The World Organisation for Animal Health and epidemiological modelling: background and objectives

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Summary
The papers in this issue of the Scientific and Technical Review (the Review) examine uses of modelling as a tool to support the formulation of disease control policy and applications of models for various aspects of animal disease management. Different issues in model development and several types of models are described. The experience with modelling during the 2001 foot and mouth disease outbreak in the United Kingdom underlines how models might be appropriately applied by decision-makers when preparing for and dealing with animal health emergencies.

This paper outlines the involvement of the World Organisation for Animal Health (OIE) in epidemiological modelling since 2005, with emphasis on the outcome of the 2007 questionnaire survey of model usage among Member Countries, the subsequent OIE General Session resolution and the 2008 epidemiological modelling workshop at the Centers for Epidemiology and Animal Health in the United States. Many of the workshop presentations were developed into the papers that are presented in this issue of the Review.

Keywords

Introduction
Modelling has become a widely used tool to support the evaluation of various disease management activities. The value of epidemiological models lies in their ability to study ‘what if’ scenarios and to provide decision-makers with a priori information about the potential consequences of disease incursions and the expected impact of control strategies. To be useful models need to be fit for purpose and appropriately verified and validated. Validation of epidemiological models is important to gain confidence in model outputs. Currently, modelling is most useful when used pre-outbreak, particularly in the areas of retrospective analysis of previous outbreaks, contingency planning, resource planning, risk assessments and training. The complexity and variability inherent in biological systems should limit the use of today’s models during actual outbreaks as predictive tools. Models are just one tool for providing scientific advice, and their results should be evaluated in conjunction with experience from experimental studies, field studies and scientific wisdom. International collaborations such as those organised by the World Organisation for Animal Health (OIE) can help address validation issues and improve the utility of models for emergency disease management.

The OIE Terrestrial Animal Health Code (Terrestrial Code) refers to concepts such as risk analysis, the performance of Veterinary Services, accountability and transparency of decision-making, animal disease emergency preparedness and response plans, and epidemiological surveillance and monitoring programmes. Veterinary Services worldwide therefore need tools to prepare for and deal effectively with such issues. Electronic and other technological advances, as well as progress in scientific understanding and analysis of animal disease...
situations and their management, are important in enabling Veterinary Services to make steady improvements in their performance and preparedness so that they can provide the optimum service to society.

Some advanced tools require highly skilled operators who need expert advice from specialists both within and outside the Veterinary Services. Epidemiological modelling is one such tool. Many OIE Member Countries already have experience with this tool, and the scientific literature contains many examples of epidemiological models having been applied to a variety of animal disease situations. Yet less experienced countries or Veterinary Services might gain from a review of the benefits and the risks associated with this newer tool, and acquire a greater understanding of how management decisions might be supported through the use of such models.

Rationale behind the use of models in the management of animal diseases

Models provide frameworks that allow ideas about the behaviour of a particular system to be conceptualised and communicated (12). In the case of animal diseases, it is well understood that disease results from the interaction of agent, host and environmental factors. Thus, models provide a logical and low-cost basis for studying these interactions, evaluating impacts and testing responses to interventions. Traditionally, the response to outbreaks of serious livestock diseases such as foot and mouth disease (FMD), classical swine fever (CSF) and highly pathogenic avian influenza (HPAI) has been based on movement restrictions and stamping out. Since 2001, following the FMD outbreak in the United Kingdom (UK), large-scale culling and disposal of animals for disease control purposes have been questioned on political, economic, ethical, environmental and welfare grounds. As a result, international guidelines on the control of FMD have now made other options, such as emergency vaccination, more acceptable from a trade recovery perspective.

There is a need for disease managers and policy-makers to examine and evaluate alternative approaches to disease control that address these concerns, such as emergency vaccination as a tool to reduce the numbers of animals destroyed. In addition, it is now well recognised that the speed with which effective decisions are taken during disease outbreaks will often determine the success of the eradication programme. Evaluating the possible consequences of these outbreaks and testing various control options in advance could help reduce the spread of disease. However, evaluating alternative approaches to controlling infectious diseases is not a simple task as there is a range of issues that will need to be considered, including:

- characterisation of the infection
- host demography
- resource requirements
- trade and economic implications
- access to appropriate technology (e.g. vaccines or diagnostic tools)
- consumer concerns
- public health ramifications.

Of particular concern for countries exporting livestock and livestock products is the attitude of trading partners, since the major economic impact of diseases like FMD may be due to loss of export markets rather than the productivity losses or the cost of implementing disease control procedures. In the case of zoonotic diseases there may be occupational health and safety issues that need to be taken into account. Finally, the choice of control measures is often a compromise between the requirement for large-scale implementation and what is logistically and economically feasible. In considering control strategies, it is important to take into account the interests of all stakeholders and the costs that will be incurred (9). Clearly, developing policy options under such circumstances is challenging.

In a policy context it is common to link epidemiological and economic models. Indeed, a range of studies on the combined use of these types of models has been published to evaluate control strategies for emergency diseases such as FMD and CSF (1, 15).

Definition of epidemiological models

The definition of 'epidemiological model' is very important for this issue of the OIE Scientific and Technical Review (the Review). However, a clear definition of the term does not seem to exist in the veterinary field. For the purposes of this Review epidemiological models are defined as: mathematical and/or logical representations of the epidemiology of disease transmission and its associated processes. These quantitative models provide representations of the transmission dynamics of infections and diseases among animals, and/or among groups of animals, in time and/or space.

An epidemiological model therefore facilitates the evaluation of the efficacy of the potential control measures and provides estimates of the future magnitude, duration and geographical extent of an outbreak given the application of specific control measures.
However, in relation to the management of animal diseases, epidemiological models could be defined more broadly to include a range of statistical/mathematical models, which do not necessarily provide just a description of disease spread. Related aspects to be considered include, for example, the design and performance of animal disease surveillance systems.

Overview of disease models

All models are, by nature, simplifications of more complex systems. Disease models can be classified into various categories depending on their treatment of randomness or variability, time, space, and the structure of the population. The approaches, which will be covered in greater detail in other papers in this issue, will vary from simple deterministic mathematical models through to complex spatially-explicit stochastic simulations. The most appropriate type of model to use in a given situation will depend on the sorts of issues being studied. For example, while deterministic models, which are typically based on average or expected value parameters, may be useful for understanding basic infection dynamics, they are of limited use as a predictive tool since any one epidemic is unique and unlikely to follow an ‘average’ pattern (9). However, when epidemiological knowledge and good quality data are available, more elaborate models that provide a range of possible epidemics can be developed.

The increasing sophistication of computers, together with greater recognition of the importance of spatial elements in the spread of disease, and interest in specific spatially targeted strategies such as emergency ring vaccination or contiguous slaughter, mean that models which incorporate spatial components are becoming more important in epidemiological studies (8). In addition, network-based modelling is a relatively new but growing field that enables the study of disease spread through contact networks (12).

The process of model building must start with specific questions to answer in order to provide the scope of the model. The choice of model will depend on how well the epidemiology of a disease is understood, the amount and quality of data available and the background of the modellers themselves. The level of complexity to include in a model should be guided by the questions that the model is intended to answer. Adding additional elements may increase complexity without necessarily improving the quality of the outputs. On the other hand, ignoring factors that are clearly important in the epidemiology of a disease may result in model findings that are misleading. Availability of data may also be an issue (9).

A critical step in model development is the process of model verification and validation to ensure that it behaves like the system it is designed to represent. Approaches and issues associated with this critical step are discussed in detail by Reeves et al. and Sanson et al. (17, 18).

Application of epidemiological models

Models can be used retrospectively or prospectively (24). Retrospective use involves fitting mathematical equations to epidemiological data and interpreting these data quantitatively. Prospective models can be either predictive, in that they use current data as the basis for predicting the potential course of a current or future outbreak, or exploratory, modelling a range of possible epidemiological scenarios rather than focusing on one particular event. Such models are often used in contingency planning. Examples of the different types of models are presented in subsequent papers in this issue of the Review.

By combining large amounts of information in a structured way, hypothetical scenarios can be developed to provide insights into the merits of different strategies in different situations, e.g., how does a pre-emptive culling strategy compare with a test and cull strategy? In this way, decision-makers can be provided with a priori supporting guidelines for control that can be used in conjunction with veterinary wisdom and experience — not as a substitute for them.

Modelling can contribute to better disease control through (20):
- performing retrospective analysis of past outbreaks to gain an understanding of their behaviour (14) and to compare the effects of different control strategies
- exploring different strategies in hypothetical epidemics (contingency planning)
- identifying the resource requirements of different strategies in hypothetical epidemics (resource planning)
- carrying out risk assessments to identify priority areas, i.e., those that might be at greater risk, to better target preparedness and surveillance activities
- evaluating the effectiveness of various surveillance strategies
- performing consequence assessments and underpinning economic impact studies
- identifying critical data gaps and helping prioritise data collection
- providing realistic scenarios for training exercises and to communicate principles of epidemiology and disease control
- providing tactical support during epidemics through analysis and hypothesis testing (limited use recommended [21]).
In addition, models can be used to define priorities for research. For instance, a sensitivity analysis of parameters, which are not well documented in the literature, can help to determine those that should be investigated.

Modelling and the 2001 foot and mouth disease epidemic in the United Kingdom

Models have been used as a tool in veterinary epidemiology for many years, but have rarely attracted attention as they have been largely confined to studies of hypothetical outbreaks, or they have been used retrospectively in analyses of past outbreaks (9). The 2001 UK FMD epidemic was the first situation in which models were developed during an epidemic and used to guide control policies.

Unfortunately, one of the legacies of the UK experience has been a questioning of the role of modelling and loss of confidence in scientific advice based on modelling (14, 16). One of the objectives of the OIE activities in modelling has therefore been to review the pros and cons of modelling and to assist Veterinary Services worldwide in benefiting from past experiences. The OIE activities take into account the experience gained during the 2001 UK epidemic as well as a variety of other situations in which models have been an important and trusted source of input for making informed decisions about the potential course of disease outbreaks and the possible consequences of animal disease management measures.

The main point of discussion on the use of models in 2001 is centred on the large-scale culling of apparently healthy livestock, which the authorities claimed was necessary to bring FMD under control. The culling called widespread community concern and the financial and social costs led to changes in national and international legislation and guidelines for controlling future epidemics (14). The experience also generated varying opinions about the validity and usefulness of the models and their predictions (11, 14, 16, 20).

Early in the outbreak, findings from predictive mathematical modelling (6, 7) were used as evidence to support conclusions that the epidemic was out of control and that current measures were insufficient to establish control. A rapid cull of suspected infected premises and all farms contiguous to infected premises was considered essential for controlling the disease (6, 7). An aggressive control policy based on culling susceptible animals on infected premises within 24 h, and the pre-emptive culling of dangerous contact premises and premises adjacent to infected premises ('contiguous cull' policy) within 48 h were introduced (14, 16). This policy was credited with bringing the outbreak under control (7). However, subsequent analyses have labelled contiguous premise culling as ‘a blunt policy instrument’ (2) and questioned whether the extensive culling programme, and particularly culling of contiguous premises, was necessary (13).

It has been suggested that the models at the time were not validated, particularly for the type O pan-Asia strain of the virus, and contained simplifications and assumptions which biased the outcomes and heavily influenced conclusions about the effectiveness of different control strategies (14, 20). For example, a recent study showed that premises close to an infected premise do not inevitably become infected – a significant proportion remain uninfected even under intense infection pressure (21). These retrospective findings suggest that selective culling of dangerous contacts would have been a viable alternative to the mass culling policy.

International collaboration on model evaluation

As part of a process designed to improve ability to deal with animal disease emergencies, Australia, Canada, New Zealand, and the United States – known collectively as the Quadrilateral Group countries or QUAD countries (QUADs) – held a workshop on FMD modelling and policy development in Canberra, Australia, in March 2005. The objectives of the workshop were to present policy-makers with disease simulation models developed for contingency planning in the QUAD countries and to review the current status of FMD response strategies. A key outcome of the workshop was the creation of a technical group comprised of epidemiologists from the QUAD countries, Ireland, and the United Kingdom. Following the workshop the technical group developed a work programme, which included a project to jointly verify and validate models for use in FMD policy development in their respective countries (5).

Unfortunately, a formal approach to infectious disease model validation does not exist. There is no set of specific tests that can easily be applied to determine the ‘correctness’ of a model. The three modelling groups involved in the QUAD countries had already taken various steps to verify and validate their models by means of sensitivity analyses, expert reviews of assumptions and comparison of model outputs with real FMD outbreak data. Comparison of model predictions with real outbreak data remains an important means of testing model validity.
provide policy-makers with reassurance of the consistency of assumptions made by model developers. Conversely, differences in model output provide a means of highlighting differences in assumptions that need to be resolved by modellers and researchers, and provide a better focus for future research (5).

Sometimes in real life a very extreme combination of parameter values may occur. Models frequently do not deal very well with interactions between parameters with extreme values.

A formal comparison of three spatial simulation models used for FMD policy development was carried out using the following three models:

- AusSpread (Australia) (8)
- InterSpread Plus (New Zealand) (19)

All the models compared are stochastic spatial simulation models that have been developed independently. The study (5) first included a comparison of the logical framework of each model, as well as a comparison of a series of model outputs from eleven scenarios of increasing complexity that evaluated various spread mechanisms and control measures. Despite different approaches to model building, and some statistically significant differences in outputs from the three models, the differences were generally small and from a practical perspective the outputs were quite similar. From a policy perspective, it was reassuring that despite the different approaches used, the models produced consistent outcomes and it was concluded that any decisions based on the findings of each model would not have differed. In addition, the study was a useful verification exercise as it required the modellers to re-examine in depth the way core functions had been implemented, and minor programming and logic errors were found and corrected. More recently, predictions made by the three models when modelling the spread of FMD using actual population and animal movement data from Ireland were compared. The results of this study are presented elsewhere in this issue of the Review (18).

A similar project – a multi-centre comparison of modelling tools for the evaluation of FMD outbreaks in Denmark – has been carried out by the International EPILAB. The objective of the study was to compare three stochastic simulation models for modelling the spread of FMD using different control strategies. The models compared were the InterSpread model (19) from Massey University (New Zealand), the DADS (Davis Animal Disease Simulation) model (United States) (3) and a Warwick University model (UK) (22). The results of comparative scenario simulations were presented at the modelling workshop organised by the OIE and the Centers of Epidemiology and Animal Health (CEAH) in 2008 (23).

### OIE involvement in modelling

In 2005 the OIE initiated activities to discuss and support the proper use of epidemiological models for the management of animal diseases among Member Countries around the world.

The activities have so far covered:

- a questionnaire survey of use and perception of models in Member Countries, 2007
- the subsequent distribution of this Technical Item paper, including some of the results of the survey, in 2008 (4)
- adoption of a Resolution (Resolution no. XXXIII) on the use of models in the management of animal diseases at the 2007 General Session with the following recommendations:
  i) to develop general OIE guidelines for epidemiological model development, verification, validation and use
  ii) to encourage the establishment of OIE Collaborating Centres on epidemiological modelling
  iii) to ensure data quality in reporting animal disease events that are relevant for modelling to the OIE
  iv) to publish an issue of the OIE Review devoted to epidemiological modelling
- the decision in 2008 by the Director General to establish the Ad hoc Group on Epidemiological Modelling and Animal Disease Management to develop general guidelines on modelling
- the decision to have the first meeting of the Ad hoc Group at the CEAH, Fort Collins, Colorado, and to arrange the meeting back to back with a CEAH-OIE workshop on modelling in 2008
- preparations by the OIE to arrange for an issue of the OIE Review on the topic of modelling to be published in 2011.

In order to provide the background and objectives for this issue of the Review, the remaining parts of this introductory paper review these activities and their intentions and summarise their outcomes.
Results of the 2007 OIE questionnaire

Questionnaires were sent to all of the then 168 OIE Member Countries in the month of February 2007 and 103 (61%) countries returned them completed (n = 92) or partially completed (n = 11).

Overall, 50 Member Countries (49% of respondents) reported having used models in contingency plans, while 48% of respondents declared they had not used models but would like to develop this area. Only four countries (4%) did not consider developing this area (Fig. 1).

Africa and the Middle East were the regions with the lowest proportion of Member Countries using models (28%) and with the most desire to develop this area (69%). More than half (58%) of Member Countries in the Americas, Europe and Asia/Far East/Oceania are already using models.

Surveillance, disease transmission and risk models were the most used and/or desired models in Member Countries, irrespective of the region, while fewer (40 to 55 countries) were promoting meteorological, economic and resource models (Fig. 2). Other models listed included: animal movement models, production models, transport models, cost/benefit models, geographical models, alert systems models, and ecosystem models. This pattern was similar for model-using and ‘would-like-to-use’ countries.

The disease management activities most frequently mentioned by countries as being activities for which they would like to use models were: vaccination, surveillance and movement restriction, each of which was listed by approximately 90 countries. Models to be used for stamping-out, ring culling and disposal capacity were less frequently considered by non-using countries than by those countries having already used models (Fig. 3). These results might be confounded by the regional differences in usage alluded to earlier and by regional differences in control policies. In addition, some countries used models to assess welfare culling, benefits of animal identification, compartmentalisation, and strategies to minimise the risk of introduction of diseases.

All countries supported the use of models both prior to and during epidemics, while model users indicated their inclination to also use models after outbreaks as a retrospective tool (Fig. 4). Thus half of all responding Member Countries use or would consider using models

![Fig. 1](image1.png)

**Fig. 1**
Frequency of response to the question: ‘Have epidemiological models been used or implemented in contingency plans to manage animal diseases in your country?’
Borokanly by the five OIE regions

![Fig. 2](image2.png)

**Fig. 2**
Frequency of response to the question: ‘Types of epidemiological models used or wanted?’
By pre-specified categories (replies to ‘other [please specify]’ are not included)
Fig. 3
Percentages of response to the question: 'Types of disease management activities used or wanted?'
By pre-specified categories (replies to ‘other [please specify]’ are not included)

Fig. 4
Percentages of response to the question: 'When would you consider using epidemiological models in your country relative to an animal health crisis?'

Both before, during and after outbreaks and 25% would use them only before and during. Other combinations were much less frequently listed.

Generally, countries that already used models stated that they involved or would involve a wider range of professionals in the development of models than countries wanting to develop modelling as a tool (Fig. 5). Epidemiologists were listed in all responses, while other professionals were listed less frequently. Other experts included in responses were: accountants, virologists, computer programmers, biologists, ecologists, GIS/spatial scientists, ornithologists, wildlife biologists, hunters, communications specialists, field experts, medical doctors and pharmacists.

There was general agreement that the Veterinary Administration should be the most involved in all steps: development, running of models and applying the results (Fig. 6). Research institutes and international experts appear to be important in the development stage.
Agricultural organisations appear to be involved in all steps, with more countries reporting their involvement in applying the results of models. Eighty-four percent of the countries that have used epidemiological models have a designated person or group responsible for epidemiological models. This is not surprising, as responses showed that the Veterinary Administration is involved in all steps of modelling.

Of the countries that completed the questionnaire 61 countries (60%) listed lack of expertise and 55 countries (54%) listed lack of resources as limitations on using models (Table 1a). Only 12 countries (12%) did not include a lack of resources or expertise as a factor that limits their use of models. Seven of those 12 countries made comments on other limitations on the use of epidemiological models, of which lack of comprehensive data – population demographics, animal movements, marketing data – was the most common. Lack of time resources, of full-time personnel, of training and of financial resources were also reported.

Some interesting differences appear between countries which use and countries which would like to use models (Table 1b and Table 1c). Although both using and non-using countries frequently listed both lack of expertise and lack of resources, the lack of expertise was much greater in the non-using countries (40 countries out of 48, or 83%) than in user countries (18 countries out of 50, or 36%). In the non-using countries with lack of expertise the majority

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**Table I**

Frequency of response to the question: ‘Are there limitations to the use of epidemiological models for management of animal diseases?’

Countries were asked to indicate whether or not there was a lack of resources and/or a lack of expertise. Replies which indicated that there were other types of limitations are not included here.

### a) Responses from all Member Countries

<table>
<thead>
<tr>
<th>Lack of expertise</th>
<th>Lack of resources</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>12</td>
<td>28</td>
</tr>
<tr>
<td>Yes</td>
<td>34</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
<td>55</td>
</tr>
</tbody>
</table>

### b) Responses from countries that already use models

<table>
<thead>
<tr>
<th>Lack of expertise</th>
<th>Lack of resources</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>10</td>
<td>22</td>
</tr>
<tr>
<td>Yes</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>32</td>
</tr>
</tbody>
</table>

### c) Responses from countries that would like to use models

(see Fig. 1)

<table>
<thead>
<tr>
<th>Lack of expertise</th>
<th>Lack of resources</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>Yes</td>
<td>25</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>21</td>
</tr>
</tbody>
</table>

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**Fig. 5**

Percentages of response to the question: ‘Which professionals have been/would be involved in the development of the models to be used in your country?’

By pre-specified categories (replies to ‘other [please specify]’ are not included)
of countries (25 countries out of 40, or 63%) did not record lack of resources as a limiting factor. It appears that technical support would be even more important than economic support in making the use of modelling more accessible to non-using countries.

Member Countries consequently expressed the wish that the OIE provide further assistance in the area of modelling by:

- developing guidelines (74 countries)
- designating Collaborating Centres (43 countries)
- establishing expert groups (59 countries)
- acting as a clearing-house for models (57 countries)

These results show that Member Countries are interested in the OIE playing a larger role in providing guidance on the development and uses of models. Other proposed roles were to:

- provide training courses, seminars or workshops
- provide expert review of models

![Fig. 6](image1)

**Fig. 6**
Frequency of response to the question: ‘Which parties would be involved in the development and application of epidemiological models used in your country?’
By pre-specified categories

![Fig. 7](image2)

**Fig. 7**
Frequency of response to the question: ‘What do you think that the OIE could do to enhance the application of epidemiological models to the management of animal diseases?’
By pre-specified categories (replies to ‘other [please specify]’ are not included)
utilise models to simulate international spread of disease and thus identify and direct where international resources (training and technical) can best be applied to limit disease spread

- establish a training centre
- develop expert groups to support Member Countries in their selection of models
- establish a virtual modelling centre where countries short of resources and/or technical capacity can have access to various epidemiological models.

Out of the four countries that indicated that they had no desire to develop the modelling area, the most frequently listed reason (three countries) was the need to know more about the use of models for the management of animal diseases before considering taking up modelling activities.

When asked which disease was a priority for modelling, most countries responded that highly pathogenic avian influenza was the disease of highest priority, closely followed by FMD. Rabies, Newcastle disease and bovine spongiform encephalopathy achieved somewhat lower priority scores (Fig. 8). Other diseases reported under ‘Other (please specify)’ in high numbers include: bluetongue, bovine tuberculosis, brucellosis, Rift Valley fever, African swine fever, contagious bovine pleuropneumonia, peste des petits ruminants and classical swine fever. The latter was listed as a disease of highest priority by 15 countries.

Although most respondents indicated that Veterinary Services should be responsible for managing the governance of epidemiological models (Fig. 9), a number of countries indicated the desire to have shared responsibilities between the public, private and research sectors. Although final accountability for the use of models in the management of animal diseases rests with the veterinary administrations, some countries mentioned that other groups should not be restricted from using the models.

![Image](image.png)

**Fig. 8**
Frequency of response to the question: ‘Which of the following diseases would you list as priority diseases for epidemiological modelling (1 = highest priority, 5 = lowest priority)?’

By pre-specified categories [replies to ‘other [please specify]’ are not included]

![Image](image.png)

**Fig. 9**
Frequency of response to the question: ‘Who do you think should govern/manage the use and application of epidemiological models?’
By pre-specified categories

The Epidemiological Modelling Workshop took place from 11 to 13 August, 2008, at the Centers for Epidemiology and Animal Health, Fort Collins, Colorado. The purpose of the workshop was to provide a forum for the exchange of knowledge regarding the principles, methods, and applications of simulation models of epidemiological systems. More than 20 keynote addresses and presentations by modelling experts from several countries were given in four sessions:

- types and components of epidemiological models
- parameter development
- verification, validation and sensitivity analysis
- use of epidemiological models.

Thanks to the experts’ dedication and support, many of the keynote addresses and presentations have been developed as papers for the present issue. The symposium provided the opportunity for modellers and epidemiologists to meet each other and to obtain a better understanding of approaches to modelling and the rationale for those approaches. In addition, it enabled participants to gain an even better appreciation of the areas where answers are needed in order to develop animal health policy and where models could potentially serve to provide those answers. Most importantly, the symposium established a framework where cooperative working relationships were formed. These cooperative relationships will be a key component in developing strategies to identify and share the information needed for more accurate parameter development and will serve to advance epidemiological modelling in the future.

OIE Ad hoc Group on Epidemiological Modelling and Animal Disease Management

The Group was established because epidemiological modelling is a valuable decision support tool that can assist disease managers and policy-makers in identifying and evaluating existing and novel approaches to disease control and risk mitigation. A majority of OIE Members have reported that their use of epidemiological models is restricted in some way so, during the 2007 OIE General Session, the World Assembly of Delegates adopted a Resolution recommending that the OIE should develop general guidelines for epidemiological model development, verification, validation and use. As the construction and development of models is likely to principally involve modelling experts and researchers, the OIE and experts, mainly from OIE Collaborating Centres involved in veterinary epidemiology, decided that detailed guidance on these aspects should be limited to the minimum necessary for application-oriented comprehension. The proposed main objective of the Ad hoc Group was, therefore, the development of OIE guidelines on the use of epidemiological models for the management of animal disease. It was recommended that the main emphasis of these guidelines should be on the proper use of epidemiological models, with a particular focus on how Veterinary Authorities can take advantage of access to existing models. However, there was growing awareness of how important it is that model users understand the basic principles of the model in question and how it has been validated and verified, in order to minimise the risk of misuse or misinterpretation of the resulting model predictions. In consequence, it was decided that certain basic technical issues on model construction and development would need to be briefly covered.

The Ad hoc Group was invited to consider the basic principles of the Terrestrial Animal Health Code and to examine any references to modelling in the existing chapters that could potentially be cross-referenced in the new guidelines, if scientifically justified and if relevant to the proposed working objective.

The presentations and discussions resulting from the CEAH-OIE workshop enabled the OIE-selected Ad hoc Group to develop draft guidelines which would serve as a reference to OIE Member Countries regarding the role epidemiological models have in answering questions related to highly infectious animal diseases. It was recommended that these guidelines be written in such a manner as to caution users against the over-reliance of model-generated solutions. Specifically, the objectives of the OIE Ad hoc Group were to:

- provide guidance on the most appropriate use of epidemiological models
- develop a list of items to consider when using models to inform decision-making
- outline a recommended approach to verifying and validating models in order to assure confidence
- discuss the value of technology transfer and the recommended approach to adapting existing models for use in other countries
- outline a preferred approach to applying field data and soliciting subject-matter-expert input relevant to the model
– consider the importance of and develop mechanisms for sharing suitable data, epidemiological knowledge, and model results.

The deliberations of the Ad hoc Group lead to a draft document which addressed specific modelling definitions and the role of models in assisting decision-making in animal health management. In addition, it outlined the components of epidemiological models and aspects of using existing models (including an overview of a variety of models in use and considerations for different epidemiological situations) and examined how to assess and assure their quality. At the same time as this draft document was being written, the OIE, in conjunction with OIE Collaborating Centres on veterinary epidemiology, launched a project to produce a guide on terrestrial animal health surveillance. This handbook, which is currently under development and will be aimed at Veterinary Services and field staff involved in surveillance, is based on an explanatory and hands-on approach to existing OIE standards on and around animal health surveillance. The handbook will contain a section on epidemiological models, and it has been proposed that the guidelines drafted by the Ad hoc Group on Epidemiological Modelling and Animal Disease Management could be included in this section.

Discussion

Epidemiological and economic modelling are recognised as valuable tools that can assist disease managers in identifying and evaluating alternative approaches to disease control. Evidence for this is seen in the extensive scientific literature on epidemiological modelling, and the increasing preparedness of many Veterinary Services to build capacity in this area. Suitably designed epidemiological models can be used to study disease impacts, perform risk assessments, assist in designing cost-effective disease surveillance and control programmes, and contribute to contingency planning for emergency diseases. Models are particularly valuable because they enable hypothetical outbreak and control scenarios to be studied in advance. For example, one can simulate outcomes under different assumptions concerning types of strategy, availability of resources, reactions of trading partners, etc. and thus help identify conditions under which different approaches might or might not be beneficial. These findings do need to be kept under review, as new technologies – such as new diagnostic methods or vaccines – and changes to international guidelines and trading protocols might alter the balance (9).

As stated by Garner et al. (9), it is important that models used to inform disease control policies are used appropriately. While there is general recognition of the value of modelling to support policy development through retrospective analyses and contingency planning, the role of predictive modelling as a tool to support tactical decision-making in an actual outbreak is less clear. Any model ultimately depends for its validity on the accuracy and completeness of the data underpinning it (11). Unfortunately the data is not always available or reliable, particularly early in an outbreak when decisions taken typically will determine the size of the subsequent epidemic. This data issue creates a serious problem for prediction using models. The models used in the 2001 UK epidemic have been criticised because they were constructed with out-of-date and poor quality data, and poor epidemiological knowledge (14). Recent analyses have cast doubts on the appropriateness of policy made at the time based on these models (14, 21). In his comprehensive review, Taylor (20) concluded that use of predictive models to support tactical decision-making is not recommended. Decisions should be based more on veterinary intelligence rather than on predictive modelling, although modelling can play a role in interpreting veterinary intelligence. Another view is that modelling can be valuable in making rapid and informed decisions about control strategies in an outbreak, provided that the model has been developed, tested and is ready for immediate application.

Modelling is a specialised field, and modellers are often considered as being remote from the real world by the management and field staff, and their outputs may be viewed with suspicion. It is important that modellers do not work in isolation and that models are understood to be just one tool for providing scientific advice (9). Any findings should not be considered in isolation from those from experimental studies and from analysis of epidemiological data. Proof of validity of any model should be required before it is used to influence policy. Communication of results to decision-makers is also an important issue. Findings reported from modelling studies should be accompanied by full disclosure of the assumptions used and any limitations of the approach (20).

Recent initiatives, the formation of the QUADs EpiTeam and the EPILAB multicentre-project, for example, have demonstrated the value of international cooperation in developing and validating modelling tools for use in animal health emergencies.

The results from the OIE questionnaire survey underline the notion that modelling to manage animal diseases is a topical and relevant issue of considerable interest and importance to the international veterinary community. They show that modelling is already a growing field of activity within many OIE Member Countries and that an equal number of other countries are in the planning or
preparatory stages of initiating modelling activities. A wide variety of conditions, diseases and application areas are being modelled, and there are strong indications that there is a need and desire to have more international cooperation and support in guiding and promoting the applications. Also, in this area there appears to be a need for strengthening Veterinary Services worldwide through international cooperation and technical support. The regional differences in the use of models shown in Figure 1 are probably linked to the differences in the availability of technical and economic resources (Tables 1b and 1c). One possible strategy for improving this situation would be to establish twinning projects between model-using and model-needing institutions to share or exchange already existing modelling expertise and outbreak data to the benefit of both institutions.

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L’Organisation mondiale de la santé animale et la modélisation épidémiologique : contexte et objectifs

P. Willeberg, T. Grubbe, S. Weber, K. Forde-Folle & C. Dubé

Résumé
Les auteurs des différents articles de ce numéro de la Revue scientifique et technique examinent les possibilités offertes par la modélisation en tant qu’outil d’aide à la conception de stratégies de lutte contre les maladies et étudient certaines applications concrètes des modèles visant à explorer des aspects particuliers de la gestion des maladies animales. Diverses problématiques liées à la conception des modèles sont abordées et plusieurs types de modèles sont décrits. L’expérience acquise avec les modèles lors du foyer de fièvre aphteuse survenu en 2001 au Royaume-Uni éclairera les décideurs politiques sur la manière appropriée d’utiliser les modèles au moment d’anticiper et de faire face aux crises sanitaires affectant la santé animale.


Mots-clés
La Organización Mundial de Sanidad Animal y la elaboración de modelos epidemiológicos: antecedentes y objetivos

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Resumen
En los artículos que forman este número de la Revista científica y técnica (la Revista) se examinan el uso de modelos como herramienta de apoyo a la formulación de políticas zoosanitarias y las aplicaciones de los modelos a distintos aspectos del control de enfermedades animales. Los autores describen distintas facetas de la elaboración de modelos y distintos tipos de modelo. Asimismo, a raíz de la experiencia del uso de modelos durante el brote de fiebre aftosa de 2001 en el Reino Unido, recalcan lo que ha de ser una correcta aplicación de modelos por parte de las instancias decisorias a la hora de prepararse para emergencias zoosanitarias y de hacer frente a ellas. Los autores de este artículo subrayan la participación de la Organización Mundial de Sanidad Animal (OIE) en la elaboración de modelos epidemiológicos desde 2005 haciendo hincapié en los resultados del cuestionario sobre el uso de modelos distribuido en 2007 entre los Países Miembros de la OIE, la subsiguiente resolución de la Sesión General de la OIE y el “Taller de elaboración de modelos epidemiológicos” organizado en 2008 en las instalaciones de los Centros de Epidemiología y Sanidad Animal de los Estados Unidos. Muchas de las presentaciones realizadas en el curso de ese taller dieron lugar a algunos de los artículos que forman el presente número de la Revista.

Palabras clave
Adopción de decisiones — Control de enfermedades — Elaboración de modelos — Epidemiología — OIE — Organización Mundial de Sanidad Animal — Participación.

References


