Macroepidemiological contributions to quantitative risk assessment

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Summary: Macroepidemiology is the study of all inputs into national patterns and determinants of disease, including economic, social, and political factors. Macroepidemiology complements and enhances the usefulness of quantitative risk assessment by increasing risk communication and understanding among policy-makers and the affected publics. Macroepidemiological applications include qualitative risk assessment, mapping of relative risk within a country and assessment of surveillance systems.

KEYWORDS: Epidemiology – Macroepidemiology – Risk assessment.

INTRODUCTION

Increasing use is being made of quantitative risk assessment as an objective tool to support decision-making with regard to proposed imports of animals and products. Quantitative risk assessments provide specific mathematical models for estimating the probability and consequences of introducing a specific disease agent into an importing country. Unfortunately, the mathematical complexity of the calculations and the conceptual difficulty of weighing abstract probabilities can diminish the usefulness of the resulting risk assessment for both negotiation and decision-making.

Macroepidemiology provides complementary analyses which increase the usefulness and acceptance of quantitative risk assessment. Macroepidemiology is the study of all inputs into national disease patterns and determinants of disease (5). Whereas epidemiology describes the natural history of a disease, macroepidemiology incorporates the economic, social and political inputs which affect the distribution and impact of a disease at the national level. The application of macroepidemiological approaches is dependent on an understanding of the natural history and risk factors of the specific disease.

The application of macroepidemiology supports the overall incorporation of risk assessment in the import decision process. The first approach is “qualitative” risk assessment, i.e. the comparison of the overall agricultural industry and disease determinants between the exporting and importing countries. The second approach involves an examination of the proposed importing country to determine where the disease would be most likely to occur first, should it occur at all. Recognition of “high risk” regions allows the targeting of surveillance resources to the areas where this

is most warranted. A third approach involves the assessment of existing surveillance mechanisms to determine whether there is evidence of the disease within the importing country, and whether the disease can be detected if introduced.

**BACKGROUND**

Import risk assessment approaches begin by outlining the potential avenues for entrance of the disease of interest into the importing country. In the quantitative models, the probability of agent entry is estimated. Subsequent steps examine the likelihood of exposure, infection and spread of the disease among susceptible animals within the importing country. The mathematical models derived from quantitative risk assessment allow examination of alternative scenarios of agent exposure, prevention or control measures, or restricted use of the imports upon entry.

Macroepidemiological approaches use data to quantify the magnitude of risk as well as the relative risk factors between exporting and importing countries. For example, quantitative risk assessment could focus on the probability of disease given the importation of one affected animal, while qualitative risk assessment might analyze the import trends for potentially infected animals, including historical records and future projections. Each approach contributes valuable insight to policy-makers.

**QUALITATIVE RISK ASSESSMENT**

Qualitative risk assessment borrows heavily from epidemiology, economics, and systems engineering. The process begins with a systems model to visualize the natural history of the disease of interest with relation to the country at risk. Each potential step in the introduction and spread of the disease is captured on a flow-chart or in a systems model.

The second step in qualitative risk assessment involves the comparison of risk factors for the occurrence and spread of the disease between the proposed exporting country and the importing country, in order to determine whether the disease patterns observed in the potential exporting country will be replicated in the importing country. These factors include the following:

- animal demographics
- agribusiness structure and conduct
- livestock and poultry production and marketing
- consumption patterns
- agricultural policies
- economic effects.

The third step in qualitative risk assessment involves summarizing the key similarities and differences between the two countries. In the information age, the sheer volume of data may obscure the key findings. The assessment is not complete until the findings are summarized so that decision-makers can assess them quickly. Liberal use of graphics and a tabular presentation of critical data enhance understanding of the assessment.
ASSESSING REGIONS OF HIGHEST RISK

Once the initial systems model has been designed, assessment of the regions of relatively high risk involves defining risk factors specific to the disease of interest. The areas of highest risk are generally those in which the largest number or greatest magnitude of risk factors are present. Identification of the relative risk in different geographical areas may be facilitated by a mapping approach, where multiple overlays correspond to different risk factors.

ASSESSMENT OF SURVEILLANCE SYSTEMS

Evaluation of the risk of importation of a disease implies that the disease is not known to occur in the importing country. Ascertainment of the true disease status for a country is not an easy undertaking. The assessment of national systems for the surveillance and monitoring of animal health is discussed more fully in another paper in this book (2).

Surveillance data are only useful if the data are compiled, analyzed and applied to decision-making. Surveillance is usually accomplished through a series of interrelated activities, such as investigation of suspected cases, veterinary practitioner reporting systems, inspection of animals at slaughter and diagnostic laboratory data. All of these data must be carefully analyzed in order to make a complete assessment.

EXAMPLES OF MACROEPIDEMIOLOGICAL APPLICATIONS TO RISK ASSESSMENT

The most recent example of the approaches described in this paper has been in risk assessment of the potential occurrence of bovine spongiform encephalopathy (BSE). Qualitative risk assessments have been completed in Europe (6) and the Americas (1, 3, 8). The relative risk of BSE has been mapped in the United States of America (7). Surveillance systems have been assessed to varying degrees by many countries (4).


Résumé: La macro-épidémiologie est l'étude de toutes les données entrant dans les caractéristiques et déterminants d'une maladie au niveau national, y compris les facteurs économiques, sociaux et politiques. La macro-épidémiologie complète l'évaluation quantitative des risques et en accroît l'intérêt en favorisant la diffusion des résultats et la communication entre les responsables et les

Resumen: La macroepidemiología es el estudio de todos los datos que configuran las características y los determinantes de una enfermedad a nivel nacional, incluyendo los factores económicos, sociales y políticos. Permite hacer más completa la evaluación cuantitativa de riesgos e incrementa su utilidad favoreciendo la difusión de los resultados y la comunicación entre las autoridades y las personas concernidas en cada caso. Las aplicaciones de la macroepidemiología incluyen la evaluación cualitativa de riesgos, la cartografía comparada de los riesgos en las distintas regiones de un país determinado y la evaluación de los sistemas de vigilancia.

PALABRAS CLAVE: Epidemiología – Evaluación de riesgos – Macroepidemiología.

REFERENCES


