FMD epidemiology and tracing dangerous contacts

Erzurum, Turkey, 8th-12th June 2009

Nick Juleff, Institute for Animal Health
• Epidemiology and spread
• DEFRA control policy
• Tracing dangerous contacts
• Prioritising: which DCs are the most important?
Routes of infection

- Direct contact with infected animals (ban on animal movements)
- Contaminated animal products (ban on meat/milk from infected areas)
- Airborne virus (use wind records to estimate spread)
- Mechanical transmission of virus on people, vehicles, etc → BIOSECURITY
Incubation and excretion periods

- Incubation period: 1–14 days, most commonly 2-5 days
- Dose-related: low dose → longer incubation

- Virus excretion: may occur *before* onset of clinical signs

| Virus excretion: range and highest excretion periods relative to appearance of first lesions |
| Day of first lesions | -8 | -7 | -6 | -5 | -4 | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Pigs | | | | | | | | | | | | | | | | | | | | | | | | |
| Cattle | | | | | | | | | | | | | | | | | | | | | | | | |
| Sheep | | | | | | | | | | | | | | | | | | | | | | | | |
Why is FMD so contagious?

- WIDE host range: cattle, sheep, pigs, goats, other cloven-hoofed animals
- HIGH Morbidity/LOW mortality
- Transmission dynamics: rapid, high level of transmission
- Patterns of viral shedding: FMD virus shed in saliva, breath, milk, skin vesicles, urine, faeces
- FMD virus can survive in environment for long periods
Key epidemiology factors

• Animal movements
  UK 2001: best estimate is that >100 farms were already infected before first diagnosis

• Role of markets & abattoirs
  UK 2001: 10 infected sheep in Longtown market exposed 24,500 sheep

• Pigs: high level excretion, airborne spread
• Sheep: subclinical infection, easily missed
• Persistence of epidemic through “local spread”: stringent biosecurity reduces risk
Most likely method of spread of FMD to premises with new disease each week (to July 9th 2001)

<table>
<thead>
<tr>
<th>Method</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airborne</td>
<td>18</td>
</tr>
<tr>
<td>Milk Tanker</td>
<td>11</td>
</tr>
<tr>
<td>Infected cattle</td>
<td>18</td>
</tr>
<tr>
<td>Infected pigs</td>
<td>1</td>
</tr>
<tr>
<td>Infected sheep</td>
<td>68</td>
</tr>
<tr>
<td>Other formite</td>
<td>10</td>
</tr>
<tr>
<td>Person</td>
<td>67</td>
</tr>
<tr>
<td>Swill suspected</td>
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</tr>
<tr>
<td>Vehicle</td>
<td>28</td>
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<tr>
<td>Local*</td>
<td>1454</td>
</tr>
<tr>
<td>Under investigation</td>
<td>171</td>
</tr>
</tbody>
</table>

**Grand total** 1847

*Local – new infected premises (IP) within 3 Km of previously confirmed IP and more than one possible conveyor (Gibbens et al., Vet Rec 2001)
• Epidemiology and spread

• DEFRA control policy

• Tracing dangerous contacts

• Prioritising: which DCs are the most important?
Principles for controlling a FMD outbreak

Prevent further transmission of the virus from infected to susceptible animals

↓↓ production of virus
Cull infected and in-contact animals, ± dangerous contacts if high-risk

↓↓ potential for direct contact between animals
Movement restrictions

↓↓ virus survival time in the environment
Biosecurity, cleansing & disinfection of infected farms

↓↓ number of susceptible animals
Emergency vaccination or contiguous culling if situation v. severe
DEFRA - Initial control measures

- Establish temporary control zone
  - Stop animal movements
  - Size – prevent spread of disease
  - Supplementary movement control zone (2007)

- “Stamping-out” on infected premises (IP)
  - 24 hours

- Cull dangerous contacts
  - 48 hours

- Establish 3km protection and 10 km surveillance zones
• Protection zone (3km radius around IP)
  – No animal movement except to emergency slaughter under licence
  – Movement of animal products, feed and bedding under licence
  – Requirement for increased on/off farm biosecurity
  – Animal products treated to destroy FMDV
  – Footpaths closed
  – census
  – surveillance - regular inspections, sero-surveillance
  – tracing at start
  – *For early / index cases, the EU requires tracing of animals and products moved from the zone since 21 days before the probable introduction of infection*

• Surveillance zone (10km radius around IP)
  – As for protection zone except:
    • Footpaths remain open
    • Licensed animal movements are possible
Additional control strategies

• Scientific and veterinary advice

• Cull other susceptible livestock exposed to disease
  – e.g. Premises under viral plumes, adjoining premises
  – Extensive sampling, clinical examination (2007 pre-clinical diagnosis)

• Pre-emptive or “firebreak” culling of animals
• Epidemiology and spread

• DEFRA control policy

• Tracing dangerous contacts

• Prioritising: which DCs are the most important?
Establishing Timelines

- Estimate age of **oldest lesion** on farm
  → date lesions first appeared (NB: error margin)

- Subtract incubation period **1-14** days → window for **introduction of virus**

- Prioritise “onto farm” contacts in most likely incubation period of **2-5** days before lesions appeared
Timeline example: UK 2007

Data from Cottam et al., 2008
Tracing dangerous contacts (DCs)

Methods:
- Interview farmer & farm staff
- Examine written records (milk tanker, feed deliveries, AI visits, etc)
- Walk boundaries of farm
- Estimate age of FMD lesions on animals
- Contact dairy, vets, AI techs etc by phone

Key information:
- Estimated age of oldest lesion
- Animal movements
- Personnel visiting farm
- Farm personnel visiting other livestock holdings
- Vehicle/equipment movements
- Security of farm boundaries
Risk periods

- *Time* of contact is very important
- Tracings *onto* farm: incubation period 1-14 days before lesions appear; most likely 2-5 days
- Tracings *off* farm: refer to *virus excretion period*

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<th>Virus excretion: range and highest excretion periods relative to appearance of first lesions</th>
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<td>Sheep</td>
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NB: virus can be excreted *before* clinical signs appear
Milk: can contain virus *4 days* before disease appears
Risk periods

- Levels of environmental FMD contamination increase from first case until after final case on farm has recovered
- Slow decrease in virus levels thereafter, related to temperature and humidity
- Fomite transmission contacts: relationship between time of contact and degree of risk
Type of contact

Animal movements most critical contact
• Pigs: high level of virus excretion
• Sheep: mild to sub-clinical disease; easy to miss

Local spread
• Check farm boundaries
• Nose-to-nose contact with neighbouring herds/flocks possible?
• Fences stock-proof?
• Shared streams at boundary – close proximity possible?
• Common grazing?
Tracing animal movements

• Trace source of animals moved onto farm during incubation period

• Trace destination of animals moved off farm during virus excretion period (from 4 days prior to disease appearance onwards)

• Identify any markets/stopovers en route, incl. pick-ups at other farms

Method: Use animal movement databases, farmer interview, records, etc

Action: restrict all implicated premises, initiate investigations
Tracing contiguous herds & common grazing

- Determine if neighbouring stock were in fields adjacent to IP; evaluate fencing/waterways/natural features between premises.
- Determine which other farms had stock grazing land also used by IP stock, and relevant timelines.

**Method:** Maps of contiguous farms, VI to walk farm boundary, telephone enquiries, local knowledge

**Action:** Issue restriction notices and initiate investigations on any farms where stock grazed commonage at same time or after stock from IP, subsequent to estimated earliest date of infection introduction, and any contiguous farms.
Type of contact:
Personnel

- Close interaction with animals? Vet, AI tech, shared labourer, foot-parers, sheep shearers, etc
- Interaction with affected stock or non-affected stock?
- Visits by farmer & staff to other livestock holdings: contact with animals at other premises?
Tracing personnel contacts

- Identify workers, especially those in contact with animals, on the IP who also work on other farms
- Identify itineraries of vets, AI techs, other technicians who were on IP during risk periods

**Method:**
- Interview farmer and farm staff, any other relevant personnel
- Interview vets, AI techs etc, examine calls book
- Relate farmer names to herd numbers, identify on map
- Relate contact dates to risk periods, prioritise accordingly

**Action:**
- Evaluate degree of risk of each contact
- Prioritise accordingly; restrict highest risk ones
- As a minimum, first 3 farms visited by vets/AI techs after IP require investigation as a priority
Type of contact: Vehicles/equipment

- Milk tankers: can leak virus-containing milk at pipe connection
- Trailers which contained animals: gross contamination with virus possible
- All vehicles: wheels, wheel arches, undercarriage contaminated with faeces/muck with virus
- Key question: was vehicle/equipment in contact with animals or in yard/lane contaminated with faeces?
Tracing milk tankers

• Identify premises visited following collection of milk from IP during risk period.

Method:
• Contact dairy by phone, request records of tanker itineraries during risk period; verify with driver (may vary route)
• For tracings off the IP, the risk period is from 4 days prior to the appearance of clinical signs, although tracings which occurred during clinical disease should be prioritised

Action:
• Identify premises visited
• Prioritise farms with large numbers of stock and farms visited immediately after IP.
Tracing other vehicles/equipment contacts

• Identify nature of contacts
• Estimate time in relation to risk period
• Ascertain origin or destination of vehicles/equipment
• Ascertain degree of contact with infected animals on IP
• Evaluate risk level and prioritise contact investigation accordingly

Method:
• Interview farmer and farm workers and other relevant personnel.
• Phone premises which were origin/destination of contact vehicles and establish number and species of stock on farms
• Establish dates of contacts and relate to risk period

Action: investigate priority contacts first
Risk of airborne spread

- Virus emission profile estimated by number of animals with FMD and age range of lesions
- Meteorological agency (e.g. Met Office) will combine this with meteorological data
- Model output: map with areas showing relative risks of airborne FMD spread
- Farms in “high risk” category: investigate first
- Virus can spread long distances by air, but this is not as common as other methods of spread (animal movement, fomites)

Summary:
- Latest UK Met Office model, including GIS output in operational service
Assessment of Biosecurity on IP

- Level of biosecurity in operation on IP *prior* to diagnosis can hugely influence onward spread
- Difficult to assess after diagnosis
- General level of farm hygiene can provide rough estimation

Biosecurity on dangerous contact: also critical risk factor, but impossible to assess without inspection, unless prior knowledge available
• Epidemiology and spread
• DEFRA control policy
• Tracing dangerous contacts

• Prioritising: which DCs are the most important?
Reasons for prioritisation

- The number of contacts to be traced can become very large
- Resources for investigations not unlimited
- Time can be critical

→ Need to prioritise “hot” contacts
Prioritising Dangerous Contacts

Three factors to consider:
1. Species: pigs > cattle > sheep
2. Type of contact: animal movement > people in direct contact with FMD animals > vehicles in direct contact etc.
3. Time of contact in virus excretion window

NB: may get multiple waves of infection in herd/flock → continual virus excretion as new animals fall ill

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|---------------------|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pigs                |    |    |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Cattle              |    |    |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Sheep               |    |    |    |    |    |    |    |    |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
Prioritising DCs: Likely result of virus spread

- Pigs: if infected, will generate huge amount of virus → tracings to pig farms a priority

- Number of animals on DC: as numbers increase, so does chance of infection and significance of outbreak

- Type of enterprise:
  - Markets
  - Abattoirs
  - Farms owned by dealers
Categorising risk posed by DCs

Very high risk:

- Animal movements during risk period
- Farms owned/worked on by workers from IP
- Contiguous herds with possibility of nose-to-nose contact
- Animals grazing common land with IP stock
- Any market or abattoir connected to IP during risk period
Categorising risk posed by DCs

High risk:

- Farms visited by vets/AI techs after IP during risk period
- Farms visited by milk tanker after collection at IP
- Contiguous farms where nose-to-nose contact is less likely but stock are in adjacent fields
Categorising risk posed by DCs

Medium risk

- Shared equipment/trailers/vehicles in direct contact with infected animals on IP
- Neighbouring/nearby farms with some distance between animals on IP and DC
- Personnel in contact with animals on IP and DC
Categorising risk posed by DCs

Low risk:

- Vehicles/equipment shared between farms but not in contact with animals
- Personnel shared between farms but not in contact with animals
- Personnel visiting the IP and then other farms but not in contact with animals
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