A review of FMD emergency vaccination strategies and their implementation in contingency planning

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Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

A review of FMD emergency vaccination strategies and their implementation in contingency planning

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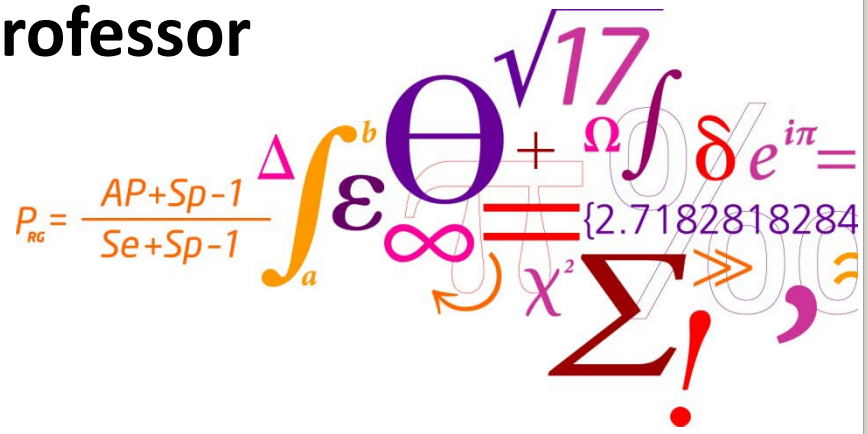


DTU Veterinærinstituttet

New publication – not included yet:

ISSN 1466-2523

Animal Health Research Reviews **12**(2); 225–234
doi:10.1017/S146625231100017X

Epidemiological simulation modeling and spatial analysis for foot-and-mouth disease control strategies: a comprehensive review

Sith Premashthira[1], Mo D. Salman[1]*, Ashley E. Hill[1,2], Robin M. Reich[3] and Bruce A. Wagner[1,4]

- New publication – not included yet:

www.defra.gov.uk

Foot and Mouth Disease Control Strategy for Great Britain

November 2011

Sources of information

- Official documents from national authorities, statements, etc. (available on the internet)
- Published papers/reports
  - Outbreak reports
  - Modelling papers
  - Other scientific papers (reviews, experiments, etc.)
- Available presentations from meetings, etc.

FMD Emergency Vaccination Protocol, AMED, Defra 14 September 2004

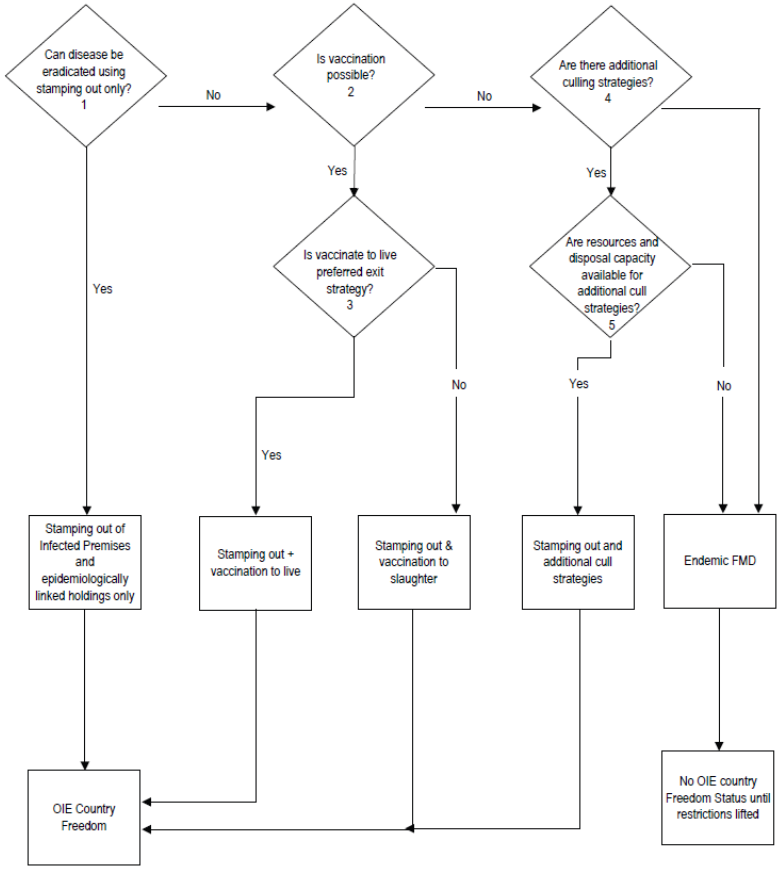
- The Government will consider emergency vaccination as a disease control option from the start of any outbreak of FMD, on the basis of **vaccinate to live**, wherever possible. This is in line with the recommendations of the main FMD Inquiries.

- The decision to adopt a particular control strategy will depend on a wide range of factors as indicated in the "Decision Tree", many of which cannot be determined until we have knowledge of the nature and extent of an outbreak. Veterinary and scientific advice and judgement remain vital in determining disease control strategy. This will, in turn be dependent on the quality of information available.

Decision tree UK

Decision Tree for the Use of Emergency Vaccination During an Outbreak of Foot and Mouth Disease (FMD)

Note: Start at top left decision – diamond box



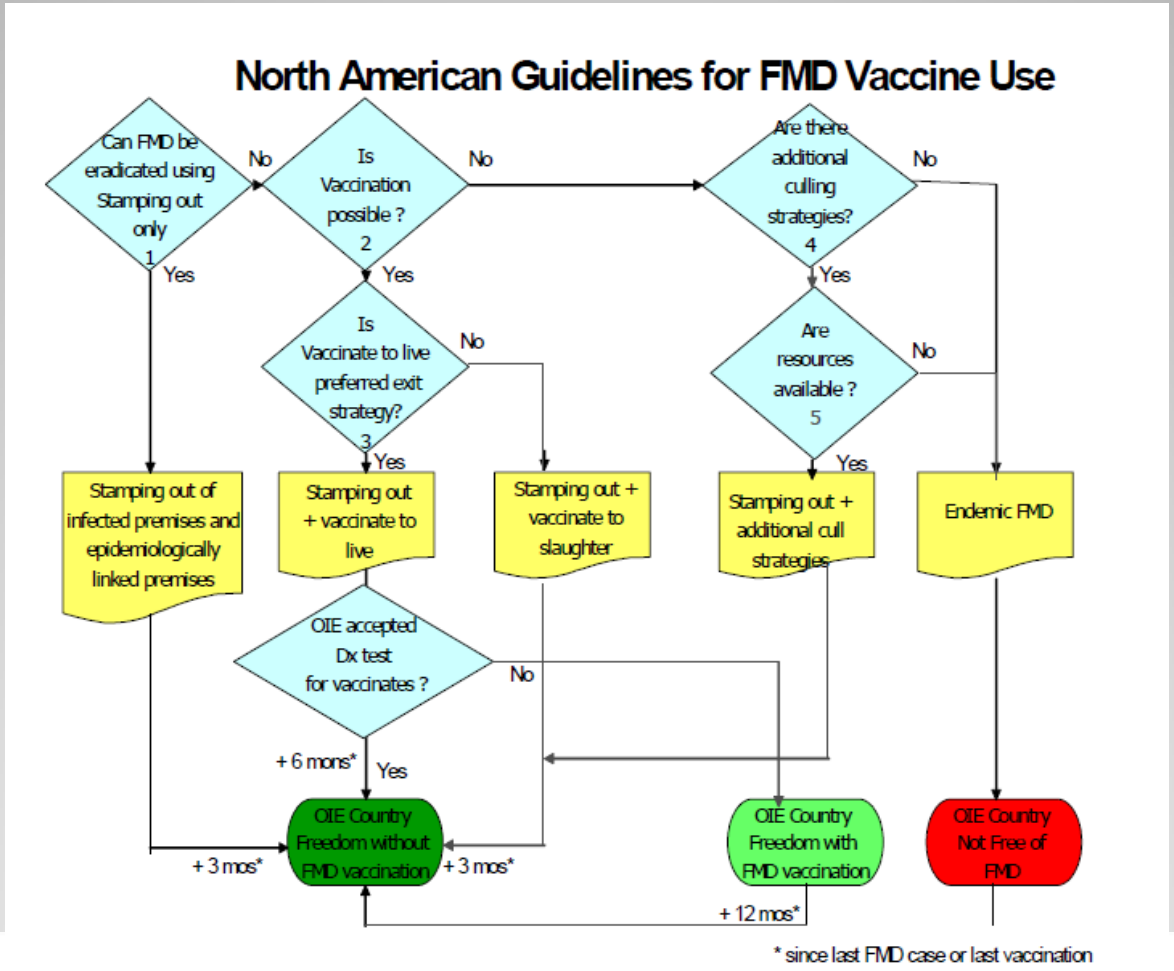
2006 Foot and Mouth Disease Summit, October 2006

As part of the presentation by the US CVO, John Clifford, the following sections appear:

“RESPONSE GUIDELINES. The agency uses a decision tree to deter-mine when vaccination is appropriate and needed. Vaccination could be used in two ways to limit FMD spread: farms closest to the reported cases could be vaccinated, or a zone around the affected area could be vaccinated from the outside in”.

“VACCINATION. Clifford also responded to questions about the federal government’s vaccination policy. USDA does not plan to vaccinate animals as a preventative measure against FMD. During an outbreak situation, vaccination only would be used as a firewall unless officials were unable to immediately contain and eradicate the disease; in which case, a vaccination control strategy would be implemented. According to Clifford, if the disease was contained and eradicated quickly, vaccinated animals would be destroyed so the United States could expedite its return to “FMD-free without vaccination” status. However, if the outbreak was widespread, the government would consider not destroying vaccinated animals”.

Decision tree US a.o.



Vaccination against foot-and-mouth disease: the implications for Canada

Protocols specify that all animals vaccinated for FMD will be permanently identified, placed under movement restrictions, and slaughtered as soon as is practicable, so that that country can regain FMD-free status without vaccination (10).

The "North American Decision Tree for FMD Vaccine Use" sets out the factors that are relevant to a decision to use vaccine (6). Rapid disease spread, or a high probability of spread, and the involvement of swine or multiple animal species are factors that favor the use of vaccine.

Can Vet J Volume 43, May 2002

The Dutch FMD Contingency Plan 2004

- **Vaccination strategy FMD**

I. In the control of FMD, as few healthy animals as possible will be slaughtered and destroyed.

II. In the first 72-hour standstill of an outbreak, vaccination will not take place. Animals at infected businesses, contact business and businesses within a radius of 1 kilometre of the infected business will be slaughtered and destroyed in this period.

III. The Minister of Agriculture, Nature and Food Quality will decide whether, after the 72-hour standstill, vaccination will take place after consultation with an expert group.

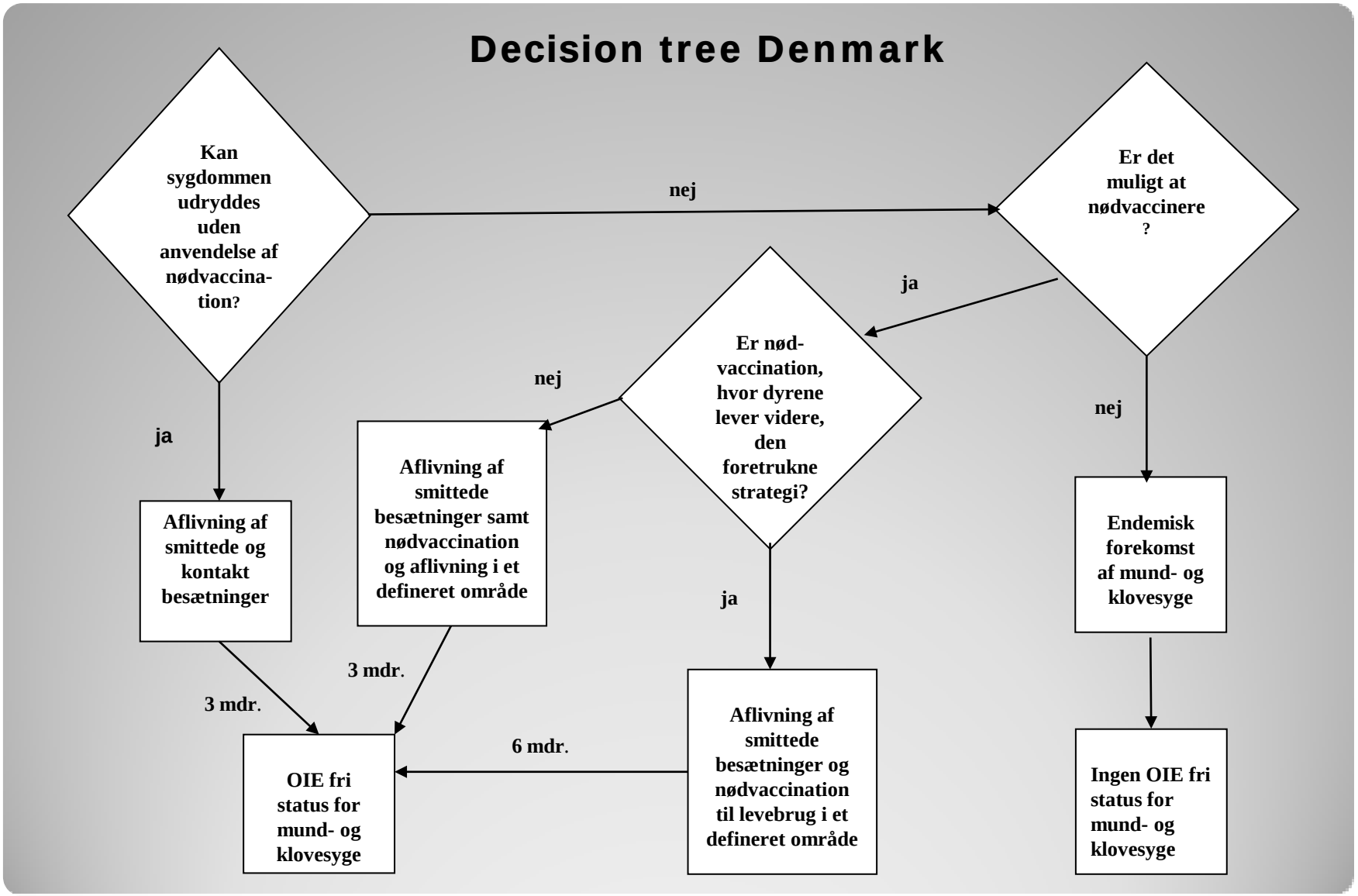
IV. At the same time it will be decided which areas will be subject to vaccination.

V. If any outbreak occurs in a different area the decision of whether or not to vaccinate in that area will be taken again.

VI. Vaccination is preventative vaccination for life. The animals will not be slaughtered after vaccination.

VII. There is no special policy for hobby animals.

Decision tree Denmark



Institution: Fødevarestyrelsen
Kontor/initialer: 1. kontor/BH/JAM
Sagsnr./dok.nr.: 2009-20-24-00763
Dato: 24. november 2010

Fastlæggelse af bekæmpelsesstrategi ved udbrud af mund og klovesyge

Formålet med dette notat er at få fødevareministerens resolution til, at Danmark i tilfælde af et udbrud af mund- og klovesyge afventer beslutning om anvendelse af nødvaccination i op til 14 dage efter sygdommen er konstateret. I de første op til 14 dage anvendes alene en traditionel nedslagningsstrategi. I samme periode fremskaffes et bredt veterinærfagligt og økonomisk beslutningsgrundlag for den videre strategi.

Modelling foot-and-mouth disease: A comparison between the UK and Denmark

Michael J. Tildesley *, Matt J. Keeling Preventive Veterinary Medicine 85 (2008) 107–124

However, optimal control is also highly dependent upon animal density. The high number of pigs in Jutland means that animal density is much greater than in the UK. Infection therefore spreads rapidly in Jutland and ring culling is not sufficient to control spread for the vast majority of parameter space.

In future, it would be interesting to extend the analysis of the Danish situation to look at a range of initial conditions prior to introduction of control and the resultant effect on optimal control strategies.

Modelling foot-and-mouth disease: A comparison between the UK and Denmark

Michael J. Tildesley *, Matt J. Keeling Preventive Veterinary Medicine 85 (2008) 107–124

The analysis for Denmark's islands suggests that a uniform national control policy is not always the best strategy to control the disease. There is little threat of a major epidemic on Sjaelland and Fyn and a policy of ring culling can aid in controlling the disease and prevent spread to Jutland. Ring culling is not, however, a good strategy to employ in Jutland owing to the very high animal density. This suggests that a heterogeneous, responsive policy could be optimal for other farm demographies (including the UK), such that high risk regions are treated in a different way from low risk regions.

Does EV work?

- **Effectiveness:**
  - **Is the size/duration of the epidemic smaller/shorter than with continued use of the basic scenario?**
- **Efficiency:**
  - **Are the economic losses smaller than with continued use of the basic scenario?**

FAZD Center economists concluded:

- Emergency vaccination reduces slaughter, but generally is not cost effective.

- However, vaccination is a viable option if the goal is to reduce the risk of a catastrophic outcome.

Foot and mouth disease virus transmission among vaccinated pigs after exposure to virus shedding pigs

K. Orsel [a,*], M.C.M. de Jong [b], A. Bouma [a], J.A. Stegeman [a], A. Dekker [c]

Vaccine 25 (2007) 6381–6391

We quantified virus transmission in homogenous groups of vaccinated or non-vaccinated pigs in which the infection chain was started by exposure to a third group of non-vaccinated infected pigs. Transmission occurred to all contact-exposed pigs in the non-vaccinated groups and to 9 out of 10 contact-exposed pigs in the vaccinated groups. The rate of transmission (β) was significantly reduced in the vaccine group. Yet, the estimated reproduction ratio in both groups was still above 1.

In conclusion, by adjusting our transmission study design and challenge method, we were able to quantify transmission of FMDV among vaccinated pigs. According to this study a single vaccination was not sufficient to stop pig to pig virus transmission. With these results major outbreaks may still be expected, even in groups of vaccinated pigs.

When to apply EV:

The UK foot-and-mouth disease outbreak — the aftermath

Daniel T. Haydon, Rowland R. Kao and R. Paul Kitching

The current DEFRA FMD contingency plan recognizes the need for a flexible set of control procedures, but the timing of the decisions regarding control options is crucial, and criteria are required with which the seriousness of outbreaks can be evaluated early so that an appropriately measured response is selected.

Simulation analyses to evaluate alternative control strategies for the 2002 foot-and-mouth disease outbreak in the Republic of Korea

H. Yoon [a], S.-H. Wee [a], M.A. Stevenson [b,*], B.D. O'Leary [b], R.S. Morris [b], I.-J. Hwang [a], C.-K. Park [a], M.W. Stern [b]

Preventive Veterinary Medicine 74 (2006) 212–225

Of all the strategies evaluated, reducing the number of days between disease incursion and commencement of controls had the greatest effect on predicted epidemic size. Controls that were applied 5 days earlier resulted in epidemics that were shorter and had a significantly smaller number of infected and depopulated farms, compared with the reference strategy (Tables 3 and 4). Increasing the number of days between incursion and commencement of controls resulted in epidemics that were larger and more variable.

How predictable were the outbreaks of foot and mouth disease in Europe in 2001 and is vaccination the answer?

Rev. sci. tech. Off. int. Epiz., 2002, **21** (3), 549-556

Y. Leforban

Vaccination will continue to be considered as a second line of defence when the disease cannot be controlled by slaughter alone. Resorting to vaccination should therefore be considered in Europe in the future as a major means for controlling the disease when slaughter alone proves to be insufficient. The time taken to detect the primary outbreak (i.e. the time between the introduction of the virus and the detection of disease), if known, is the deciding element in the choice of control method. The key elements that indicate that a slaughter policy alone is insufficient to halt the disease are, firstly, the number of outbreaks and the rapidity with which the disease spreads. Whatever the circumstances, the decision to use vaccination should be taken very rapidly (between a few days to a week after the detection of disease).

Description of recent foot and mouth disease outbreaks in nonendemic areas: Exploring the relationship between early detection and epidemic size

Can Vet J 2007;48:1051–1062

Melissa McLaws, Carl Ribble

While late detection may be a factor in the scale of an epidemic, it does not act in isolation. Rather than guaranteeing a large epidemic, late detection of FMD increases the probability of the occurrence of a large epidemic by extending the time period in which another event to augment the epidemic may occur. Such an event might be animals passing through a hub, the occurrence of climatic conditions suitable for windborne dispersal of the virus, or extensive local spread in an area of extremely high animal density.

Based on this study, we can present a number of recommendations for consideration when developing contingency plans for an outbreak of FMD or other contagious foreign animal diseases. First, premises that act as hubs with respect to normal animal movement should be identified prior to an outbreak, and this information should be kept updated as animal movement patterns change.

Where to apply EV:

Foot-and-mouth disease in the UK: What should we do next time?

M.E.J. Woolhouse *Journal of Applied Microbiology* 2003, **94**, 126S–130S

Reactive vaccination must be implemented on an appropriate geographical scale; in the case of a disseminated epidemic this will be regional or national – small scale ring vaccination may have limited impact.

One possible strategy is to use vaccination as a complement to, rather than a replacement of, the culling of at-risk holdings, as in the Netherlands in 2001. For this strategy to be effective, it is important that implementation of the vaccination programme does not reduce the resources available to the culling programme, nor lower compliance with the culling programme.

How to apply EV:

Aspects of emergency vaccination against foot-and-mouth disease

P. Barnett[a,*], A.J.M. Garland[b], R.P. Kitching[c], C.G. Schermbrucker[d]

Comparative Immunology, Microbiology & Infectious Diseases 25 (2002) 345–364

Although the option of emergency vaccination is included in the EU contingency plans, the qualifying conditions for vaccination have not been finally determined. An EU working group has prepared a report on this issue [34] and potential amendments to the legislation have been proposed. However, none of these recommendations provide definitive guidance on the details of vaccination. It would be problematical for guidelines to encompass all the circumstances that could arise, but it is important that most possibilities are considered.

Ideally, a situation in which the decision to vaccinate was delayed until the vaccination area encompassed most of the country would be avoided. Indeed there is an opinion that emergency vaccine should be employed as a first, rather than a last, resort.

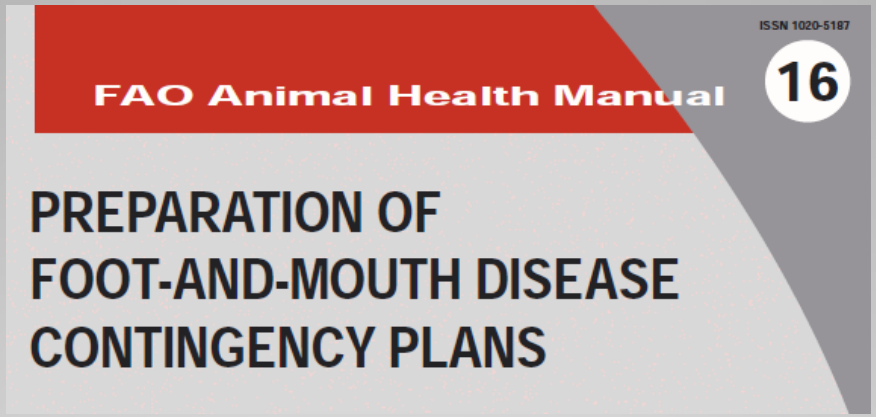
Aspects of emergency vaccination against foot-and-mouth disease

P. Barnett[a,*], A.J.M. Garland[b], R.P. Kitching[c], C.G. Schermbrucker[d]

Comparative Immunology, Microbiology & Infectious Diseases 25 (2002) 345–364

- **The choice of whether or not to apply emergency vaccination is probably the most difficult decision facing the authorities when disease breaks out in an erstwhile FMD free country. Effective computational models should be actively financed for a range of outbreak scenarios to assist objective decision-making and minimise bureaucratic delays in vaccine application.**

- **Contingency planning should include provision for emergency vaccination and must address the complex decisions of not only when, where, and how to apply vaccine but also its economic consequences. Computer modelling may be a useful aid to cost benefit and decision support systems in this context. Planning must be detailed and regularly reviewed.**



Geering & Lubroth, 2002

- **Countries that plan a stamping-out policy should also have a fall-back position. They should have a vaccination plan, which can be applied if the rate of FMD spread gets out of hand and outstrips the resources for stamping out.**

- **A decision can be made later as to whether it is desirable to slaughter vaccinated animals to get a declaration of FMD freedom for trade purposes more quickly.**

- **For most countries, large-scale stamping out is not a viable option. In these cases emphasis must be given to targeted vaccination campaigns, supported where possible by livestock movement controls and judicious stamping out.**

Control of foot and mouth disease: lessons from the experience of the outbreak in Great Britain in 2001

J.M. Scudamore & D.M. Harris

Rev. sci. tech. Off. int. Epiz., 2002, 21 (3), 699-710

- **No contingency plan can ever be considered finalised or complete. A contingency plan is a living and constantly evolving document, a process to which the highest priority must be given.**
- **A contingency plan must allow implementation of different components or procedures in particular instances in response to the situation at that time. Each outbreak is unique, so a flexible and adaptable approach is required.**
- **The plan must be updated and amended to ensure that policy developments, operational experience, perceived risks and recommendations from all recognised authorities are reflected.**
- **Contingency planning includes identifying potential vaccination centres and their requirements, and updating instructions for running a campaign.**
- **Experience shows that fixed trigger points for vaccination are difficult to define, due to the many variables involved in different outbreaks.**
- **Lessons will, and must, continue to be learned. Perhaps the most important is that disease is unpredictable and whilst previous experiences and outbreaks may serve as a guide for actions in the future, no two outbreaks are the same and responses to them must remain flexible and adaptable.**

Summary of emergency vaccination (EV) strategies in FMD contingency plans (CPs}

- EU directive requires EV options in FMD contingency plans
- Start FMD control with conventional culling of infected and in-contact herds, zoning and movement bans
- Intensions on the use of EV may be expressed in some CPs
- If epidemic is expanding “out of control”, consider adding EV
- Use a decision tool to prepare for when EV might be used
- Need to specify: When? Where? How?
- Actual decision depends on specifics of outbreak