Comparison of two cases where epidemiological modelling was used to support decisions regarding foot-and-mouth disease control in UK.

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Summary

Two cases where models were used in decision support are described and compared. In the first case, models were developed with little collaboration with 'non-modelling' experts. Critical assessment of the models was difficult and discussion of their possible limitations did not feature greatly in the decision support process. In the second case, the modelling process involved consultations with other technical advisors to the decision-makers. The modelling process provided a framework for discussion of the issues involved in the decision and the resulting model was more transparent to those involved in the decision-making process.

Introduction

Between February and October 2001, the UK suffered a widespread epidemic of foot-and-mouth disease (FMD). Mathematical modelling of the epidemic played a prominent role in decision-making on control policy (Taylor, 2003), notably the introduction of culling on farms contiguous to infected farms (MAFF, 2001a/b). During the epidemic, strict controls on livestock movement were introduced. Among these controls was a whole farm animal movement standstill of 20 days after the movement onto a farm of any FMD-susceptible species. This measure remained in place after the end of the epidemic, but was unpopular with farmers. During the winter of 2002/2003, a review of the policy, which included modelling (Risk Solutions, 2003) and cost-benefit analysis (VEERU, 2003), resulted in a reduction of the standstill period in England and Wales to six days (DEFRA, 2003). The role of modelling in the decision support processes followed in each of these two cases is described and compared.

Modelling and the Contiguous Cull Policy

The FMD epidemic in UK in 2001 was the first situation in which models were developed in the heat of an epidemic and used to guide control policy. The rapid build-up of cases in the first few weeks of the epidemic overwhelmed the state veterinary services, and the size of the epidemic soon exceeded anything envisaged by contingency planning in place at the time. Amid fears that traditional stamping-out measures were failing to control the epidemic, mathematical modellers were invited to contribute to the analysis of the emerging data.

The report of the 'Lessons to be Learned' inquiry, which followed the epidemic, (Anderson, 2002) describes how several groups of modellers began their analyses in early March 2001. A meeting between the mathematical modellers, the Government's Chief Scientific Adviser, the Chief Veterinary Officer and experts from the Institute of Animal Health and the Veterinary Laboratories Agency occurred on March 21 (MAFF, 2001a). Model outputs, which supported conclusions that the epidemic was out of control and that current control measures were insufficient to establish control, were presented. The bleak predictions of models precipitated a change in the management of the disease control efforts. The Government's Chief Scientific Adviser took over the lead role in policy advice and he created the FMD Science Group, comprising of representatives of the modelling groups and other FMD specialists.

Between March 21 and March 26, when the first meeting of the FMD Science Group was held, the modellers looked at the potential effects of various culling policies. Following the first meeting of the FMD Science Group, on March 26, a slaughter policy was introduced in which culling was to be carried out on premises neighbouring infected premises (the 'contiguous cull' policy) (MAFF, 2001b). The contiguous cull policy met with considerable resistance among farmers and remains controversial.

The 'Lessons to be Learned' inquiry reported that it was "*unable to find a clear account of decision making around that time*." (Anderson, 2002). The inquiry highlighted problems within the FMD Science Group. Although experts from other scientific disciplines (including veterinarians) were included, the highly specialised nature of the modelling made it difficult for these other experts to engage with the detail of the models. The group was criticised as being a 'modelling sub-committee' and at times there were polarised views within the group but no mechanism for handling such conflict (Anderson, 2002).

Modelling and Animal Movement Policy

Work was commissioned in November 2002 with the objective of making a preliminary decision on animal movement policy in spring of 2003. None of the existing models could be quickly adapted to answer the specific question about the effects of different movement standstill regimes on spread of FMD. Therefore a completely new model (known as 'silent spread') was developed (Risk Solutions, 2003). Work on this model was linked to concurrent work on the costs and benefits of different movement standstill regimes (VEERU, 2003).

The group carrying out the modelling had no track record in modelling epidemics, rather they were specialists in modelling risky situations as an aid to decision making. The silent spread model was heavily dependent on the expert judgement of contributors, including epidemiological modellers, veterinarians, industry experts, and other stakeholder representatives. Many contributors were consulted in order to parameterise the model. The philosophy was to develop a model that was highly visible to all the participants, so the effect of its different assumptions and uncertainties in its input data could be fully understood. In effect the model acted as the collective brain of the experts and practitioners who contributed to the study. The model was developed iteratively through a series of expert consultations, model refinements and 'show and tell' sessions involving experts, decision makers and their advisors. External review of the model was also carried out by independent experts.

It was openly recognised that the model could not provide a simple single answer to the problem and its findings were interpreted bearing in mind the limitations of the modelling. While the review process resulted in some disagreement over the robustness and accuracy of the model, the model played a key role in demonstrating the limitations of animal standstills in controlling early spread of FMD, the relative importance of methods of spread not affected by animal movement control and the high importance of early detection of disease (DEFRA, 2003). The conclusion from the modelling that long movement standstills were of limited use in preventing early spread of FMD was seen by some as counter-intuitive, but this result stimulated debate among experts and decision makers. The final decision to reduce the standstill period from 20 to six days was supported by this debate, along with other social and economic considerations (DEFRA, 2003).

Conclusions

Although the two situations were very different, particularly with regard to urgency, comparison of the ways in which models were used in the decision-making process can yield useful lessons.

In the first case, models were developed rapidly and with little collaboration with 'non-modelling' FMD experts. The need to make decisions very quickly, in the face of an apparently deteriorating situation, compromised the decision making process. One model in particular, that of Ferguson *et al.* (2001), played a key role in the decision leading to the contiguous cull policy (MAFF, 2001c). A newspaper article from the time reproduces outputs from the model under the caption "*scientific predictions*" (*Daily Telegraph*, April 11, 2001). However, this, and other models, contained simplifications and assumptions which heavily influenced the conclusions about appropriate control strategies (Taylor, 2003). Critical assessment of the models within the FMD Science Group was difficult and discussion of their possible limitations did not appear to feature greatly in the decision-support process. One interpretation is that decision makers were seduced by the illusion of truth provided by mathematics (Gupta, 2001), with the result that the models were taken as prescriptive tools, providing a ready-made solution to a decision problem.

In the second case, the modelling process involved regular consultations with veterinary epidemiologists, technical advisors to the decision makers, and those providing data for the modelling. The engagement of the advisors in the modelling process provided a framework for discussion of the issues involved in the decision. The resulting model was more transparent to those involved in the decision making process and its limitations were openly identified. Although the model was not used to directly justify the decision arrived at, the way in which the modelling process was carried out positively supported the decision making process.

Decisions are commonly based on a mixture of tacit and explicit knowledge. One of the advantages of using models in decision making is that they can force tacit knowledge to be made explicit, and thus open for debate. An example is the way in which the tacit knowledge that movement standstills are an effective control of early spread of FMD was challenged by the 'counter-intuitive' modelling result, leading to discussion and better understanding of the situation. This can only happen if a model is transparent and accessible to the wide range of advisors involved in decision support, suggesting that simple models have an advantage over complex mathematical models in this respect.

Since the process of model building can itself be a learning process there is much to be said for decision makers and their advisers themselves interacting with the process. This would ensure that the simplifications, assumptions and limitations of the model are fully appreciated by all involved in the decision.

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These results can be used to support and develop effective policies for FMD control. Box and whisker plots showing: (a) the ratio of the predicted number of infected premises (IPs) to the median number of IPs for the stamping-out (SO) scenario and (b) the ratio of the predicted epidemic duration to the median epidemic duration for the SO scenario when vaccination is deployed randomly (V1), outside in (V2) or on large farms. first (V3) in a simulated outbreak of foot-and-mouth disease in the UK.Â Disease simulation models are widely used as decision. support tools to aid in planning for disease outbreaks, predicting or assessing outbreaks in real-time and as.Â when its outputs make epidemiological sense given. the underlying population dataset and parameters. Foot-and-mouth disease (FMD) exemplifies these trade-offs, and is particularly important in South America, where FMD virus circulation has declined and appears limited to certain regions. As a result, opportunities for higher-value exports in sustainably produced pasture-fed beef and lamb are growing.Â The role of integrating epidemiological and economic data and analysis in supporting policy change options. The value of an integrated epidemiological-economic analysis has long been recognised (see for example Perry et al. 2001, 2013; Rich and Winter-Nelson 2007; Rushton et al. 2009; Rich and Perry 2011; Randolph et al.Â The economic impact of foot and mouth disease and its control in the Philippines. OIE Scientific and Technical Revue, 21, 645â€"661. CAS Article Google Scholar. These results can be used to support and develop effective policies for FMD control.Â @article{Roche2014EvaluatingVS, title={Evaluating vaccination strategies to control foot-and-mouth disease: a model comparison study}, author={S. Roche and M. G. Garner and R. Sanson and C. Cook and C. Birch and J. Backer and C. Dub{\'e} and K. Patyk and M. Stevenson and Z. Yu and T. Rawdon and F. Gauntlett}, journal={Epidemiology and. Disease spread models can be used to evaluate the design of optimal strategies. Using a previously developed susceptible-infected-recovered geographic automata model (Sirca) to simulate the spread of FMD through white-tailed deer populations in south Texas, we conducted a series of experiments to determine how pre-emptive mitigation strategies applied to white-tailed deer populations might impact the predicted magnitude and distribution of outbreaks following FMD virus incursion.Â Inactivated conventional vaccines against foot-and-mouth disease (FMD) are used routinely in endemic countries and are effective against clinical disease. Increased systemic IgG levels can be obtained with these vaccines whereas local more. Prevention and control of other major diseases of livestock 3. Objectives and expected results of the Global Strategy 4. FMD Control (Component 1) 4.1. Tools to be used for implementing the Global FMD Control Strategy 4.2. Building on experience: lessons to be learned from regional FMD control programmes 4.3. Research needs and expectations 4.4.Â Annexes to Part A 1. Socio-economics of FMD 2. Tools to be used for implementing the FMD Control Strategy component. (Component 1) 3. Tools to be used for implementing the Strengthening Veterinary Services component.Â The specific objective is to improve FMD control in regions where the disease is still endemic, thereby protecting the advanced animal disease control status in other regions of the world.