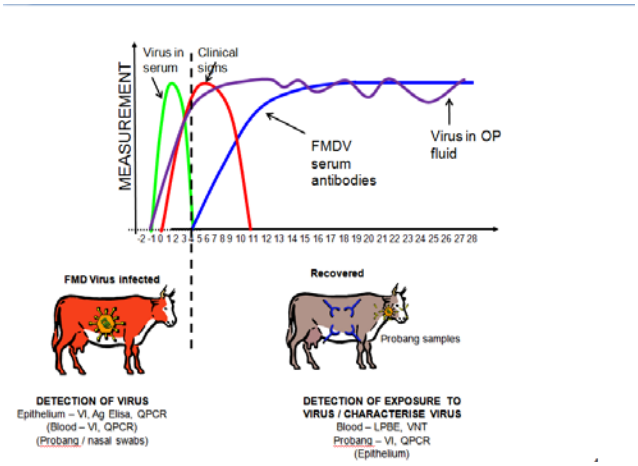
Structural protein (SP) antibodies
Antibodies are directed against proteins in the viral capsid (shell). SP antibodies are induced by both vaccination and infection. They usually start to appear approximately 3-4 days after the appearance of clinical signs. SP antibodies are relatively serotype specific.

Non structural protein (NSP) antibodies
Antibodies are directed against non structural proteins involved in virus replication.
Non structural protein (NSP) antibodies are directed against non structural proteins involved in virus replication. Non-structural protein antibodies are induced by infection and by non purified vaccine. They are non serotype specific. In other words, the NSP antibody tests can detect infections caused by all 7 serotypes.
NSP antibodies appear around 6-7 days after the appearance of clinical signs. Although the response may be reduced or delayed in the case of subclinical or mild clinical infection following vaccination

Both SP and NSP antibodies are detected in serum sample by various ELISA tests. SP antibodies can also be detected by virus neutralization tests.

FMDV diagnosis: Window of detection by different techniques





Taking Diagnostic Samples

A diagnostic test is only as good as the quality of the samples. It is very important to take care to take the correct samples, and to collect them in such a way that they will be diagnostic.

1. Sampling if lesions are present

The richest source of virus for detection is vesicular fluid or epithelium from fresh lesions. Where epithelium is sampled, at least 2cm2 of epithelium is needed (roughly a thumbnail sized amount). Ensure that the animal is adequately restrained before attempting to take samples.
In some cases, it is easy to mistake a large fibrin clot for epithelium. It will be necessary to test the texture of a sample before submitting it. Fibrin is unlikely to contain virus, as by the time fibrin appears, antibodies have removed most of the virus from circulation.
Virus can also be isolated from blood: clotted whole blood should be taken in order to collect serum. In the case of myocarditis, virus can be isolated from affected heart muscle.

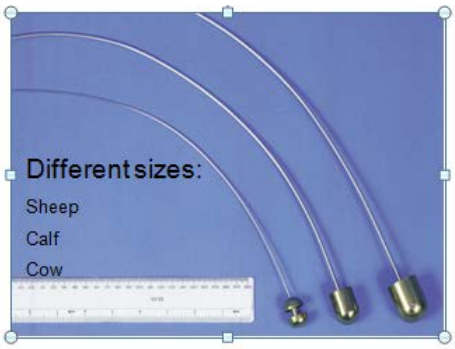
2. *Sampling if no lesions are present*

In some situations there may be no suitable lesions to sample, but good reasons to suspect FMD, either because the animals suspected to be incubating disease or lesions present are typical of older infection but there is no longer any epithelium to sample.
In this case clotted blood samples should be taken. If the animal is suspected to be incubating infection the sample should be tested by PCR. If old lesions are present the sample should be tested for antibodies. At least 10 animals should be sampled, prioritizing those with symptoms such as fever or milk drop, or those showing signs of healed lesions. Additionally, virus may sometimes be isolated from nasal swabs or probang samples, as long as laboratories are equipped to handle these samples (able to test with PCR).

3. *Sampling using a probang cup*

Sampling using a probang is sometimes used to detect virus in the oropharynx of clinically recovered carrier animals. The probang is a metal cup on the end of a flexible wire. Various sizes are available according to the size of the animal to be sampled.

1. Ensure adequate restraint
2. Measure the distance to the oropharynx on the outside of the animal and mark on the wire of the probang as a guide.
3. Introduce the probang into the mouth centrally- if it deviates to the side you will feel the animal chewing it
4. Feel the outside of the larynx and upper oesophagus- you will feel as the probang reaches this area
5. Gently move the probang backwards and forwards five times in this region
6. Gently withdraw the probang, aiming to keep the cup upright so as not to tip out the sample
7. Transfer the sample to probang transport medium



3 bucket "system"
- Water
- 4% Na^2CO^3 or 0.2% citric acid
- Water

Overview

		Detect virus				Detect Exposure to virus	
		(RNA) QRTPCR	(Biological) VI	Protein AgElisa	Protein LFD	(antibodies) SP	(antibodies) NSP
Acute Phase Sample	Epithelium / Vesicular fluid	✓✓✓	✓✓✓	✓✓✓	✓✓✓	✗	✗
	Serum	✓	✓	✗	✗	✗	✗
	Probang	✓	✓	✗	✗	✗	✗
Recovered / Persistent Phase Sample	Epithelium / Vesicular fluid	✗	✗	✗	✗	✗	✗
	Serum	✗	✗	✗	✗	✓✓✓	✓✓✓
	Probang	✓	✓	✗	✗	✗	✗

- Vesicular fluid / Epithelium is sample of choice for acute phase testing
- Serum is sample of choice for detecting exposure to virus – animals which have become persistent, probang is also sample of choice for identifying Virus
- If at all unsure as to phase of disease, Epithelium, serum and probang samples should be collected.

FMD Epidemiology

An efficient epidemiological investigation of an outbreak of FMD is crucial in order to understand the outbreak's source, and where and how the disease is likely to spread. This is important in guiding decision making on an effective control strategy and also in monitoring control strategies once they are in place.

Outbreak investigation requires knowledge about:

- dynamics of infection,
- risk factors for introduction and spread of disease
- impact of the disease

Carrying out the outbreak investigation is also a way of to raising awareness with farmers and owners on prevention of further spread and prevention of re-introduction.

The main aims when investigating an outbreak are to establish:

- Is it likely to be FMD?
- How long has the disease been on the premises?
- Where did the disease come from?
- Where might the disease have spread to?
- Determine magnitude of problem: count cases, define epidemiological units and population at risk.

1. Constructing a timeline

Constructing a timeline is a useful way of representing the time periods in which infection and transmission of disease might have taken place, and therefore guiding outbreak investigation.

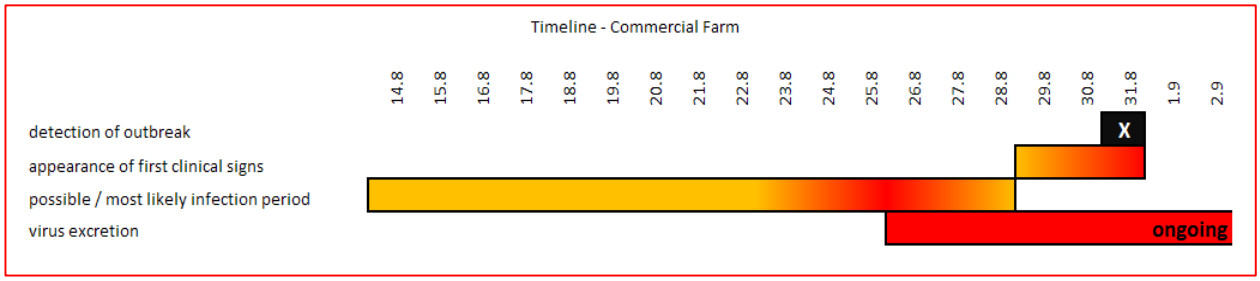
Timelines are used to determine:

- A time window for introduction of the virus, based on the incubation period
- A time window for spread to other units, using the period of virus excretion

In order to determine these, the oldest lesion present on the premises must be identified, and accurately aged. In order to achieve this, it is important to examine as many of the animals on the premises as possible. This will allow you to determine the date at which clinical signs first appeared on the premises.

To create a time line, based on oldest lesion observed:

1. Establish a time window of likely introduction of virus using the incubation period (1-14days) The most likely incubation period is between 2 and 5 days)
2. Establish a time window of likely spread to other units using the period of virus excretion (4 days before clinical signs) The most likely time period for spread begins one day prior first lesion and continues until cull and disinfection.



2. Using the timeline

Once a timeline has been established, the next step is to use the timeline for source and spread tracing, in order to establish contacts that have occurred that could have led to virus transmission during the calculated timeframe.

Some risk factors for disease spread include:

- Animal movements
- Personnel In direct contact with livestock on other farms visiting the premises, for instance the veterinary surgeon
- Personnel working on the premises visiting other livestock holdings
- Movements of vehicles or equipment between livestock holdings
- Direct contact with livestock at the farm boundaries
- Movement of animal products such as purchase of milk for calves
- Non livestock personnel movements, for instance the visit of a delivery driver
- Waterborne spread, for instance through sewage contamination
- Wildlife.

3. Identifying potential contacts

There are a number of ways in which you can investigate potential contacts. A good epidemiologist will conduct a thorough and logical investigation making use of all of these:

Interviews
Interviews with the farmer, and with other personnel responsible for the animals on the premises, should be carried out. A semi structured participatory interview is used to obtain a standard set of data.
Carrying out an effective interview requires skillful technique, especially in circumstances where the farmer is likely to be under considerable stress. Effective interview techniques include:

- Explain the purpose of the interview
- Use time and patience to build a relationship with the interviewee
- Avoid blaming or frightening the interviewee
- Include "open" questions, which allow the interviewee to give their full thoughts, rather than simply answering yes or no.

It is important to have a questionnaire available which has been carefully designed and adapted to circumstances to assist you in carrying out a thorough FMD investigation.

Records
Examine livestock and personnel movement records. Other records such as medicines records or milk tanker receipts may hold valuable information.

Observations
Alongside interviewing the farmer, a careful survey of the premises should be made. The perimeters of the premises should be walked in order to establish any contact with neighboring livestock. It is often helpful to produce a sketch map of the area, showing the location of animal housing, animal groups, entry and exit points and boundaries.

Wider enquiries
It may be appropriate to contact others involved with the premises, for instance veterinarians, milk collectors, or artificial inseminators

4. Prioritising contacts

Once potential disease transmitting contacts have been identified, it is important to prioritise contacts in order to carry out further epidemiological investigation. This allows rapid investigation and control of those contacts at risk of spreading disease further. Such prioritisation is especially important where personnel and resources are limited, as is often the case in an FMD outbreak.

Contacts that occurred during the most likely time period for infection should be prioritized. The type of contact is also important. Those which should be prioritized include:

- Premises with pigs
- High census premises
- Premises where animals from multiple premises meet, including livestock markets and abattoirs

- Premises where regular animal movements take place, for instance livestock dealers
- Direct animal contacts, for instance animal purchases, neighboring premises with FMD susceptible animals.

Field Investigation Perspective: The 2007 UK FMD outbreak

Virus escape from Pirbright site (IAH and Merial vaccine plant); 8 infected premises, most consisting of multiple holdings; Mainly extensive beef production; Most farms in semi-urban areas; Part-time/hobby farmers; 1578 animals on IPs culled; 278 animals infected.

IP1: 3 holdings	29 July: farmer notices an animal "off colour"
	2 August: several cattle lame & drooling. PVP tells farmer to contact Defra directly.
	3 August: Defra vet examines & takes samples; +ve for FMDV
	4 August: cattle at all 3 holdings killed; virus identified as O1 BFS 1860 (used at Pirbright)
IP1:main holding	38 cattle, all infected
	Lesion ages: 3 to 10 days old
	Beef store cattle grazing on open pasture 4km from Pirbright site
	No handling facilities: Defra brought in gates & straw bales to make corral
	Shot with rifles then pithed.
IP1: two other holdings	4 cattle at home farm: no FMDV
	22 cattle on open pasture: no FMD lesions; one animal PCR +ve (viraemic)
	Only link between premises: farmer
	First time preclinically viraemic animals detected using PCR in an outbreak
	Logistical problems again: straw bales, rifles
	Carcases transported by sealed lorry to incinerator 70 miles away
IP2:3 holdings	49 cattle 1km from IP1; 58 at home farm; 12 on third holding
	6th August: farmer notifies Defra, samples taken from holding with 49 cattle: +ve
	25 killed that night, the rest on next day
	Cattle examined & bled post-mortem
	- Logistical problems: no handling facilities, no water, rifles, journalists
	58 cattle on 2nd farm: no FMD lesions BUT
	- 15 of 58 viraemic by PCR/VI
	12 cattle at 3rd holding: no FMD
Phase 1: August	3 Aug: IP1 (3 locations)
	6 Aug: IP2 (3 locations)
	3 contact herds culled
	24 Aug: PZs lifted
	8 Sep: SZ lifted
	Origin: contamination from Pirbright site
Likely times of lab escape of virus from Pirbright site in 2007	20th July: flooding
	23rd July: best airborne spread day
	22nd July: 1st centrifuge waste discharged
	25th July: 2nd centrifuge waste discharged
	20th July: 4 lorries via Westwood Lane
	25th July: 2 lorries via Westwood Lane

Difficulties

Assuming lesion of 12 days and longish incubation then likely release times too late;
Flooding period fits best as time of release most consistent with lesions and incubation;

But flooding and first lorry movements precede likely virus release through drains;
Second period of lorry movements more likely associated with viral contamination, but too late to have infected farm.

Phase 2: September IP3

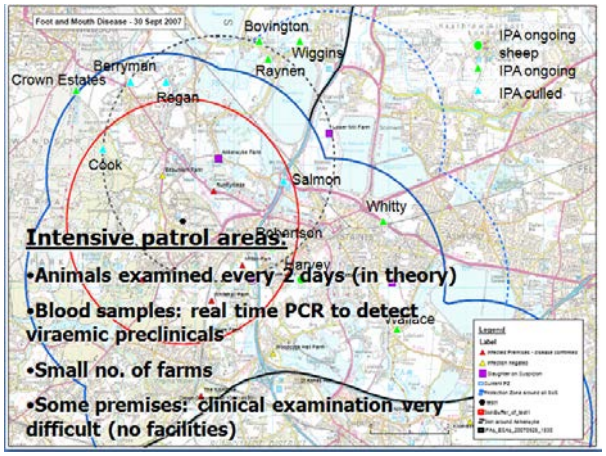
Confirmed 12th Sept; 8 locations: 2 FMD+ve; 36/47 cattle had FMD lesions, 1-5 days old; 9/29 cattle had lesions at 2nd holding, 1-5 days old; Other holdings all FMD negative; Culling completed 16 Sep (4 days later); Logistical problems on out-farms: No handling facilities, escapees, police.

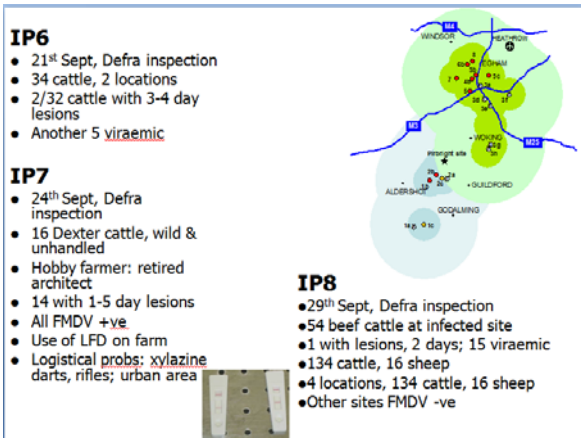
IP4

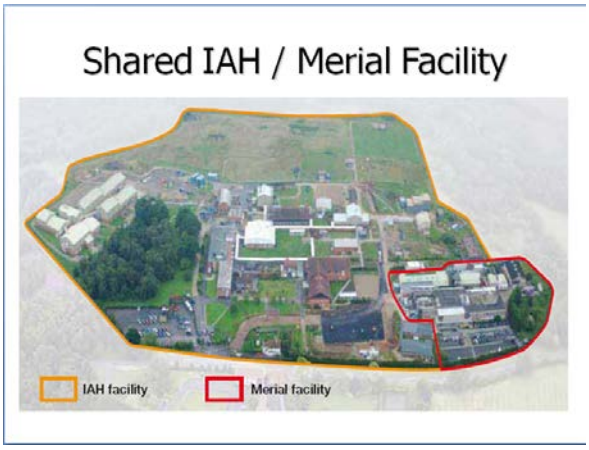
Separated from IP3 by narrow stream; Diagnosed Sept 13th (farmer report); 54/54 beef cattle had FMD lesions, 5-10 days; 800 pigs kept 500m away: no FMD; Farmer had been on holidays for 10 days – unclear who checked cattle; Excellent handling facilities – fast cull.

IP5: the missing link

After IP3 & 4, 3km PZ implemented; All sheep bled, cattle & pigs "clinically inspected" – often just observed over fence; 17th Sep: IP5 sheep tested seropositive; IP5: 16 sheep, 22 cattle, 2 pigs; Farmer retired & unwell; animals were pets; FMD lesions ~ 3 weeks old (large error margin); Virus detected in probangs – 10/16 sheep carriers.

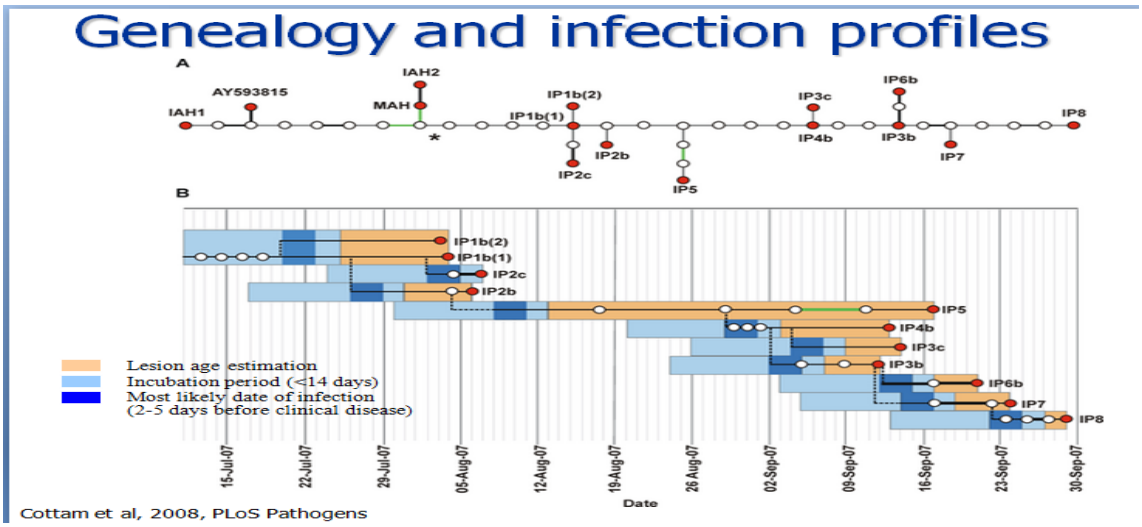






Source of virus: Pirbright site

Virus: O1 BFS1860 (1967 UK outbreak)
3 strains used on Pirbright site:
IAH1 (v. small quantities, Institute for Animal Health research)
IAH2 (v. small quantities, Institute for Animal Health research)
MAH (6,000 litre batches for vaccine production, Merial Animal Health)
Molecular epidemiology reveals transmission pathways
(Cottam et al, 2008, PLoS Pathogens 4(4): e1000050)



Unresolved questions:
How did virus get from Pirbright to IP1?
How credible is the pipe/soil/lorry theory?
How did it get from IP1/2 to IP5?

Lessons from the field
Epidemiological benefits of lesion ageing, extensive sampling, sequencing virus isolates in real time

- 2nd phase of outbreaks (IP3 – IP8) shares all the unique changes common to 1st phase
- Therefore outbreaks are linked and not due to independent sources
- IP5 (farm with FMD serology positive cattle and sheep) bridges gap between two phases of the outbreak

Diagnosis of preclinical viraemic animals using real-time PCR.
Hobby/part-time farmers with inadequate handling facilities: implications for neighbouring farmers?

Biosecurity and FMD

FMD virus is sensitive to pH, it is inactivated below pH 6.5 or above pH9. Survival in the environment is dependent on pH, temperature, humidity and initial concentration.
It has been shown to survive: 14 days in dry faeces, 39 days in urine, 6 months in slurry in winter, 3 days on soil in summer and up to 20 weeks on hay or straw
Veterinary personnel visiting farms during an FMD outbreak are often in close contact with infected animals, and frequently travel between premises. They are therefore a high risk for spreading FMD.
Biosecurity is the implementation of measures that reduce the risk of the introduction and spread of disease agents. Achievable level of biosecurity depends on the circumstances. Apply general principles using veterinary judgment. Every effort should be made to maximize biosecurity it is essential to avoid any feeling among farmers that we may be spreading disease. Veterinary personnel must lead by example during an FMD outbreak, and demonstrate proper biosecurity in order to encourage farm staff and visitors to adopt similar practices
Biosecurity requires the adoption of a set of attitudes and behavior by people to reduce risk in all activities involving animals and their products.
There are three principle steps for biosecurity

1. Physical segregation
2. Cleaning- removing contamination
3. Disinfection- killing any remaining virus.

1. *Physical Segregation*

By far the most important and effective of these steps is segregation. Virus cannot be transmitted if the virus never comes into contact with uncontaminated animals or equipment. Therefore every effort should be made to use segregation whenever possible.
The segregation could be: Physical (e.g. a wall or gate), temporal (e.g. time between visits) or procedural (e.g. changing footwear).
Some examples of segregation measures include:

- Not taking any unnecessary materials onto infected premises. For instance, cars should be left outside.
- A person who has visited an infected "dirty" premises should observe a quarantine period before visiting uninfected "clean" premises.

2. *Cleaning*

Disinfectants cannot kill virus hidden beneath layers of dirt, and many disinfectants are inactivated by organic material. It is therefore extremely important to clean all visible dirt before disinfection. This means using a scrubbing brush or pressure washer. Particular care should be taken to remove all dirt from the treads of shoes.

3. *Disinfection*

- ***Disinfection is important but its effectiveness depends on many factors, in particular the quality of the cleaning process.***

It is important to use a disinfectant that is effective against the FMD virus, and at the correct concentration. Acidic or alkaline disinfectants which maintain the pH below 6.5 or above 9 will be effective against FMD virus:

- Washing Soda (Na^2CO^3): 4%
- Citric Acid: 0.2%
- "FAM 30": 1:240
- "Virkon" 1%.

It is also very important to ensure that all surfaces are covered by disinfectant where possible. It is very easy to miss hard to reach areas. If possible, items should be immersed in the disinfectant, rather than simply splashing disinfectant over a surface.
Disinfectants must be applied for sufficient contact time to allow them to work properly
List of disinfectants approved for FMD virus is available at:
http://www.oie.int/fileadmin/Home/eng/Animal_Health_in_the_World/docs/pdf/FOOT_AND_MOUTH_DISEASE_FINAL.pdf

Virus	Washing Soda Na^2CO^3	Citric acid + 0.005% NP40	FAM 30	Virkon
Foot-and-mouth disease	4%	0.2%	1:240	1%

4. *Kenya: specific instructions*

- Make every effort to maximise biosecurity, even in challenging circumstances. It is important to lead by example.
- Laboratory: Work on FMD virus samples inside safety cabinet; clean & disinfect hood before and after use
- Prior to returning home, submerge all clothes worn on farms or in lab in Virkon for 30 minutes in bath, then have hotel clean them (Citric acid will be provided)
- Once you return home you must not visit any premises with FMD susceptible species present (farms, zoos, schools etc) for 7 days.

Vademecum for FMD Outbreak Detection and Investigation

Foreword

This document is prepared by the EuFMD Secretariat and is intended to assist veterinary services with the investigation and response to suspect FMD outbreaks. It should be adapted for application by field officers, and updated after changes in diagnostic capacity or experience.

Protocol for outbreak detection

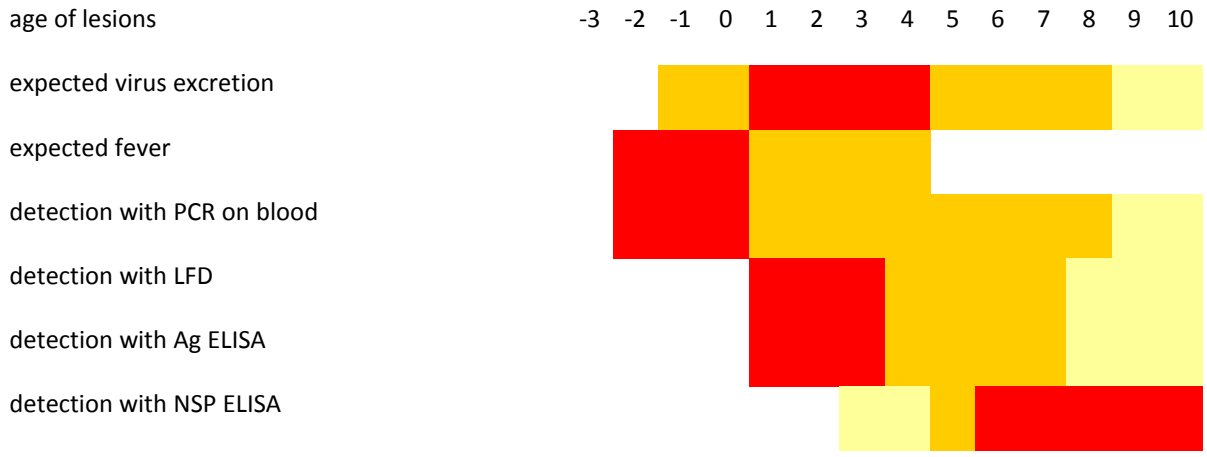
In case of confirmation of the suspicion, suitable samples should be taken in order to confirm infection. The investigation of suspicions should be made by competent persons under authority of the vet services, who understand the type of samples required for laboratory confirmation. Penside tests (Svanodip – FMD) can be used on site or at the laboratory, but only with suitable samples from early cases. A range of samples, including whole blood for serum, are advisable if early lesions (<6 days) are not abundant. The veterinarians collecting samples should complete tables for each animal, supplying information (table 1).

Table 1. Information collected on animals examined and sampled.

nb	animal ID	species & sex	age	clinical signs						type of lesions						samples taken	Vac. status	Est.td age of oldest lesions
				lameness	fever[2]	salivation	foot[3]	mouth[4]	teats	intact vesicle	recently ruptured	raw eroded area	ulcer with fibrinous	ulcer with fibrosis	indistinct break			

The basis for use of tests is given below, and information collected at sampling used to compile tables such as shown in Tables 2 and 3.

Progression of disease as related to expected signs of disease and diagnostic detection:



Red = most likely time frame of detection; Yellow = likely time frame of detection; Pale yellow = less likely time frame of detection

In case of positive result, the immediate measures previewed in the CP should enter into force. These measures should include the treatment of animals and the disinfection of the premises.

Official investigation to identify possible source and risk of spread

The official investigation should try to identify the oldest lesion in the epidemiological unit; the date of entry of infection is up to 14 days previously. The investigation should identify which events in this 14 day period may explain the entry of infection, such as entry of contaminated animals, or vehicles, and the most likely sources identified.
Further analyses should be done in order to identify the serotype involved in the outbreak, on an urgent basis with the aim to identify type within 24 hours and if the national lab cannot do this, by an international lab within 5 days.
The authorities should apply a ring vaccination with a vaccine containing the involved serotype. For this purpose, a suitable monovalent type, or at least a bivalent vaccine A/O should be available for the national vaccination campaign.
The reporting of the investigation should provide the following information (example):
Information concerning the **epidemiological unit:**

- Province:
- Village (s):
- Name of owner (owners):
- Animal population susceptible to FMD, identification, type of husbandry...
- Maximal capacity:
- Maps – GIS code:

Information concerning the **outbreaks** (or epizootic):

- Timeline (from earliest to last event)
    1. Start of possible window of introduction of FMDV (date and possibly risk factor of introduction of FMDV, dissemination of the disease) (1-14 days before first signs)
    2. First observation of clinical signs (date)(=day 0)
    3. Notification of suspicion to veterinary services (date)
    4. Date of sampling
    5. Date of official investigation
    6. Date confirmed

- Clinical examination and sampling of the animals
    1. Describe (table 3)
    2. Clinical signs (table 3)
    3. Aging of lesions (table 1)

- Sampling
    1. Blood sampling
    2. Tissue sampling
    3. Pen side test
    4. Bio-security & disinfection
    5. Sending samples to the lab

- Vaccination history: Describe (date, vaccine, animals...)
- Results of the laboratory analysis (table 2)
- Source and spread of infection:
    1. most likely event that introduced infection in the unit
    2. time period when spread of infection most likely to occur from the epi-unit (= from 2-4 days before signs depending on species).

Table 2. Results of the laboratory investigation of the samples taken in the village (example)

Animal ID	LFD	NSP	Ag Elisa	Clinical signs	Conclusion[3]
	+[1]	+	inconclusive	+(2-3 d)	infected
1234567	+[1]	+	Type 0	+(2-3 d)	infected
6789234	+[2]	+	-	+(2-3 d)	infected

[1] epithelium and saliva; [2] epithelium and vesicle fluid; 3 conclusion based on references in table 3

After the Real Time Training

Cascade Training

One of the aims of real time training is to 'train the trainers'. The courses enable real time trainees to become trainers and to pass on their knowledge about FMD diagnosis, investigation and control to their colleagues. We hope this will mean that EuFMD member state veterinary services are better prepared should an FMD outbreak occur.

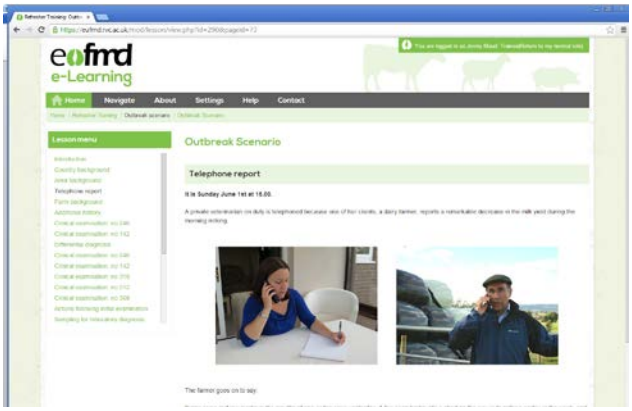
This cascade training principle doesn't only apply to colleagues in veterinary services. We also hope you might be able to use your knowledge from the course to spread awareness of FMD more widely, to farmers, private veterinarians and other stakeholders. As you will have heard during your training, early recognition of an FMD outbreak is crucial for effective control- so training the 'people on the ground' to recognise FMD is very important.

To assist trainees in carry out cascade training we have created a page on the e-Learning site with resources and tips to assist with training. You will be given access to this course when you return home from Kenya.

Refresher training

Approximately six months after you training in Kenya finishes you will be asked to join the online 'Refresher' training course. This short course consists of a scenario exercise where you can apply the knowledge gained on the course to an FMD free country setting. We will also discuss the cascade training that you have carried out, and whether you require additional assistance with this. There will also be a live online 'webinar' where we will discuss the issues raised in the Refresher course with EuFMD experts.

You will be issued with a certificate indicating successful completion of this course.



EuFMD staff are always available to assist you in any way after the course finishes. Please contact us on eufmd-training@fao.org.

Example Report: NTC13 (21-25 Jan 2013)

EXECUTIVE SUMMARY

FAO and its EU-FMD Commission held a 4 day real time training course for veterinarians, in field diagnosis and management of FMD in Nakuru, Kenya. The participants included local Kenyan veterinarians and also visiting vets from Libya and several European countries.

The course began with an overview from Dr Wanasamba, Deputy provincial Director of Veterinary Services of Kenya. Presentations were then performed by Dr Nick Lyons, Dr Kees van Maanen. Topics covered included procedures for FMD investigations, biosecurity, and sample collection; history of FMD in Kenya; a session on lesion aging; and detailed information on epidemiology, laboratory tests and dangerous contact tracing. Field sessions for practicing biosecurity measures, diagnosing FMD and establishing epidemiological patterns were planned for Day 2, for which the thirteen people were divided into two groups. Both groups visited smallholder subsistence farms. On Day 3 all participants took part in an area survey walk in the same area. Data relating to risk factors for FMD were gathered from short interviews with smallholder farmers. Day 4 was spent writing and collaborating reports, and preparing a summary presentation for the Provincial Director of Veterinary Services and the Director of the Nakuru Veterinary Investigation

Laboratory. The area was struck by a recent outbreak of FMD, serotype A. This serotype has not been seen in this area in recent years. A vaccination campaign against serotype A, O and SAT-2 started in the last month.

GENERAL INFORMATION ABOUT FMD IN KENYA

In Kenya FMD has been diagnosed since 1915 and the disease has been endemic ever since that year. The first serotyping was done in 1932. Today Kenya struggle with five different serotypes of FMD: Serotype O, A, C, SAT1 and SAT2. Until 2009 serotype O caused most of the cases of FMD, but in the recent years SAT 1 and SAT 2 have become more and more important strains. Very recently serotype A was detected in the province of Nakuru. There are not yet exact data covering this outbreak. The most recent overview is from June 2012.

GENERAL INFORMATION ABOUT FMD IN RONGAI DISTRICT

In the Rongai district the landscape is rather flat although it is situated on a higher point than the surrounding area. From October to December there is the "short rains" season in the district with much precipitation. The temperature is between 15 and 30 °C. The district has according to a local counting 81282 bovines, 50846 ovines and 58391 caprines. There are mostly small scale farmers with 3 to 35 cattle and many of them hold some sheep or goats in addition to cattle. The properties have from five to ten acres of land. There are also some few big dairy farm situated among the smallholders with more than 50 to 200 milking cows. The farmers practice different grazing systems. The cattle could graze only on the farmer's property within fences or they could go to common graze-land or often a combination of these two systems. Occasionally small holders practice zero grazing.

Milk is collected on a daily basis by milk collectors who either drive motorbike or a truck from farm to farm.

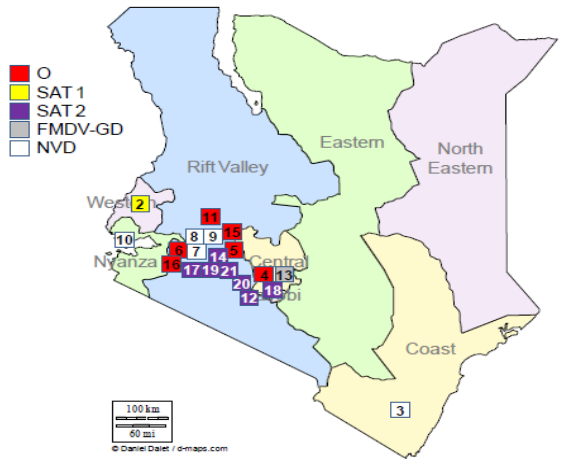
The water is supplied from water tanks or dams which many cattle herds use regularly. The farmers bring their herd to the well. Some farmers have their own water supply that could be the only supply, but in dry periods these supplies could get dry so the farmers have to use the common wells. Additionally there are small rivers that are used as drinking water for the livestock. Biosecurity measures are usually not present. Most of the farmers bring their cattle to the dipping place regularly (places for tick prevention). If the distance to the dipping place is too far the farmer spray their cattle with insecticides. During vaccination campaigns smallholders are asked to bring their cattle to so called Vaccination points. Larger farms are vaccinated within the compound. In the district four different serotypes have been present in the last 2-3 years: Serotypes A, O and SAT1 and SAT 2.

LOCATION AND DESCRIPTION OF FARMS

Visited farms are farm located in the division of Ngata, Rongai district, Rift Valley province of Kenya.

Kenya
WRLFMD/2012/00024
Date received: 29/06/2012
No. of samples: 20
O/EA-2: 6
SAT 1/I: 1
SAT 2/IV: 6
SAT 2 (NVI)*: 1
FMDV-GD: 1
NVD: 5

*, no virus isolated in cell culture/VP1 RT-PCR negative



TEAM MEMBERS
Trainers: Nick Lyons, Kees van Maanen, Abraham Sangula, William Birgen and Jenny Maud
Epidemiology team: Aldin Lika, Elena Nakova, Idbeaa Wissam, Miia Kauremaa, Leah W. Kirega, Patrick Ndonga, Maria Mavropoulou
Clinical team: Anna Lindhe, Vivi Dalseng Johnsen, Henk Jan Ormel, Ibrahim Mohamed El Daghayes, Vlastimil Krivda, Peter Mwangi

FARM A

The owner, Bethesda Children's home, has 5 cattle in total, mainly two lactating cows and 3 calves. No other susceptible species (i.e. small ruminants or pigs) were present at the farm. Two weeks ago the owner noticed clinical signs in the two adult animals i.e. a drop in the milk production, salivation and lameness. He reported the situation to the local veterinary officer. At the time of the visit, the owner had noticed that one of the calves also presented symptoms of dullness and depression. The animals had been vaccinated against FMD on January 18th.
The farmer stated that he has been aware of at least one farm with confirmed FMD in the surrounding area.
In respect to animal husbandry practices in the farm, the animals are grazing outside the farm in a pasture about 200 m away from the premises. The same pasture is used by other five neighbouring herds, one of which has confirmed FMD and another three have animals with clinical signs. Following the clinical signs, the animals were kept inside the premises. The farmer waters the animals inside the premises. Breeding is performed by AI.
According to the owner and with the exception of vaccination, no animals came in or out of the holding recently. Also no animals were bought or sold, with the exception of on calf bought in October from a different farm. Spraying in the premises is performed instead of dipping. Regarding personnel movement, a milk collector comes in the premises once a day. The same person collects the milk from all the neighbouring farms. The last visit from a vet was two weeks ago and the owner doesn't have a private vet coming on a regular basis.

CLINICAL FINDINGS

Farm A

ID of the animal	ANIMAL A	ANIMAL B	ANIMAL C	ANIMAL D	ANIMAL E
Species and sex	Bovine, F	Bovine, F	Bovine,F	Bovine,F	Bovine, F
Age	6 months	6 months	8 months	adult	adult
Vaccination	Yes	yes	yes	yes	yes
Eating	yes	yes	no	yes	yes
Drop in milk production	-	-	-	Yes(25%)	Yes(50%)

Salivation	no	no	no	no	yes
Temperature (ºC)	38.1	38.5	40.8	37.9	38.6
Lameness (foot)	no	no	no	no	no
Mouth lesions	no	yes	yes	yes	no
Teat lesions	-	-	-	yes	no
Intact vesicle	no	no	no	no	no
Ruptured vesicle	no	yes	yes	yes	no
Raw eroded area	no	yes	yes	no	no
Fibrinous scab	no	no	yes	yes	no
Healing lesions	no	no	no	yes	no
Feet lesions	no	no	no	yes	no
Sample taken	no	epithelium	epithelium	blood	no
Age of Lesions (early lesions)	-	2 days	1-3 days	3-4 days	-
Age of Lesions (older lesions)	-	-	-	7 days	-
Treatment	no	yes	yes	yes	no

Probable timeline and source of the infection in Farm A

date January	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
Event								clinical signs obs by owner										vacs				7 days old lesions obs by EU FMD
disease dynamic days	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
high risk for intro																						
Poss.intro																						
high risk for virus shed.																						

Epidemiological information gathered indicated there are several risk factors, mainly common grazing and personnel movement that could have been the reason for the introduction of the disease to this farm.

As regards the introduction of FMD in the farm in question, the contacts with animals of other holdings during common grazing are the most likely point of entry.

Regarding the disease spread, common grazing as well as the practice of vaccinating the animals in a common vaccination spot and personnel movement could facilitate the spread of the disease to other farms.

FARM B

The second farm visited was located in about 200m from Farm A.

The herdsman, James Diego, has 4 cattle in total, including two lactating cows, one heifer, one calf and one goat. Vaccination against FMD was performed one year ago. The first clinical signs appeared two weeks ago in an adult lactating cow, presenting drop in the milk production, salivation and lameness. The owner reported the situation by phone to the local veterinary officer. A week later, a second cow presented similar symptoms. At the time of the visit, the owner stated that only the two cows showed symptoms of the disease. The farmer was aware of at least one farm with confirmed FMD in the surrounding area. In respect to animal husbandry practices in the farm, the owner

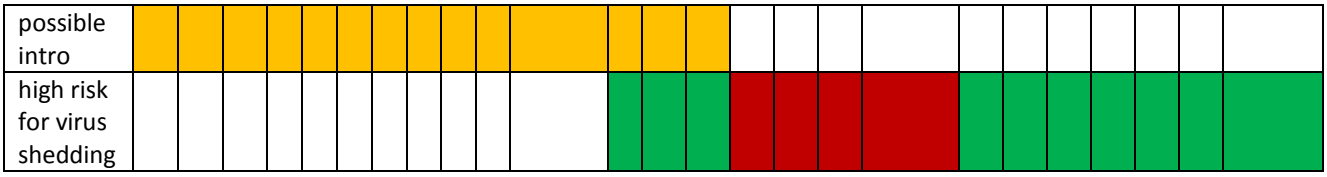
uses two pastures where animals are grazing. The first pasture is located about 200 m away from the premises and is used only by this farm. The second one is located about one km away and is shared by other five neighbouring herds, one of which has confirmed FMD and the other one has animals with clinical signs. According to the owner, a bull from another farm came in close contact with the heifer on the 15th of January, a week following the initial presentation of signs. The farmer waters the animals inside the premises; however a truck is used to deliver fresh water once a month. Breeding is performed by natural mating. According to the person responsible for the animals, no animals were bought or sold to the holding recently. Spraying in the premises is performed instead of dipping. Regarding personnel movement, a milk collector comes in the premises once a day. The same person collects the milk from all the neighbouring farms.

Farm B

ID of the animal	ANIMAL A	ANIMAL B	ANIMAL C	ANIMAL D	ANIMAL E
Species and sex	Bovine, M	Goat, F	Bovine, F	Bovine, F	Bovine, F
Age	3 months	1 year	heifer	adult	adult
Vaccination	-	-	1 year ago	1 year ago	1 year ago
Eating	yes	yes	yes	yes	yes
Drop in milk production	-	-	-	Yes(60%)	Yes
Salivation	no	no	yes	yes	no
Temperature (°C)	39.3	39.2	38.7	37.6	37.8
Lameness (foot)	no	no	no	yes	yes
Mouth lesions	no	no	yes	yes	yes
Teat lesions	-	-	-	yes	no
Intact vesicle	no	no	no	no	no
Ruptured vesicle	no	no	yes	yes	yes
Raw eroded area	no	no	no	no	no
Fibrinous scab	no	no	no	no	no
ID of the animal	**ANIMAL A**	**ANIMAL B**	**ANIMAL C**	**ANIMAL D**	**ANIMAL E**
Healing lesions	no	no	yes	yes	yes
Feet lesions	no	no	no	yes	yes
Sample taken	no	**blood**	no	**blood**	**blood**
Age of Lesions (early lesion)	-	-	-	-	-
Age of Lesions (older lesions)	-	-	7 days	7-10 days	7-10 days
Treatment	no	no	yes (vitamins)	yes	no

Probable timeline and source of the infection in Farm B

Date Dec/Jan	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Event											clinical signs obs.by owner							contact with bull on common grazing area							10 days old lesions obs by EU FMD
disease dynamic days	-14	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
high risk for intro																									



Epidemiological information gathered indicated there are several risk factors, mainly common grazing and personnel movement that could have been the reason for the introduction of the disease to this farm.
As regards the introduction of FMD in the farm in question, the contacts with animals of other holdings during common grazing are the most likely point of entry.
Regarding the disease spread, common grazing and personnel movement could facilitate the spread of the disease to other farms.

In **Farm A** we managed to perform epithelial sample results Ag pan, Penside test from Animal B and C with positive results. We took a blood sample from animal D because it presented the oldest lesions.

Type of test	Animal A	Animal B	Animal C	Animal D	Animal E
SP Ag Results (from Nakuru)	-	positive serotype A	positive serotype A	-	-
NSP Ab ELISA results (from Nakuru)	-	-	-	negative	-
Epithelial sample results (Ag pan. Penside test)	-	positive	positive	-	-

In **Farm B** we took blood samples from animal B (goat), D and E. There were no fresh lesions so therefore we did not perform any epithelial samples test.

Type of test	Animal A	Animal B	Animal C	Animal D	Animal E
NSP Ab ELISA results (from Nakuru)	-	negative	-	negative	positive

FMD AREA SURVEY

In addition to the investigation at the farm a small area survey study was performed to assess the spread of the disease in the neighborhood and the exposure to some of the identified risk factors.
Four teams of 3-4 people with one Swahili speaker in each team were sent in four different directions along the roads in the village and interviewed farmers in all farms along the road. The interviews were done at the farm gate using an EpiCollect questionnaire prepared in advance.

Table 1, Type of farms

	Variable	Number of farms	%
Type of farm	Cattle	13	62
	Cattle and sheep	3	14
	Cattle and goats	0	0
	Cattle, sheep and goats	4	19
	Sheep	1	5
	Goats	0	0
	Sheep and goats	0	0
total		21	100

The vast majority of the farms (13) were cattle farms (62%). 4 farms had cattle and small ruminants, 3 cattle and sheep and one only sheep.

Table 2, EpiCollect query analysis

	Variable	Mean number of animals per farm	Range number of animals per farm	Number of farms	%
Nb of animals	Cattle	14	0-64	20	95
	Sheep	1,6	0-15	8	38
	Goats	4,6	0-81	4	19
FMD	FMD signs			2	10
	No signs			19	90
	Don´t know			0	
Grazing	Zero grazing			0	
	Common grazing			6	29
	Grazing within the farm			14	67
	Comm + within			1	5
Watering	Water within farm			19	90
	Shared water outside the farm			1	5
	Both			1	5
New animals	New purchased			2	10
	No purchase			19	90
Vaccination	Vaccination			16	76
	No vaccination			5	24
Marketplace	Visits to marketplace			0	0
	No visit			21	100
Breeding	Breeding AI			14	67
	Breeding own bull			1	5
	Breeding own bull, common use			1	5
	Breeding bull from another farm			5	24
Personnel movement	Visit by vet/AI			13	62
	Visit other farmers			5	24
	Visit milk collector			12	57
	Visit water supplier			4	19
Dip	Dip performed			3	14
	No dip/spray			18	86

The average number of animals per farm was 14 (0-64) cattle, 1.6 (0-15) sheep and 4.6 (0-81) goats. Out of the 21 farms interviewed 2 answered that their animals were affected by FMD and reported classical clinical signs.
In respect to grazing, 14 farms apply grazing within the farm, 6 common grazing and one applies both.
16 herds were vaccinated against FMD and only 5 were not. Out of the two farms who reported the disease, one had been vaccinated within the last 6 months.
Only two farms introduced new animals in their herd – one of them has signs of FMD. Most of the farms (19 out of 21) watered their animals inside the premises.14 farms used AI and 5 used a bull from another farm.

GENERAL RECOMMENDATIONS

In the scope of reducing the spread of FMD the following measures are suggested:

1. Communicate the risk of infection to animal owners. Farmers should be aware of FMD clinical signs, symptoms and the range of species affected.
2. Communicate practical prevention and control measures. In case of suspicion or confirmation, grazing inside the premises would play a crucial role in avoiding disease spread.
3. Improve vaccination cover. Routine vaccination regimen should be instituted and vaccines should be available at a regional level. Vaccination campaigns should be organized.
4. Apply biosecurity. Basic biosecurity measures like such as separating pathways for milk collectors and trucks coming into the farm should be applied.

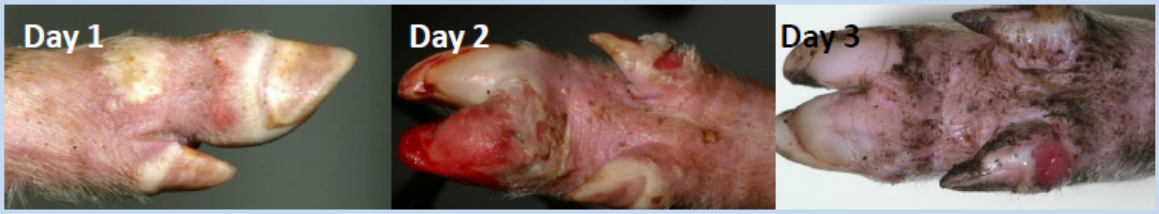
A field guide to estimating the age of Foot-and-Mouth disease lesions

Lesions and their ages from experimentally infected cattle	Lesions and their estimated ages from cattle observed in the field

Guidelines for estimating the approximate age of FMD lesions

Day 1 –The first day Intact fluid filled vesicles are seen to be formed. The overlying skin becomes blanched.
Day 2 - The vesicle is ruptured but much of the blanched epithelium is still intact, having sharp edges (arrowed), and where detached, raw red underlying dermis can be seen.
Days 3-4 - Vesicular epithelium is lost, with subsequent fibrin deposition evident on the exposed dermis. Epithelium starts to re-grow at lesion borders
Day 5-7 - Epithelial regrowth is marked, with loss of fibrin infilling, and subsequent scarification present
Day 7 onwards - Fibrin infilling has disappeared, with new epithelium covering the dermis. Scar formation progresses.

Ages of lesions in experimentally infected pigs



Ages of lesions in experimentally infected sheep

FMD in cattle:

•Initial clinical signs are drooling, excessive salivation, fever, lameness, milk drop, lip smacking, depression.

•Lesions are located on the tongue, dental pad, muzzle, coronary band, heels, inter-digital skin, teats.

•Calves may die of myocarditis.

FMD in pigs:

•Initial clinical signs are fever, depression, lameness, inappetance. Pigs may "dog sit" and huddle together.

•Lesions are located on the snout, tongue, coronary band, interdigital skin.

•The horn of the foot may detach entirely ("thimbling").

•Piglets may die of myocarditis.

FMD in sheep:

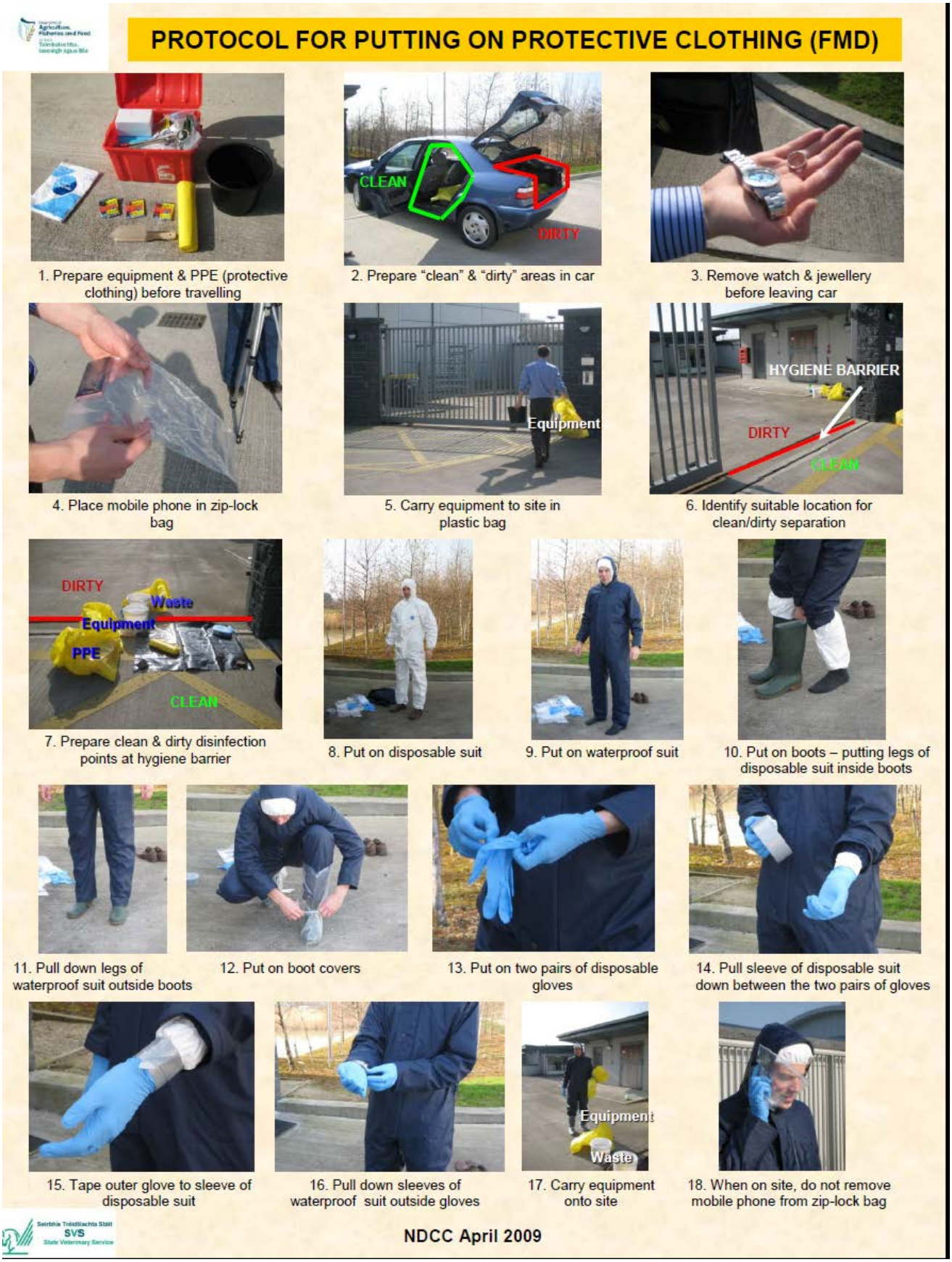
•Clinical signs can be subtle and difficult to detect in some cases. Lesions may only occur in the mouth or on the feet. Signs include lameness, fever and depression, although these may be mild.

•Lesions are located on the dental pad, tongue, coronary band, interdigital skin.

•Lambs may die of myocarditis and pregnant sheep may abort / result in foetal mummification.

Further information on FMD clinical signs and lesion ageing is available at http://www.fao.org/ag/againfo/commissions/en/eufmd/training_material.html.
Produced by the European Commission for the Control of Foot-and-Mouth Disease. Photographs of infected animals are courtesy of the Institute for Animal Health, UK, and Carolina Stenfeldt, Danish DTU.

Protocol for Protective clothing



PROTOCOL FOR TAKING OFF PROTECTIVE CLOTHING (FMD)

1. Disinfect equipment & outside of sample boxes/bags

2. Place equipment & samples in equipment bag on clean side

3. Remove boot covers & place in waste bag for disposal

4. Disinfect legs of waterproof suit

5. Clean soles of boots thoroughly & disinfect

6. Disinfect remainder of waterproof suit

7. Remove waterproof suit

8. Place suit in PPE bag on "clean" side

9. Remove first outer glove – touching only the outer surface

10. Remove second outer glove by hooking thumb under cuff - place in waste bag

11. Step onto clean side & disinfect boots

12. Remove disposable suit & place in waste bag on "dirty" side

13. Remove first inner glove – touching only the outer surface

14. Remove second inner glove by hooking thumb under cuff - place in waste bag

15. Double bag & seal the equipment & PPE bags

16. Disinfect outside of bucket

17. Disinfect hands using 6-step procedure

18. Wipe face with wet-wipes

19. Pour disinfect over plastic mat & place mat in waste bag

20. Place equipment & PPE bags in "dirty" area of car

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Clinical Examination Form (can be adapted)

Name of the Owner/Household: ..... Farm ID: ……. Epidemiological unit: Date:

Animal ID	Species	Type	L/S/M/PD/A	Temp.	Vesicular Lesions Y/N	Age of Lesions	Samples **T**issue/**B**lood/**S**erum	Number of Photos	Comments
if no eartag, give order of animals examined; No. 1, 2 etc	bovine	calf	-	n.m.	Y (M + F)	> 7d		PA 130073, PA 130077	

L: … Lameness, S: … Salivation, M: … Drop of Milk Yield, PD: … Perinatal Death, A: ……Abortion

Estimated age of oldest lesion seen:

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