EpiMAN-FMD: a decision support system for managing epidemics of vesicular disease

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A comprehensive epidemiological information system (EpiMAN-FMD) has been developed to assist national disease control authorities contain and eradicate outbreaks of animal diseases as efficiently and cost-effectively as possible. The system was initially developed to control an incursion of foot and mouth disease (FMD) or any clinically indistinguishable vesicular disease, although it has since been progressively expanded to manage other exotic and endemic diseases.

Design objectives for the information management elements of EpiMAN-FMD included the following:
- the need to manage the vast quantities of data that eradication procedures for an FMD epidemic would generate within a very short time
- the ability to innovatively apply epidemiological understanding of disease spread to the data processing tasks
- the reduction of some of the foreseen processing bottlenecks
- the provision of decision support tools for data entry personnel.

Design objectives for the veterinary management elements of the system included the following:
- the presentation of up-to-date status reports in formats that facilitate decision-making at the national or regional level
- the ability to optimise manpower resource allocation
- the capacity to evaluate the relative merits of alternative technical decisions, each of which carry different implicit risks.

The system combines a multi-user database management system, expert system elements, various computer simulation models of specific aspects of FMD epidemiology and a range of statistical analyses designed to monitor the state of the epidemic. Although designed in New Zealand, EpiMAN-FMD has been constructed in a flexible style which makes adoption of the system possible in other countries with broadly similar ‘stamping-out’ contingency plans.

Keywords
Database management system – Disease control – Expert system – Foot and mouth disease – Simulation model.

Introduction

Foot and mouth disease (FMD) is an acute, highly communicable disease which affects both domesticated and wild cloven-hoofed animals and may well be the most contagious disease known in the animal kingdom (23). The key features that contribute to this high transmissibility include the following:
- the ability to infect animals through multiple routes
- the small infective dose
- the short incubation period
- the release of virus before the onset of clinical signs
- the massive quantities of virus excreted from infected animals
- the ability to spread large distances very rapidly due to airborne dispersal
- the environmental persistence of the virus on fomites

Historically, outbreaks of FMD in susceptible populations have on occasion resulted in massive epidemics, caused by a combination of factors favourable to the rapid and widespread dissemination of the virus through the animal population. Lorenz examined a number of FMD epidemics in fully susceptible populations of cattle and pigs in Europe between 1965 and 1982, and reported a highly skewed distribution of epidemic size with a range of 1 to 6,400 infected properties, a median of approximately 30 and a mean of 1,050 (16, 17).

In the face of a large epidemic, a typical ‘stamping-out’ programme, which involves rapid elimination of all virus sources, surveillance of at-risk properties and stringent movement control, would place severe demands on the resources of any national disease control authority. Clearly, a decision-support system (DSS) which facilitated the management of data relating to control and eradication procedures, and provided timely and epidemiologically sound information and guidance to personnel involved in an eradication programme would be an extremely valuable tool. Such a system could restrict the size and length of the epidemic, resulting in lower overall costs of eradication, and permit an earlier resumption of trade.

Decision-support systems are interactive computer-based systems that help decision makers to utilise data and models to solve relatively unstructured problems (29). The purpose of the DSS is to provide a set of tools to help interpret data and evaluate disease control choices. The DSS should provide decision makers with an appreciation of the risks implicit in particular decisions, and the factors that can be varied to modify those risks. The objectives during the design and development of EpiMAN-FMD were to create a system which could meet these requirements and offer the flexibility to adapt to changing requirements in the future. This paper presents an overview of EpiMAN-FMD and describes in particular the epidemiological aspects of the system.

Overview of control procedures supported by EpiMAN-FMD

EpiMAN-FMD is primarily designed for use in countries or regions where FMD is exotic, and where stamping-out procedures would be employed to eradicate the disease in the event of an outbreak. Animal health authorities in many of these countries have detailed contingency plans, backed up by appropriate legislation, that will be activated on diagnosis of an outbreak.

Typically, the components of these programmes include a number of key operational tasks, such as slaughter and disposal of all susceptible livestock on the infected premises (IP), followed by thorough cleaning and disinfection, urgent investigation of all properties directly or indirectly associated with IP, followed by active surveillance or pre-emptive slaughter on those livestock units judged to be at risk of FMD, coupled with stringent movement restrictions in various geographically defined areas around the epidemic foci. In addition to these measures, ring or mass vaccination may be employed to reduce the rate of dissemination into the surrounding population.

In New Zealand, the eradication procedures would be conducted from the Exotic Disease Response Centre (EDRC) which is part of the National Centre for Disease Investigations at Wallaceville. This is a purpose-built facility close to the Ministry of Agriculture and Forestry Head Office. In addition, one or more resource nodes (RN) will be established in the outbreak zone(s). Overall management of the epidemic will take place at the EDRC in consultation with the Chief Veterinary Officer (CVO), with field activities conducted from the RNs.

For management reasons, the various operational activities, such as rostering of patrol veterinarians, movement tracing, etc., have been assigned to a number of discrete functional groupings within the EDRC (Table 1). EpiMAN-FMD supports the EDRC structure by allocating the various data processing tasks to the EDRC groups in a modular fashion. This modular design is flexible, however, so that alternative operational group structures can be defined, should another country with a different management structure wish to use the system.

Structure of EpiMAN-FMD

The structure of EpiMAN-FMD is shown in Figure 1. The core of the system is the EpiMAN-FMD database, which comprises a client-server database management system which contains all the records of the outbreak and emergency response, and the knowledge base which encodes current knowledge of the epidemiology of FMD in a series of simulation models and expert systems to provide the expertise for enhanced decision-making. Users interact with the system via a graphical user-interface (‘window’), which varies according to the category of user, as outlined in Table 1. The ‘epidemiologist’s workbench’ is the part of the system that allows the epidemiologist(s) to conduct a range of epidemiological and statistical analyses and make predictions of the epidemic using various simulation models.
Table I

Description of the major functional groupings within the Exotic Disease Response Centre in New Zealand

<table>
<thead>
<tr>
<th>Group</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease investigation group</td>
<td>Management of the pool of patrol veterinarians; surveillance of properties within the patrol zones around IP and other at-risk properties throughout the controlled area; maintenance of farms database</td>
</tr>
<tr>
<td>Restricted place support group</td>
<td>Gate security, valuation, slaughter, disposal and C&amp;D procedures on IP; weather data collection on new IP where required</td>
</tr>
<tr>
<td>Tracing group</td>
<td>Tracing of movements to and from IP – identification of contaminated transport vehicles and exposed livestock holdings</td>
</tr>
<tr>
<td>Epidemiology group</td>
<td>Epidemiological advice to other groups; prediction of airborne spread risks; statistical analysis of epidemic</td>
</tr>
<tr>
<td>Movement control group</td>
<td>Administration of vehicle C&amp;D throughout the controlled area; management of the movement control system</td>
</tr>
<tr>
<td>Resource group</td>
<td>All aspects of personnel administration, including transport and accommodation needs; provision of equipment and supplies for all operational activities</td>
</tr>
<tr>
<td>Controller</td>
<td>Delegate of the CVO at the EDRC; responsible for key decision-making at EDRC; supervision of all groups</td>
</tr>
</tbody>
</table>

C&D: cleaning and disinfection  
IP: infected premises  
CVO: Chief Veterinary Officer  
EDRC: Exotic Disease Response Centre

The major data flows within the system from the discovery of clinical disease on a new property and the entry of that data into the database. A notification message is immediately distributed to all screens to alert each user to the discovery of a new IP. Each data item is tracked in the system and available to the relevant personnel for action where necessary. Whilst providing decision support to each of the groups and ensuring that key tasks are completed, EpiMAN-FMD permits sufficient flexibility regarding the timing and method of execution of the tasks to accommodate various management styles and time constraints. For example, a tool is provided to aid the rostering of veterinarians for future farm visits. This can be worked on throughout the day, as time is available, and the resulting farm visit forms can either be individually printed on demand or batch processed at the end of the day. Thus, EpiMAN-FMD is designed to operate as a suite of decision-making tools rather than a rigid procedural system, all users are given access to a variety of tools appropriate to their responsibilities within the emergency response system.
A large number of reports are available in each of the modules supporting the different functional groups. These allow the user to monitor the progress of the eradication programme, both nationally and on individual IP, track key documents and gauge workloads in order to support resource planning.

Spatial data is processed as described below. EpiMAN-FMD contains a copy of Agribase, a national spatial farm database (24), which is updated on a regular basis. Information about farms includes ownership and stock details, as well as geographical co-ordinates of the farm (as polygons [boundary data] or individual point locations of farms in countries where farm outlines are unavailable). The data is stored in a standard relational database. A number of spatial queries employed within the various EpiMAN-FMD modules, and the production of individual farm maps are based directly on these data. More specialised spatial analysis procedures, for example within the InterSpread simulation model, utilise subsets of these farm data held in separate disk files associated specifically with the particular program. This improves the speed of response and ensures that simulations are run from a known state of the epidemic, using a sequence of snapshot copies of the main file as the epidemic evolves. The above arrangement means that EpiMAN-FMD is not dependent on expensive commercial geographic information systems (GIS) and yet makes spatial data widely available to a large number of users. If spatial data of farms are not available, EpiMAN-FMD can still operate, albeit without some of the spatial functions. Provision is made for the farm database to be updated progressively during the epidemic, as data become available.

The entire system is constructed so that only widely available computers, operating systems, and software are used, with flexibility to shift processing loads between components of the system according to local circumstances and changing technology. All of the specialised features of this very powerful system are constructed within the EpiMAN-FMD system using industry-standard widely used software development tools, rather than specialised tools such as commercial GIS software. This means that the system can readily be adapted to the specific requirements of the user-organisation.

Epidemiological components

Some of the specialised epidemic components contained within EpiMAN-FMD are described below.

On-farm virus production model

When a new IP is discovered, it is important to evaluate opportunities there have been for further spread of disease from the moment the virus arrived on the property to the time of diagnosis. The probability of spread for each contact is directly proportional to the build-up of infection on the farm and the consequent release of virus into the environment. A Monte Carlo model that simulates the likely sequence of events on the farm, and quantifies the degree of airborne excretion of FMD virus has been developed and incorporated into EpiMAN-FMD. The model simulates the spread of infection among the first species infected on the farm and the subsequent transmission to other species on the same farm. The model reports the numbers of animals infected and how many are likely to be showing clinical signs on a daily basis and computes the total daily quantity of virus released into the atmosphere for inclusion in an airborne spread model. Airborne excretion curves used in the model have been derived principally from the work of Sellers and Parker (26) and that of Donaldson et al. (8), supplemented with values derived from later findings (9, 27). Mean excretion curves have been derived for the three principal farm species, namely: cattle, sheep and pigs. Figure 2 shows the mean excretion curve for pigs used in the model. Deer are treated similarly to cattle based on the work of Forman et al. (11), and goats are treated identically to sheep, relying on the findings of McVicar and Sutmoller (19).

During the epidemic, model inputs are extracted from the investigations on each new IP. These include the following:

- the initial date of infection on the farm (known or estimated)
- the age of oldest lesions in each species
- the size of the initial infection group
- the total number of each species on the farm
- the number of separate animal management groups
- whether the farm has an intensive or extensive livestock husbandry system
- the date and time of diagnosis
- an estimate of the number of animals with clinical signs in each species.

An additional model parameter relates to whether or not FMD was introduced to the farm through animals incubating the virus.

WindSpread

EpiMAN-FMD includes a tool for investigating the potential extent of airborne spread of FMD virus from IP. This system includes both a Gaussian plume-dispersion equation model (12) and the puff diffusion model 'RimPuff' (28). This program uses the output of the virus production model for a given farm, in addition to actual recorded or estimated weather parameters to calculate the 24-hour cumulative virus concentration at various points downwind for each day that virus is excreted from the particular source farm. The outputs are a series of virus concentration isolines plotted on a large scale farm map. The farms at risk under the plume can then be identified directly from the map.
Foot and mouth disease virus particle (log_{10} TCID_{50})

Days relative to onset of clinical signs

TCID_{50}: median tissue culture infective dose

Fig. 2
Mean daily excretion of foot and mouth disease virus by infected pigs relative to the onset of clinical signs

The Gaussian model is used when the terrain is flat and weather conditions are assumed to be relatively stable between successive hourly observations. Under these conditions, this model produces results similar to the more technically advanced puff diffusion model. However, the advantage of the latter model is that it can utilise a three-dimensional wind-flow field produced for localities with complex terrain.

The weather variables used include hourly wind speed (knots), wind direction (to the nearest 10 degrees), relative humidity (RH%), cloud cover (octers), and whether or not there was significant rain during the preceding hour. Weather data can be obtained from local or national weather recording stations or from data collected on IP. In New Zealand, arrangements exist for the establishment of temporary weather recording stations in the vicinity of outbreaks.

Windborne spread is excluded as an infection method if RH is below 60% (because desiccation of the virus will occur [5]), or if there are significant periods of rain which would wash the virus out of the air and reduce the concentration of the virus to insignificant levels.

**InterSpread – interfarm spread model**

A true DSS should allow a manager to conduct a series of 'what-if' scenarios to investigate the likely consequences of major policy options. In managing a FMD epidemic using a stamping-out policy, strategies include changing the size of the various surveillance and movement control zones as well as specifying what movements or agricultural activities are permissible in the different zones, instigating pre-emptive slaughter (dangerous contact slaughter without laboratory confirmation of infection) and implementing various vaccination regimes as adjuncts. In order to evaluate these options, a spatial simulation model has been developed that uses the actual epidemic data, including the geographic layout of farms.

Six separate spread mechanisms are modelled – local spread, airborne spread, movement-related spread, saleyard spread, dairy tanker movements and recrudescence of infection on emptied farms after re-stocking. Default spread parameters have been derived from analyses of past outbreaks and knowledge of farm movement patterns in New Zealand [22]. Prior to running the model, the user specifies any changes to the default values, and enters the appropriate control procedures being tested. The entire epidemic can be simulated repeatedly with alternative policies in operation and the results of different options can be compared.

Outputs of the model are available in graphical and tabular form and include the number of farms diagnosed per day (or per week), together with the likely geographical pattern, the dissemination rate, a summary of the mechanisms responsible for the outbreaks and the likely length of the epidemic.

**Expert system elements**

Tracing of movements that have occurred from and to infected farms prior to diagnosis has always been recognised as an extremely important yet personnel-intensive task. In the last major suspected vesicular disease outbreak in pigs in New Zealand, at Temuka in 1981, some fifty direct movements had
to be traced in addition to investigating the sources of garbage fed to the pigs (21). In a large epidemic, multiple IP will be identified daily, for example, during the 1967-1968 epidemic in the United Kingdom (UK), 80 new farms were identified as infected every day at the height of the emergency (1). In these circumstances, the number of traces to investigate will quickly place an overwhelming demand on manpower resources.

Investigation of traces involves first establishing whether or not a risk of FMD transmission is posed by a particular movement. In EpiMAN-FMD, an expert system assigns priority ratings varying from very high to nil for each of the traces recorded in the system, and presents the movements in priority order. The principal issues considered by the expert system in the assignment of a priority rating are the date of movement, whether the movement is to or from the farm, type of conveyor and whether there was any direct contact with livestock on the infected property. In the case of milk tanker movements, one additional variable is employed (relating to whether or not emergency hygiene measures have been applied to the tankers). Figure 3 depicts the logic used to establish a priority based on the time of the movement relative to the chronology of infection on the farm, where the date of infection is only estimated.

The second step in tracing involves confirmation by telephone of the movement and fate of the moved items, what livestock units have been exposed, and whether or not there are any signs of disease on the contact farm. This process identifies ‘at-risk’ properties and places them on the list of farms for surveillance by veterinarians, together with associated risks (very low, low, medium, high and very high risks). Likewise, contaminated vehicles and equipment are registered for appropriate cleaning and disinfection.

If the virus was transferred to susceptible animals during a particular movement episode, disease will develop following an incubation period. Knowledge of the distribution of incubation periods is useful for deciding when to visit the farm. Similarly, if after the maximum likely incubation period, no clinical signs are apparent in animals which may have been exposed, one can reasonably assume that no disease was transmitted. EpiMAN-FMD keeps track of all episodes recorded against particular livestock units, provides a summary risk rating, and suggests the time period during which surveillance should occur. As with all recommendations made by the system, the user can replace the suggested surveillance period by his/her own estimation.

Fig. 3
Chronology of events relating to infection with foot and mouth disease and the evaluation of the risks associated with movements to or from the property when true infection date is unknown.

E : estimated date of infection
I : actual date of infection (unknown)
IP : infected premises

Earliest infection date (maximum incubation period)
Earliest clinical signs
Diagnosis
Depopulated

Earliest infection date
Estimated infection date
True date of infection
Estimated incubation period

Less concern
Greater concern
Less concern
Less concern

Movements onto IP (possible sources)

Movements off IP

nil

E - 2 days
E + 2 days

E - 2 days
**Dissemination rate model**

The probability of a susceptible property becoming infected in a particular time period is considered to be a function of the number of infectious farms (which indicates the number of point sources of the agent) in the previous time period and the dissemination rate. The dissemination rate represents the average number of premises to which the agent is delivered by each infected property acting as a source. The estimated dissemination rate (EDR) for FMD is the number of new IP in any given week divided by the number of IP diagnosed the previous week (20). A program that displays the epidemic curve and calculates EDR is included in EpiMAN-FMD. Provided the weekly EDR is declining, this program can extrapolate forward to give an indication of the number of IP anticipated each week and the expected duration of the epidemic. This is achieved by log transforming the EDR and fitting a linear least-squares regression line, which is extended until a user-specified minimum level of EDR is reached, after which it is assumed this minimum level is maintained until the disease dies out. The minimum EDR represents the base level of disease spread that could occur despite the control measures in place.

When this model was applied to the figures obtained from the outbreak which occurred in the UK in 1967 and 1968, using the epidemic figures at the end of the fourth week (prior to the peak of the epidemic), and using a base level of 0.75, the model predicted a total of 2,381 affected farms, with an epidemic duration of 25 weeks. In reality, 2,364 farms were infected over a period of 32 weeks (1), although the number of outbreaks per week had reduced to zero by the nineteenth week, with intermittent outbreaks thereafter.

**Epidemiological reports**

In addition to the components outlined above, EpiMAN-FMD can produce a series of specialised epidemiological reports which are designed to provide insight into the epidemic and the effectiveness of the control measures.

One of the tasks for the epidemiologist during an outbreak of FMD is to ascertain the source (and therefore cause and date) of infection for each new IP. To help with this task, EpiMAN-FMD presents a list of all episodes recorded against the IP in question, as well as the findings of the patrol veterinarian who diagnosed the case. If required, the epidemiologist can consult a status map of all outbreaks in the vicinity of the farm. This process can lead to further field investigations. Once a decision is made, the source, cause and date are entered. This task has four principal purposes. Firstly, it establishes the chronology of infection on the farm, which is important for setting priorities in investigation of traces. Secondly, it helps mitigate against non-investigation of what then become undiagnosed source farms. Thirdly, it allows the various mechanisms responsible for disease spread in the epidemic to be monitored; and fourthly, it provides information on the distribution of inter-farm incubation periods. Four reports have been designed to summarise these findings. These are as follows:

- **a)** a restricted place epidemiological report which shows the chronological history of infection on the IP and the risks in terms of opportunities for further spread off the farm
- **b)** a graphical network of spread diagram is progressively constructed from the incoming data, showing the chronological relationships between all infected farms in the epidemic, both as a generational diagram (Fig. 4), and as a geographical map
- **c)** a report of the proportions of IP caused by the various episode types is produced, using the source of infection identified for each IP (this could reveal weaknesses in the control strategy)
- **d)** a histogram representing the distribution of incubation periods experienced during the epidemic can be viewed and printed. This latter information provides an important feedback cycle to be used elsewhere in the DSS, namely within the virus production model and the expert system which sets optimal patrol dates for at-risk farms.

The decision to invoke pre-emptive slaughter can have a profound effect on the course of an epidemic (20). An analysis of the numbers of 'successful' transmissions that actually occur following various forms of contact should serve to prompt the CVO to instigate dangerous contact slaughter for those mechanisms that are shown to be important in the development of the epidemic. A report that provides a cross-tabulation of the numbers of new infections per risk rating by episode type has been designed within the system. This report could reveal the appropriateness or otherwise of the priority-setting rules.

The at-risk/IP ratio is computed by counting the number of at-risk farms for each IP diagnosed during each week of the epidemic. This information is tabulated and graphed against week number.

When the epidemic begins, no controls are in place. The disease has the potential to have spread extensively by the time the initial diagnosis is made. The number of farms which have had direct or indirect contacts with the index farm(s) will have a direct bearing on the number of newly infected premises, and hence the dissemination rate. This will be influenced by the period of time between arrival of infection on the index farm(s) and the initial diagnosis. As controls are activated and public awareness of the disease increases, the opportunities for contact between IP and new properties should be severely curtailed. This should mean that the ratio of at-risk farms to IP would typically start high and then diminish rapidly. Examination of the at-risk/IP ratio should reveal any shortcomings in disease control measures, especially when combined with an analysis of the types of contacts in operation.
If the EpiMAN-FMD information system and associated field surveillance procedures are sufficiently comprehensive, there should be relatively few surprises in terms of infected farms. Most farms that become infected should already be recorded as at-risk. If this is not the case, it implies that the epidemic is spreading faster than the investigations can proceed, or alternatively, that the EpiMAN-FMD system is not sufficiently comprehensive in terms of the transmission mechanisms that it tracks. In this sense, the ratio of 'known' at-risk farms breaking down to 'unknown' farms being diagnosed provides a quality assurance check on the system. The proportion known is the number of pre-recorded at-risk farms breaking down divided by the total number of IP. This should be close to 100% in the ideal case.

A program that estimates the probability of susceptible farms contracting disease via local spread has been incorporated within EpiMAN-FMD. The calculations are based on survival analysis of the data derived from farms within different distance zones around IP. The output of this program facilitates the establishment of the optimal patrol zone size around IP. Experience has shown that in areas of New Zealand, in excess of 100 farms can be present within a 3 km buffer around a given farm, so any change in the size of patrol zone can have a massive impact on the numbers of veterinarians required for surveillance. Using an analytical procedure allows the size of patrol zone around IP to be evaluated on risk rather than an arbitrarily pre-defined distance.

**Computer system**

EpiMAN-FMD has been designed to handle small epidemics using a single stand-alone personal computer (PC), as well as large epidemics involving hundreds of control staff, each having their own PC connected to a powerful database server. The scale of the operational structure would be dependent on needs (Fig. 5). The EpiMAN system can be transported to remote sites and installed in a matter of hours, or configured.
Computer network configuration for EpiMAN-FMD using a local area network within the livestock response headquarters and providing remote access across a wide area network.

Discussion

The system has necessarily been conceived, designed and built under FMD-free conditions because FMD has never occurred in New Zealand. However, a number of those involved in designing the system have had experience in the control of vesicular diseases elsewhere. Default values of important indices for use in the prediction of disease behaviour had to rely on historical data, published research findings and anecdotal experiences of the numerous veterinarians who have been consulted during the project.

Although FMD must rank as one of the most researched diseases in the world, surprisingly little information is available about rates of disease spread and probability of spread via various mechanisms. This seems so because, in those countries where the disease is endemic, either insufficient routine data are collected or the nature of data that are recorded is such that the data rarely yield useful epidemiological knowledge. On the other hand, disease outbreaks that have occurred in countries which implement stamping-out policies, means that full expression of the disease is rarely seen under these circumstances, and very little material has been published which assists the estimation of epidemiological indices. Even where computerised data recording has been conducted, typically only information relating to cases was recorded, with little or no data included about farms at-risk which did not succumb to disease. Furthermore, many of the published research findings relate to studies conducted under controlled laboratory conditions, and are therefore of limited applicability to field conditions. Finally, the disease behaves differently in different climates, and caution is needed in extrapolating findings in one country to another which is ecologically different. For these reasons, a comprehensive system such as EpiMAN-FMD, which records data on cases and at-risk properties in the outbreak zone, has the potential to yield much valuable knowledge that will benefit disease control in the future.

Verification and validation of the system are crucial processes for disease control managers who wish to gain confidence in the use of a system such as EpiMAN-FMD. It is envisaged that validation will be an on-going task incorporating two aspects.

The first aspect relates to the design philosophy. The system is undergoing periodic field trials of simulated outbreaks in New Zealand and in addition, a range of EpiMAN-based DSSs for other disease problems are under development (18, 30). As these systems are deployed, they should provide ample trial of the techniques employed in EpiMAN-FMD.
The second part of the validation process refers to the FMD-specific components. Many attempts have been made to obtain historical data of relevance. The massive epidemic of FMD in the UK from October 1967 to June 1968 has yielded a wealth of information. The tremendous research efforts that followed that outbreak, by workers such as Burrows (2), Burrows et al. (3), Donaldson (5, 6, 7), Hedger and Dawson (13), Hugh-Jones (14, 15), Sellers and Parker (26) and Tinline (31), have contributed substantially to the state of knowledge about the epidemiology of FMD. Several studies have been undertaken to measure the opportunities for disease spread in New Zealand. Where quantitative data are lacking, subjective techniques have been employed (10). However, the ultimate trial for EpiMAN-FMD must be its use during a genuine vesicular disease epidemic. Naturally, it is hoped that this opportunity will never be provided within New Zealand, but the growing number of countries adopting EpiMAN-FMD as an operational tool may one day provide that test.

Veterinary epidemiologists should continue to monitor such developments in other fields to further enhance the effectiveness of disease control throughout the world.

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Conclusion

The EpiMAN-FMD system provides a model for animal disease control that could be easily adapted to other veterinary problems. The computer-based technologies employed within EpiMAN-FMD were developed to service other disciplines generally remote to veterinary science, but adapted for veterinary applications. Veterinary epidemiologists should continue to monitor such developments in other fields to further enhance the effectiveness of disease control throughout the world.

EpiMAN-FMD : un outil d'aide à la décision en cas d'épidémie de maladie vésiculeuse

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Résumé

Un système global d’information épidémiologique (EpiMAN-FMD) a été mis au point pour aider les responsables de la santé animale à enrayer et éradiquer les maladies animales de manière aussi efficace et rentable que possible. Le système a été dans un premier temps élaboré pour lutter contre la fièvre aphteuse ou toute maladie vésiculeuse cliniquement similaire, mais il a été ensuite progressivement étendu pour contrôler d’autres maladies exotiques et endémiques. Dans son volet gestion de l’information, EpiMAN-FMD a été conçu pour répondre notamment aux objectifs suivants :

- gérer les nombreuses données que les procédures d’éradication d’une épidémie de fièvre aphteuse ne manqueraient pas de générer dans un très court laps de temps ;
- appliquer de manière novatrice une interprétation épidémiologique de la propagation de la maladie lors du traitement des données ;
- résorber certains goulets d’étranglement attendus au niveau du traitement ;
- fournir des outils d’aide à la décision au personnel chargé de la saisie des données.

S’agissant du volet de gestion vétérinaire, les objectifs du système sont les suivants :

- présenter des rapports actualisés de la situation selon un modèle qui permette la prise de décision aux niveaux national et régional ;
EpiMAN-FMD: sistema de ayuda a la adopción de decisiones para gestionar epidemias de enfermedad vesicular

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Resumen
Con el objetivo de ayudar a las instancias sanitarias nacionales a contener y erradicar brotes de enfermedades animales del modo más eficaz y económico posible, se ha elaborado un sistema integral de información epidemiológica (EpiMAN-FMD). Aunque concebido inicialmente para luchar contra la penetración de la fiebre aftosa o de cualquier otra enfermedad vesicular clínicamente indiferenciable, el sistema se ha visto desde entonces progresivamente ampliado para cubrir la gestión de otras enfermedades exóticas o endémicas. En la concepción de sus elementos de gestión de la información, se consideró que EpiMAN-FMD debía cumplir los siguientes objetivos:

- gestionar con rapidez la enorme cantidad de datos que podrían generar los procedimientos de erradicación de una epidemia de fiebre aftosa;
- ser capaz de incorporar al proceso de tratamiento de datos los nuevos conocimientos epidemiológicos sobre el modo de propagación de la enfermedad;
- reducir algunos de los puntos de estrangulamiento previsibles en el tratamiento de la información;
- proporcionar herramientas de ayuda a la decisión al personal responsable de introducir los datos.

En cuanto a los elementos de gestión veterinaria del sistema, su concepción debía satisfacer los siguientes requerimientos:

- elaborar partes actualizados con un formato de presentación que facilitara la adopción de decisiones de alcance nacional o regional;
- optimizar la asignación de personal a las diversas tareas y evaluar las ventajas relativas de distintas alternativas técnicas, cada una de las cuales conlleva una serie de riesgos implícitos.

EpiMAN-FMD combina un sistema de gestión de bases de datos para diversos usuarios, elementos de sistema experto, varios modelos para simular informáticamente determinados aspectos de la epidemiología de la fiebre aftosa y un repertorio de análisis estadísticos concebidos para seguir la evolución del
proceso epidémico. Aunque elaborado en Nueva Zelanda, la concepción de EpiMAN-FMD es lo bastante flexible como para permitir su aplicación en otros países con planes de emergencia similares, que exijan procedimientos de sacrificio sanitario total.

Palabras clave
Control de enfermedades – Fiebre aftosa – Modelo de simulación – Sistema de gestión de bases de datos – Sistema experto.

References


