

Management of Disease - The UK Foot and Mouth Disease Experience

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■ Introduction

Foot-and-mouth disease (FMD) is a highly infectious viral disease of cattle, pigs, sheep, goats and wild cloven hoofed animals, characterised by fever, loss of production, and vesicles on the mouth, feet and teats; in young animals the virus attacks the developing heart muscle, resulting in death without other clinical signs. It is caused by a small RNA virus, within the family Picornaviridae; there are seven immunologically distinct serotypes of FMD virus, types O, A, C, Asia1, and SAT1, SAT2 and SAT3. It is considered to be the most contagious of all animal virus diseases, and is the single most important constraint to international trade in live animals and animal products.

The United Kingdom had been free of FMD since 1981, when there had been a single outbreak in a dairy herd on the Isle of Wight, off the coast of southern England. On Feb 19th, this year, pigs waiting slaughter in an abattoir in southern Essex, to the north of London were identified by the on duty veterinarian with feet lesions consistent with FMD, and this was confirmed positive the following day at the high security Institute for Animal Health laboratory, Pirbright. This laboratory is also the World Reference Laboratory for FMD, and apart from having the largest research group working on FMD, also maintains a library of FMD virus isolates collected from around the world during the last 60 years.

The virus strain was quickly identified by nucleotide sequencing to be the PanAsia strain of serotype O FMD virus, which was known to be present throughout most of Asia, and had recently caused new outbreaks in Japan (free since 1908), South Korea (free since 1934) and South Africa (this was the first outbreak of serotype O ever recorded), Mongolia and eastern Russia. The pigs affected in the abattoir had been held over the weekend before developing signs, and it was assumed that their farm of origin was the source of infection;

however, tracing back showed no evidence of infection, and it was concluded that they had acquired infection in the abattoir. Other farms supplying pigs were then visited, and on the 23rd Feb., a farm in north east England, close to Newcastle was found with evidence of FMD; on 24th Feb. a movement ban on all FMD susceptible species was applied to the whole of the UK, which included markets, race meetings and dog shows. The affected farm contained over 500 adult animals, mostly cull sows and boars, and following clinical examination it was apparent that disease had probably been introduced as early as the beginning of February, as most of the pigs had lesions of approximately 10 days old. The farmer fed almost exclusively a diet of waste food (swill), collected from nearby schools, hospitals and restaurants. Regulations relating to swill feeding make it compulsory to boil all waste food before feeding to pigs, but this is difficult to enforce.

FMD transmits following the movement of infected animals, the feeding of animal products contaminated with FMD virus, by contact with mechanically carried FMD virus (on vehicles, clothes, hands, instruments, etc.) or as an aerosol produced by infected animals. Persistently infected (carrier) cattle can also precipitate new outbreaks, although this is rare. It is likely that the pigs had been infected from the swill feed, and subsequent seizure of illegally imported animal products by the customs authority supported the hypothesis that this farm was the index case. Infected pigs produce a large amount of aerosol virus, up to 3000 times more than infected sheep or bovines, and immediately neighbouring farms were examined for evidence of disease. A number of nearby farms had been exposed to the virus, and one in particular, on which there were infected sheep and cattle, had earlier sold sheep through two markets to a farm in south west England, in Devon. When this farm was visited, it also was infected with FMD. Tracing back through the markets revealed a very large number of potential contacts, and visiting these contact premises quickly exhausted the veterinary resources of the Ministry of Agriculture (MAFF, now called DEFRA). Only 200 veterinarians were employed by MAFF, and vets that had once visited an infected farm could not, for disease security reasons, go on another farm for 3 days. However, the potential animal contacts from the markets, and their subsequent contacts, numbered many thousands, because of the methods of sheep trading used by the animal dealers, whereby some animals could change owners up to seven times in as many days.

FMD outbreaks then started appearing throughout the country, particularly in the west of England and southern Scotland and Wales. Disease had also spread through the movement of infected sheep to Northern Ireland, the Republic of Ireland, France and the Netherlands.

Control of the outbreaks was taken over from MAFF by the Chief Scientist, supported by four teams of mathematical modellers and other involved groups, who reported directly to the Prime Minister's Office. The slaughter policy was extended to all neighbouring farms and those within a 3km radius of the

infected farm; slaughter of the infected farm was to be completed within 24 hours of diagnosis, and neighbouring farms within 48 hours, and this became the responsibility of the Army.

Clinical disease in cattle and pigs is relatively easy to diagnose, but FMD in sheep is frequently mild, and can easily be confused with other common conditions, such as footrot, orf and non specific mouth ulcers. The majority of suspect cases were in sheep, and while samples were not collected from all of the suspect farms, of those that were submitted for laboratory confirmation, many were negative. The rate of transmission of FMD in sheep is also much lower than in cattle or pig herds, so that the potential for infected sheep flocks to transmit the virus as an aerosol to neighbouring farms is considerably lower (Sorensen et al, 2000). Consequently many uninfected animals were slaughtered, which added to the problem of carcase disposal. During the last major outbreak of FMD in the UK, in 1967/68, approximately 2500 farms were diagnosed infected and 500,000 animals were slaughtered; during the current outbreak approximately 2000 farms have been diagnosed infected, and over 4,000,000 animals have been slaughtered. The policy of slaughtering neighbouring farms and those within a 3Km radius was modified once it was shown that this particular strain of type O virus did not spread significantly as an aerosol (Donaldson et al, 2001), and that most transmission that occurred after the movement ban was a consequence of illegal movements, direct contacts, or farmers not applying strict disinfectant procedures when visiting other livestock - farmers in the north of England frequently have several livestock holdings on different premises. The use of vaccination was considered, but would not have significantly altered the disease distribution or the final outcome, and was likely to confuse subsequent re-establishment of disease free status.

The total cost of the outbreak has not been calculated, but including the effect on tourism, will likely exceed 30 billion C\$.

■ Discussion

Resources

While the lessons to be learned from the recent FMD outbreak in the UK await to be fully documented in a Government inquiry, there were a number of problems which arose during the course of the outbreak which would have been better addressed by contingency planning before the event. Some of these were predictable, but most only became apparent once the outbreak had started. Most important was the availability of resources such as veterinary staff, valuers and slaughterers. UK, like all other European countries had been reducing its Civil Service numbers, including those employed by MAFF, and while it was always considered that an outbreak of FMD was possible, it was

never envisaged on the scale that occurred. The concept that the first case would immediately be identified, and subsequent spread prevented, was clearly wrong; as was the assumption that other European countries would be infected before the UK, and that there would therefore be ample warning of its possible introduction. But no government in the world would have been able to maintain the manpower resources required, for an event that might never happen. Arrangements were in place to bring in veterinarians trained in disease control from around the world, but the manner in which the disease became established throughout the UK before its presence was even realized, made it impossible to bring in the necessary help quickly and sufficiently.

The Sheep Industry

Although the disease started in pigs, its spread and establishment in the sheep population also delayed and confused the control programme, because of the difficulty of recognizing clinical signs in sheep. Farmers did not immediately recognize infection, and even after the declaration of the outbreak, many were not taking sufficient precautions when moving between flocks, because they thought their own animals were free of FMD. Consequently when disease was recognized, either in the sheep, or because it had spread to in-contact cattle or pigs, the virus was well established in a number of flocks owned by the same farmer, and possibly in neighbouring farms; on quite a large number of occasions, the disease had been present for many weeks, having been introduced before the movement ban. Added to this was the very large volume of sheep movements that were routinely taking place at that time of year. There were a large number of sheep markets taking place, and it is normal for farmers to inspect the mouths and teeth of any sheep they intended to buy, which is an ideal way of spreading infection, and contaminating the farmers themselves. There were even instances of the handlers in the markets taking infection back to their own farms. Most of the transactions that occurred in the markets were recorded, but those occurring outside the market, for instance in the car park, were not registered, which made tracing even more difficult, particularly as the sheep were not individually identified. There was legislation put in place following the outbreaks of swine vesicular disease in the 1980's in the UK that prevented the movement of pigs off a farm for 21 days after the introduction of any additional pigs from another premise. This did not apply to sheep, so it was frequent to discover that sheep had been moved from one farm to another over a relatively short time period, particularly through the premises of the sheep dealers.

Swill Feeding

The FMD virus had almost certainly been introduced with infected meat, imported illegally. There had been an outbreak of classical swine fever (hog cholera) during the previous year in the UK, also thought to have been

introduced in infected meat products, which had already alerted MAFF to the dangers of this route of introduction. The volume of illegal movement of all products across international borders is impossible to quantify, but is likely to be extremely large, involving drugs, cars, even people, and the ability of any country to control it is limited by staff resources and the desirability not to disrupt legal movements. It is likely that no country can prevent the occasional introduction of a foreign animal pathogen, the only defence is to prevent it making contact with a susceptible species. The feeding of waste food to pigs is an obvious method by which this contact can take place, in spite of any legislation in place to render the material sterile by boiling or other treatment. In the UK, approximately 1% of the pigs were fed some swill in their diet, making it a marginal market of little economic significance to the pig industry. However, the consequences of the introduction of a disease such as swine vesicular disease, hog cholera, pseudo rabies or FMD affects all producers, not only pig producers - many more could be added to this list such as strains of salmonella, arteriovirus, parvovirus, circovirus. The European Union has now banned the use of swill in pig feed throughout Europe.

Carcase Disposal

Because of the large numbers of animals being slaughtered, carcass disposal became a prominent issue in the media, and the pictures of large piles of dead animals clearly affected the decision of many tourists to visit the UK. While it remains the duty of the Government inquiry to establish whether the size of the cull was necessary, the consequence of the control strategy employed, and the use of the army to carry it out, resulted in an accumulating number of carcasses which could not be immediately buried or burnt. Because of environmental considerations, such as proximity to housing and water catchment areas, it was not usually possible to bury or burn carcasses on the infected farms. Many were transported in leakproof vehicles to rendering plants, but these were quickly overwhelmed. Other problems encountered included: cattle over 30 months of age could not be buried because of the possible contamination of the ground with the agent of BSE, leakage from burial sites could contaminate local streams, funeral pyres could give off dioxins as well as acrid smoke. Together these considerations made decisions on whether to bury, burn or transport extremely difficult and complex, involving many different agencies.

Public Footpaths

The decision to close all footpaths across non-urban land also severely affected the tourist industry, making it pointless for visitors to take holidays in some of the most scenic areas of the UK. A risk assessment had been carried out as to the dangers associated with free movement of people across land on which there could be susceptible animals, and while the risk of mechanically carrying virus from an infected farm would have been small, the decision was taken. It

can be appreciated that farmers worried about virus getting on to their land would be very concerned by strangers using footpaths in proximity to their animals.

Wildlife

At no time during the outbreak was there any evidence for the involvement of susceptible wildlife species, such as deer or feral pigs. The diagnostic laboratory received samples from farmed deer close to infected farms, and from deer killed by hunters or in road accidents - all were negative. This is consistent with FMD outbreaks in other regions of the world, except southern Africa, where the African buffalo is often associated with outbreaks in domestic stock. Generally, if wildlife are affected, they are unable to maintain the disease because of low stocking density or lower susceptibility, and the virus dies out. Even if they were affected it would be inadvisable to attempt control because it would likely scare the wildlife involved out of the area, and thereby possibly introduce FMD into a previously free area.

Vaccination

Considerable discussion took place concerning the use of vaccination, and vaccine was formulated from the bank held in the UK for use in the north of England. The situation was different from that in the Netherlands where vaccination was used, because unlike the Dutch outbreak, which was focal, and could be surrounded by a barrier of vaccinated animals, the outbreak was well distributed around the UK before FMD was even recognized, making the choice of where to vaccinate impossible. The total sheep population exceeded 20 million, and cattle over 10 million, and because the distribution of the disease was not known, vaccination could have actually spread the disease. None of the animals in the UK had previously been vaccinated, and therefore would not have become protected for at least 5 days; if already infected animals were vaccinated, there was the danger of needle spread of the virus, as well as the danger that bringing the animals together for vaccination would encourage contact spread. Vaccination would not prevent disease in infected animals, and even those animals that were vaccinated would not be saved from infection should they have subsequently contacted active virus. It is a characteristic of FMD virus that it will persistently infect ruminants, following recovery from clinical disease, or even animals, which have been protected by vaccination; cattle can remain carriers for up to 3 years, and sheep for up to 9 months. There is a small risk that these infected animals can precipitate new outbreaks of disease. Not only does vaccination not prevent infection, but the duration of immunity is generally less than 6 months, and it will not completely protect all vaccinated animals, depending on the level of live virus exposure. Pigs cannot be fully protected by vaccination, and if one of a group does develop disease, it will overwhelm the immunity of the others. One option was to vaccinate the

cattle coming out of winter accommodation in the north of England, onto land on which there may have been infected sheep. If they had become infected, they would have consumed considerable resources in their disposal. The idea was discarded after the Food Standards Agency insisted (although later changed its mind) that milk from vaccinated animals would have to be labelled; the farmers rightly said that this would reduce the value of the milk, and could even prevent its sale. They were also concerned that they would have to slaughter their vaccinated animals as was the decision made in the Netherlands, and if that was likely, they preferred to have the compensation paid at once.

Re-establishment of FMD Free Status

The decision to slaughter vaccinated animals, as occurred in the Netherlands was determined by the need to re-establish freedom from FMD so that trading in live animals and animal products could be resumed. Free status can be obtained 3 months after the slaughter of the last infected animal, or the last vaccinated animal, whichever is the later, in addition to a surveillance programme to show that the disease has been eradicated. The presence of vaccinated animals makes this more difficult, because of the possibility of carrier animals, and the problem of vaccinated animals having antibodies to FMD virus. If vaccinated animals are not slaughtered, a minimum of a year is required before the country can be recognized as disease free. The UK is currently undertaking a serum survey, testing up to 160,000 sera a week with an expectation of testing over 2 million samples to prove to its trading partners that it has the disease under control, and ultimately eradicated. An application by Scotland in September to relax trading restrictions was rejected by EU partners as premature.

■ Conclusion

At the time of writing (September 2001), sporadic outbreaks of FMD are still occurring in the UK. Most of these had been hidden by their association with sheep. This situation is quite normal in any large outbreak, and can be expected to cease over the next few months. Many questions have been raised concerning the management of the control programme, some of which have been discussed in this paper, and an inquiry will undoubtedly take place. The results of the inquiry will be of considerable interest and value to all FMD free countries, particularly those with an economically important and flourishing export trade in live animals and animal products.

■ References

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