Use of epidemiological models for the management of animal diseases

Steve Weber
Kim Forde-Folle
Office of International Collaboration and Coordination
Centers for Epidemiology and Animal Health

Safeguarding Animal Health

Outline

- What are epidemiological models?
- Why use epidemiological models?
- What do we use epidemiological models for?
- Conclusions

What are epidemiological models?

- Epidemiological models are simplified representations of:
  - The spread of an infectious disease in a population
  - Interactions between populations
  - The efficacy of disease control measures like vaccination or culling

"A model is the representation of a physical process designed to increase appreciation and understanding of the process… In epidemiology… models are constructed to attempt to explain and predict patterns of disease occurrence and what is likely to happen if various alternative control strategies are adopted." Thrushfield, 2007

Why do we use epidemiological models?

- Models may be used to assess disease behavior under a variety of conditions
- Models may be used to compare the efficacy of different control strategies
- Models enable us to answer **"What if?"** questions
  - **What if** you detected disease 'x' days earlier?
  - **What if** we initiated a vaccination campaign after 'x' number of herds had been detected?
- Model building often highlights gaps in existing knowledge about a system

"One considerable challenge to any modelling study is parameterization, in particular assessing the many unknown and immeasurable parameters that allow the model to capture the observed outbreak." Tildesley, 2008

Types of models

- Vary from simple, deterministic mathematical models to complex, spatially-explicit stochastic simulation models
- The modeling approach used varies depending on:
  - The intended purpose
  - How well the epidemiology of a disease is understood
  - The amount and quality of the data available
  - The background & training of the modelers

Veterinary Services

Safeguarding Animal Health

Source: Garner, Graeme (2008) "Principles of Epidemiological Modeling", Presentation prepared for the OIE Epidemiological Modeling Workshop

Multi-disciplinary approach has lead to a new generation of epidemiological models

- Stochastic simulation models
- Spatial models
- Network models
- Agent-based simulation models

Use of epidemiological models for the management of animal diseases

- Models need to be fit for their intended purpose and appropriately verified and validated
- For informing disease control policy, modeling is most useful when used prior to an event
- Recent experience suggests that predictive modeling during an outbreak should be used cautiously
  - Models are just one tool for providing scientific advice and should not be used in isolation

"… surely the FMD experience should have made the modelers appreciate the limitations of their science and accept at least some responsibility for the misery and expense that their models initiated." (Kitching, 2004)

Using epidemiological models prior to an event

- Evaluate the effectiveness of various surveillance strategies;
- Illustrate the consequences associated with differing probabilities of detection and reporting;
- Identify areas to target preparedness and surveillance activities;
- Provide realistic scenarios for exercises;
- Evaluate proposed disease control strategies;
- Assess the potential economic impacts of disease and associated control measures;
- Estimate consequences as part of the risk assessment process;
- Estimate resources needed in the event of an outbreak;
- Develop animal disease emergency preparedness and response plans

Using and communicating model results

- Modern epidemiological models are specialized tools which require trained users and a solid understanding of the model's strengths and limitations
- Findings need to be interpreted in light of model limitations and data quality
- By definition models are simplifications of complex systems
- Model output helps policy makers and disease managers evaluate what could happen rather than what will happen

Veterinary Services

Safeguarding Animal Health

Source: Garner, Graeme (2008) "Principles of Epidemiological Modeling", Presentation prepared for the OIE Epidemiological Modeling Workshop

Conclusions

- Epidemiological models are valuable tools to assist in the development of policy related to disease prevention and control
- A multidisciplinary, collaborative approach is useful in developing and applying sophisticated models of disease spread and control
- Epidemiological models enable simulated disease spread and control to be studied from a geo-spatial, economic, and political perspective

Veterinary Services

Safeguarding Animal Health

Source: Garner, Graeme (2008) "Principles of Epidemiological Modeling", Presentation prepared for the OIE Epidemiological Modeling Workshop

Conclusions

- Models need to be developed and used for their intended purpose
- Best practices to model development and application include collaboration among epidemiologists, modelers, and disease managers
- Modern epidemiological models are specialized tools which require trained users and a solid understanding of the models' strengths and limitations in order to properly interpret the outputs
- Models are just one tool for providing scientific advice and should not be used in isolation

Source: Garner, Graeme (2008) "Principles of Epidemiological Modeling", Presentation prepared for the OIE Epidemiological Modeling Workshop

Questions

Source: http://www.9news.com/weather/outdoors/fall_colors/default.aspx?N=1