10.1 Background

Around 10 March, the Chief Veterinary Officer was realising that the existing policies of infected premises slaughter together with tracing and slaughter of dangerous contacts, were not containing the epidemic. Information available at the time could not fully explain why this was so. Either the policies themselves were inadequate or they were not being fully implemented or, to some degree, both.

The number of infected premises was doubling every week. The epidemic was on track to overwhelm resources. Around the country, including at MAFF’s Page Street Headquarters, the notion was growing that new instruments of policy were needed. MAFF’s Veterinary Management meetings pondered options for increasing the culling of sheep. Pre-emptive slaughter of sheep on Dartmoor was considered, focusing on premises contiguous to infected animals, as was a cull of all fat-stock sheep. The Chief Veterinary Officer was also considering extending the definition of ‘dangerous contact’.

The epidemiologists at the Veterinary Laboratories Agency were simulating the epidemic on computers using the InterSpread model. By 12 March, they were forecasting that it might reach between 1,000 and 2,000 cases, compared with the 182 so far confirmed.

In Scotland, the Scottish Executive, working very closely with the NFU Scotland, had started to contemplate unprecedented steps in an effort to control an increasingly desperate situation. The epidemic in Dumfries and Galloway was exploding, threatening the valuable cattle populations to the north. Informally at first and, as far as we have been able to discover, without any scientific advice, plans were rapidly worked out for a 3km pre-emptive sheep cull. All sheep within 3km of a confirmed infected premises would be slaughtered. Meetings with MAFF in London and at Downing Street were called urgently and agreement quickly reached to coordinate policy across the Scottish-English border.

On 15 March, these policies were announced simultaneously in Scotland and England, although they were not implemented until 22 and 28 March respectively. The fact that the Minister of Agriculture, Nick Brown, announced that “animals within the 3km zones” were to be destroyed on a precautionary basis, without explicitly excluding cattle, caused confusion and consternation. Although a clarification was made later in the day that cattle were specifically excluded from this policy, resentment remained and affected local attitudes. The scene was set for confrontation.
10.2 The genesis of the FMD Science Group

If we step back from these events and return to late February, in parallel with the activity of the State Veterinary Service and MAFF, Sir John Krebs, Chairman of the Food Standards Agency was concerned how the FMD outbreak might develop. Before the end of the month, he was already speaking to a number of experts in epidemiological modelling to seek their views. Following these discussions an ad hoc group was hosted by the Food Standards Agency on 6 March. The epidemiologists discussed their initial view of the outbreak and what information they needed from MAFF to help analyse and predict the progress of the emerging epidemic. MAFF supplied the data requested on 13 March. Four groups of epidemiologists began their analysis. The Imperial College team (some of whom had recently published an analysis of FMD data from the 1967/8 outbreak) was the most advanced at this stage. On 16 March they sent MAFF their initial view of the outbreak and what information they needed from MAFF for their analysis. The models had been constructed independently, and although the forecasts were bleak. The models had been constructed independently.

The epidemiologists met again on 21 March at the Food Standards Agency. Professor David King, the Government Chief Scientific Adviser, and the Chief Veterinary Officer were among those present. The conclusions of all the forecasts were bleak. The models had been constructed independently.

10.2.1 “Out of control” – the R₀ number

The epidemiologists had looked at what was happening to the so called ‘case reproduction number’, R₀, which is the average number of new cases generated by one current case.

Suppose there are FMD cases on 10 farms. How many new farms will these infect? With no movement restrictions or any kind of culling, it might be 50, corresponding to an R₀ value of 5. With movement restrictions and culling of infected herds it might be 15, an R₀ value of 1.5. These newly infected farms will go on to infect further farms. As long as R₀ is greater than one, then the number of new cases at each stage continues to increase and the epidemic is out of control. To get the epidemic under control, R₀ has to be reduced below one, so that the 10 current cases directly cause fewer than 10 new cases. To be sure of stopping the epidemic quickly, getting R₀ to a smaller value, say 0.5, is a good idea if possible. But keeping R₀ below 1 is the prime aim of any policy for managing an epidemic.

Preliminary data from the 2001 UK FMD epidemic implied that, early in the outbreak, on average, one infected premise had infected 1.2 other farms by 24 hours after its own infection was discovered. Thus, even a perfectly implemented cull of infected premises within 24 hours of discovery would not, on its own, have controlled that epidemic until the disease itself had reduced the density of susceptible farms to such an extent that the epidemic ended naturally.

10.2.2 The role of the FMD Science Group in informing policy

The analytical evidence presented by the Science Group was seized upon by decision-makers in a situation where hard evidence was difficult to come by. The policy decisions that were underpinned by the Group’s analysis were contentious. Yet the creation, constitution and operation of the Science Group did not conform completely with the Office of Science and Technology’s guidelines on scientific advice and policy making, nor take cognisance of the lessons drawn by The BSE Inquiry. The genesis of the Group was a decision to bring together a particular group of experts – epidemiological modellers – to inform the Food Standards Agency. Although other scientific disciplines were represented this led some people to comment that the group was more of a ‘modelling sub-committee’ than a full FMD Science Group. That the group was open to such criticism was unhelpful.

The Science Group epidemiologists are world experts in their field. Many of the public accusations levelled at their work are based on limited knowledge of the statistical and mathematical techniques they employed, for example to address weaknesses in the raw data. Nonetheless, the highly specialist nature of their work made it difficult for other FMD experts to engage with the detail, especially when they themselves were under huge pressure of work in managing the outbreak. At times there were polarised views within the group but no convincing mechanism for handling conflicts of opinion.

The membership of the Group was gradually extended, with increased veterinary input. By this stage the contentious decisions had already been taken.

These matters were now seen to have much wider implications for the whole of government. So, from then on, the Chief Scientific Adviser took the lead. Building on the group that met at the Food Standards Agency he created the FMD Science Group which met regularly from 26 March until 1 November (31 meetings in all).

34. We recommend that DEFRA’s Chief Scientist maintain a properly constituted standing committee ready to advise in an emergency on scientific aspects of disease control. The role of this group should include advising on horizon scanning and emerging risks. Particular attention should be given to the recommendations on the use of scientific advisory committees in The BSE Inquiry report of 2000.

"...it was the right decision to take, the contiguous cull, and if the contiguous cull was done at Willy Cleave's farm when his sheep were all in the shed and the surrounding farms were all contiguously culled out that would have been the end of foot and mouth in Devon."

Public Meeting, regional visit to the South West

10.3 The emergence of the contiguous cull

By 21 March, the Chief Veterinary Officer and the epidemiologists in the State Veterinary Service, along with those of the Chief Scientific Adviser and groups of independent epidemiological modellers were all coming to the same conclusion. Existing policies were not yet controlling the spread of the disease. Something needed to be done and done fast.

The findings of the 21 March modelling meeting were due to be sent to MAFF so that it could make a policy announcement later in the week. However, although there had been agreement at the 21 March meeting "that individuals would not talk to the media", Professor Roy Anderson, Head of Infectious Disease Epidemiology at Imperial College, stuck to a pre-arranged appearance on the BBC’s ‘Newsnight’ that evening. He did not discuss the details of that afternoon’s meeting but he did say "I think everybody is in agreement, both government, the farming community and the independent scientific advice, that this epidemic is not under control at the current point in time”. He went on to say "if this cull [i.e. the 3km cull in Cumbria, Dumfries and Galloway announced on 15 March] is applied vigorously and effectively enough you could turn the epidemic in to a decaying process hopefully within, a month to two months. Doing something even better than that is not convinced is possible at the moment."

Professor Anderson’s intervention on 21 March forced the pace of developments, bringing into public discussion the notion that the outbreak was out of control.

On 23 March, at a press conference with the Minister of Agriculture, Nick Brown, Professor King reiterated that the epidemic was out of control. Subsequent press reports on 24 March said that the time between report and slaughter needed to be brought down to 24 hours. Some suggested that the recently announced 3km sheep cull, which had only begun to be implemented in Scotland two days previously and would not be started in Cumbria for another four days, would need to be extended. Others alluded to a 1.5km ring cull of all susceptible animals.

We have been unable to find a clear account of decision making around that time. The pressure on the Government from all sides was growing. The press reports on 24 March talked of "confusion". Some suggested that the Prime Minister had already given the order for a pre-empitive cull.

Tensions were rising. The MAFF Permanent Secretary, Brian Bender, told us that, between 21 and 26 March, there was a great deal of confusion. The epidemiological modellers were concentrating on the principal factors influencing the spread of disease from an infected place to neighbouring farms. The vets, desperately short of resources and knowing that they were failing to deliver the critically important rapid slaughter of infected animals, were also considering extending the definition of dangerous contacts to bring more animals into the culling net. Everyone involved accepted that the slaughter of infected cases as rapidly as possible and certainly within 24 hours of report or less was the priority but that this, on its own, would not be enough to contain the disease at this stage. Some believed that enhanced biosecurity was what was needed, but the resources were not available to realise fully the biosecurity measures already in place.

It has become apparent to us that, while some policy decisions were recorded with commendable clarity, some of the most important ones taken during the outbreak were recorded in the most perfunctory way, and sometimes not at all. In the context of our own Inquiry, this has made the task of constructing an audit trail extremely difficult in some vital policy areas, including the contiguous and 3km culls, and the decision to close footpaths.

Good record keeping is essential. Records are not kept purely to inform potential future Inquiries. They should set out what has to be done, when and by whom, to help ensure that results are delivered.

35. We recommend that, from day one of an outbreak, provision be made to keep a record of all decisions made and any actions to be taken.

The Chief Veterinary Officer feared that a national 3km pre-empitive cull was neither practical nor likely to be legal (17.3). Professor King told us that, in the period between 21 and 24 March, he had asked the Imperial College team to model smaller radii than 3km. On the basis of that modelling, a radius of between 1 and 1.5km had appeared to be optimum in bringing the epidemic under control with the minimum necessary cull. Somewhere in the midst of this the idea was born that a contiguous premises cull would have a similar impact to a 1.5km cull, although the FMD Science Group was to be asked to advise on the definition of ‘contiguous’ during the following weeks.

The models showed that a national policy based on slaughter of infected animals within 24 hours of report and the pre-empive slaughter of all animals on contiguous premises would contain the disease and eventually eliminate it while minimising the total number of animals slaughtered, compared with the other scenarios that had been modelled (10.3.1).

This led to the introduction of the so-called 24/48 hours slaughter policy.

We have been unable to establish the precise rationale for the target of 48 hours, nor ascertain the source of that timescale. Professor King told us that it was designed to allow for the prioritisation of infected premises culling and that it recognised that the incubation period gave some time for manoeuvre in tackling contiguous premises. The target of 48 hours was first stated in the Number 10 lobby briefing on the morning of 26 March. It formed part of the Minister’s statement to the House of Commons, which formally confirmed the new policy, on 27 March. We have been unable to establish any formal record of the decision to introduce the 48 hour target. For what became such a central component of disease control policy, albeit one that proved unattainable in practice, this is regrettable.
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10.3.1 Predicted impact of culling policies

Each scenario has a different impact on the shape of the epidemic (chart A) and on the numbers of FMD cases and farms culled out in total (chart B). What happened in the actual epidemic (scenario 1) can be compared with the theoretical scenarios. The models were calculated using farm numbers, rather than numbers of animals, at July 2001.

Timing of the slaughter of infected premises has the most significant effect on the size of the epidemic. Had the 24 hour target for infected premises been achieved from the start, the epidemic would have been dramatically reduced. (Compare scenarios 1 and 5 in chart B.) However, culling of infected premises alone would not have eradicated the disease. The modelling suggests that, without any non-infected premises culling, the epidemic would have been catastrophic (scenario 6 in chart A). Not only does the culling of non-infected premises reduce the predicted number of FMD cases, but it also – perhaps counter-intuitively – reduces the total number of farms culled (for example, compare scenarios 4 and 5 in chart B). Thus, overall, appropriate pre-emptive culling reduces the numbers affected by the epidemic and its duration.


10.4 Slaughter on suspicion

In practice, the 48 hour contiguous cull was probably never more than 50% implemented. Certainly, in the areas of the highest infectivity, the implementation rate was lowest. But efforts to slaughter infected premises within 24 hours of report (rather than confirmation) increased dramatically along with monitoring of success. Before 22 March, when a vet felt unable to confirm a case on clinical grounds but was equally unable to be sure there was no infection, samples were taken and tests carried out. Only if these proved positive were the animals slaughtered. This testing could take up to four days so infected animals could be left alive for up to five days. Slaughter on suspicion was introduced on 24 March, requiring slaughter of all suspicious animals whether clinically confirmed or not.

This policy highlighted the tension between the need for speed and the desire for certainty of diagnosis. In the event only a small proportion of sheep slaughtered on suspicion subsequently tested positive. This led people to call for the use of rapid on-farm tests and technologies which were being newly developed (10.4.1). These technologies drew upon standard laboratory techniques and some people argued that, as they were available, they should be used. However the tests they could perform in the field had not been validated to the same standards as conventional laboratory tests. It would have been inappropriate to use potentially unreliable tests during the FMD crisis.

Rapid diagnostic tools could be of considerable value by supporting clinical judgement and, potentially, improving the quality of decision making on the ground. For the last few years, the Pirbright Laboratory has been developing pen-side tests for detecting FMD virus. These are test sticks, based on the technology used in home pregnancy tests, and give rapid results within a few minutes. Limited but encouraging trials have been conducted in the field to date.

36. We recommend that the State Veterinary Service be routinely equipped with the most up-to-date diagnostic tools for use in clinical practice, to contribute to speed and certainty of action at critical times.

Source: Ferguson et al. 4 (Data at 16 July 2001)

The epidemiologists modelled different scenarios. These include various culling policies:
- culling infected premises (IP or FMD cases) within 24 hours of report
- pre-emptive culling of non-infected premises (non-IP), namely dangerous contacts and contiguous premises (CP)
- contiguous premises culling within 48 hours.

Implementation of all these policies was modelled:
- from the start of the outbreak
- from 1 April 2001.

What actually happened in practice was also represented on the computer, for comparison.

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10.4.1 Developing rapid on-farm tests

One specific offer of testing came from the Agricultural Research Service of the United States Department of Agriculture. In collaboration with private companies, the Agricultural Research Service had developed a Real-Time Polymerase Chain Reaction (RT-PCR) test using portable equipment, such as the ‘SmartCycler’. US scientists offered to visit the Pirbright Laboratory with their equipment and materials in order to test them under field conditions during the UK outbreak but the priorities of managing the outbreak made this impracticable.

The Agricultural Research Service claimed that their tests which give results in a couple of hours were straightforward and reliable. However, they wished to publish their results in the scientific journals before proceeding to validation.

The Pirbright Laboratory and the FMD Science Group considered the technology carefully. Pirbright Laboratory uses RT-PCR routinely in the laboratory and had evaluated the use of portable equipment. They concluded that RT-PCR has much potential for rapid testing in mobile or local laboratories, but not on the farm itself.

RT-PCR goes through cycles of copying specific sequences of DNA which, if present, can then be visualised. It is a sensitive technique which allows pre-clinical detection of small amounts of FMD virus within a couple of hours. Contamination can lead to false positives. In the field RT-PCR can be unreliable, resulting in false negatives.

10.5 The justification of the contiguous cull

The justification for culling contiguous premises was founded on a statistical concept. All the models showed that culling farms neighbouring infected premises would reduce spread of infection and control the epidemic. This was based on the observation that, on average, animals on 34% of premises within a radius of 1.5km of infected premises came down with FMD. Although culling contiguous premises was a blunt policy instrument, it had the benefit of speed in decision making. It did not depend on the epidemiological groundwork to identify dangerous contacts, which was resource intensive and time consuming.

From some perspectives the rigorous application of a contiguous culling policy was a desperate measure. But the situation was desperate. The epidemic was expanding out of control. FMD could have become endemic. The pressure was intense. Resources were stretched. There was no time to explore alternatives or carry out experiments. Here was a simple formula that both the Chief Veterinary Officer and the Chief Scientific Adviser said would work. And that was the advice that was followed.

10.6 Implementing the culling policies

MAFF now had a range of culling policies to be implemented on the ground:

- Culling of all susceptible animals on premises with clinically confirmed cases within 24 hours of report.
- Slaughter on suspicion.
- Culling of known dangerous contacts.
- Culling of sheep, pigs and goats within 3km of infected premises in Cumbria and Dumfries and Galloway.
- Culling of all susceptible animals contiguous to infected premises within 48 hours.

Vets in MAFF Headquarters at Page Street and around the regions had to organise all this and communicate the details to everyone concerned. There was little time for reflection or any opportunity to think through all the issues. And many complex issues were to arise.

The 3km cull was controversial in Cumbria though less so in Scotland. The contiguous cull was controversial wherever it was rigorously applied. Many representations were made to us by farmers. They believed they were victims of the unthinking application of a generic policy in spite of obvious local circumstances and mitigating factors that should have been considered.

In Scotland the contiguous cull policy was not generally applied. It was instead used strategically to help control spread at the edge of the epidemic.

Many farmers did not understand or accept the statistical basis for the policy. Most contiguous premises were not infected and probably would not have become infected. But some would and, if not culled out, would have revealed themselves only when they had contributed to the further spread of disease.

Many vets accepted this and had no professional doubts. But some, including many Temporary Veterinary Inspectors, did not. They called for more local discretion. However, introducing widespread discretion was judged not to be wise at the height of the epidemic.

There were numerous appeals against the contiguous cull and many of these were upheld. In several instances the farm in question was re-designated as not contiguous. A climate of confrontation and opposition to the cull was generated in many parts of the country.

The experience in Scotland at this stage is illuminating. Through the State Veterinary Service, the Scots were implementing national policies but, because of the powers vested in the Scottish Minister, there was considerable local discretion. First, with the help of the NFI Scotland, it had been possible to explain the rationale and to build a reasonable consensus in support of the 3km sheep cull in Dumfries and Galloway.

In other words, communication of the policy goals was successful. Second, a decision was taken to apply the contiguous culling policy pragmatically and only in those premises at the edge of the epidemic zone as an extra precaution to prevent the spread of infection into new territory. These policies worked well. The disease was eliminated after 91 days.

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Commissioner David Byrne, response to the European Parliament Temporary Committee on FMD, 25 March 2002

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“The contiguous cull was the single most controversial policy initiative of the entire battle against Foot and Mouth disease. It was crude, medieval and extremely brutal. And the fact that it was stepped up when the General Election loomed closer made many suspicious that it was driven by politics, not science.”

Editorial, Western Morning News, 22/05/02
In an FMD outbreak tight central direction is necessary both at the early stages of the epidemic and as it reaches its height. Good epidemiological judgements are only possible when all relevant factors are taken into account. This is one reason why reference had to be made to the State Veterinary Service specialists in Page Street. When eventually the Chief Veterinary Officer saw the epidemic was tailing off, more local discretion became possible. From 26 April the rules governing the contiguous cull were altered.

37. We recommend that in order to build support steps always be taken to explain the rationale of policies on the ground, particularly where implementation is likely to be controversial. Wherever possible, local circumstances should be taken into account without undermining the overall strategy.

The introduction of the explicit 24 hour report to slaughter policy (including slaughter on suspicion) and the contiguous cull policy played a critical part in disease control in the 2001 outbreak. The Government felt it had little choice but to accept the advice it received on these matters from the Chief Veterinary Officer and the Chief Scientific Adviser. But the process of determining and responding to that advice should have been better. It was certainly not in line with the recommendations on scientific advice made by The BSE Inquiry. Communication of the rationale generally was poor. The decision making process remains unclear. In some cases too the statutory position was insufficiently clear. Although the circumstances which led to this were exceptional, it was in part a failure of advance planning.

The possibility of adopting a contiguous culling policy in future should be retained. However, it is imperative that it should only be applied in the light of up-to-date scientific and veterinary advice. Robust management information should be available to support any decision. The rationale must be discussed with stakeholders and understood in advance by those who may be affected, as part of the strategic preparations for disease control. This position supports the general conclusion that draconian steps at the beginning of an outbreak are likely to produce a favourable end result in terms of cost and numbers of animals slaughtered. A more discretionary approach may be introduced once the picture becomes clearer.

There are many lessons here for contingency planning, for clear communication of policy rationale to those most affected and for a wider understanding of the circumstances where local discretion may be applied.

38. We recommend that provision be made for the possible application of pre-emptive culling policies, if justified by well-informed veterinary and scientific advice, and judged to be appropriate to the circumstances.

The dense cluster of infection on the Isle of Anglesey made it feasible to implement a more radical culling policy from late March to mid April. This involved removing all sheep in a geographically defined area. The policy was effective in stamping out the virus on Anglesey but led to a higher number of animals being culled per infected premises than in the rest of Wales. Thus, 4,235 animals were culled per infected premises whereas elsewhere in Wales the average was 2,779. The then Welsh Minister of Rural Affairs, Carwyn Jones, suggested to the Inquiry that the cull was widely supported by local farmers as the approach was simple and equitable. Nevertheless a small group of farmers mounted a legal challenge and were able to keep their animals.

The Anglesey cull was an example of how policy could be tailored to local circumstances. Elsewhere in Wales the pattern of disease was less dense and culling on the Anglesey model was not a viable option.

10.6.1 Anglesey

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