Assessment of national systems for the surveillance and monitoring of animal health

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Summary: Continued growth in international trade and the developing concepts of zoning and risk assessment demand effective assessment of national surveillance and monitoring systems for animal health. The ideal national epidemiological delivery system incorporates surveillance for disease agents, host monitoring and environmental assessment. An extensive veterinary infrastructure is necessary to support the ideal epidemiological delivery system. While the full spectrum of epidemiological services is represented worldwide, a standardized approach to assessing national surveillance and monitoring systems is proposed, in order to meet the emerging demand for scientifically-based import regulations.


INTRODUCTION

World trade in animals and animal products has expanded dramatically over the last decade and will continue to increase. Political changes in the world order and the ongoing General Agreement on Tariffs and Trade (GATT) negotiations promise to open new markets for a wide variety of agricultural products. However, the increased potential for international trade places additional constraints on both importing and exporting countries with regard to disease surveillance and the monitoring of animal health.

Surveillance and monitoring are two components of an ideal national epidemiological delivery system which serves to protect domestic animal populations as well as capturing and preserving markets for agricultural exports. Surveillance and monitoring are integrally linked with other attributes of the ideal national epidemiological delivery system, such as veterinary infrastructure and risk assessment capabilities. The purpose of this paper is to discuss a proactive approach to surveillance and monitoring which can meet the new and emerging challenges facing countries today. In addition, a scheme for the assessment of national systems for surveillance and

monitoring is proposed. Additional attributes of an ideal epidemiological delivery system, such as veterinary infrastructure and risk assessment, are discussed more fully in the other papers of this book.

**BACKGROUND**

The European Community (EC) represents a microcosm of the emerging challenges for national surveillance and monitoring systems. Under EC rules, individual countries may not create trade-restricting animal health requirements unless they can provide scientific evidence of freedom from the disease in question. Testimonials and anecdotal evidence will not be accepted as adequate proof of the disease-free status of individual countries. Furthermore, the EC has mandated that national surveillance and control programmes be applied for a list of diseases, which places a strain on both fiscal and veterinary resources, especially in the smaller countries.

Both large and small countries are searching for cost-effective surveillance and monitoring systems which meet both internal needs and the demands of the world marketplace. New concepts such as zoning and risk assessment have become major topics of scientific inquiry and negotiation. Zoning is the division of a country into distinct geographical areas of differing animal health status, so that exports can be maintained from disease-free areas. Risk assessment involves the quantification of risks associated with the potential spread of disease from a specific import or export. Both zoning and risk assessment are multidisciplinary scientific activities which build on epidemiology, economics and statistics as well as veterinary medicine.

The disciplines of epidemiology, economics and statistics are receiving renewed attention with regard to animal health. The economics of animal disease and the analysis of the cost-effectiveness of disease prevention and control strategies are still in the initial stages of development. The ultimate question remains: what are the essential components of an ideal national surveillance and monitoring system for animal health, to meet the needs of all trading partners?

The science of epidemiology provides the foundation for surveillance and monitoring. The ideal epidemiological delivery system is composed of a programme of activities which address each aspect of the epidemiological triad of agent, host and environment: agent surveillance, host monitoring and environmental assessment. All three of these activities are dynamic processes, documenting trends over time in order to portray an accurate representation of the animal health status of the country.

The epidemiological delivery system also requires an infrastructure which can marshal the resources necessary to respond with a range of intervention strategies. The ideal epidemiological delivery system includes a trained field force, diagnostic laboratory support, data collection and analysis capabilities, telecommunications to transmit and receive surveillance information, and the legal authority for animal disease regulation.

Operational examples of each component of the ideal surveillance and monitoring systems can be found around the world. However, no single nation has successfully
implemented all three programme activities in conjunction with a functional epidemiological delivery system. The diversity of programmes and resources necessitates a standardized assessment process which is transparent to all potential trading partners.

PROGRAMME ACTIVITIES

Disease agent surveillance

Investigation of suspicious cases of animal disease is the most obvious application of disease agent surveillance. On a national basis, such investigations focus principally on the early detection of clinical cases of unusual diseases, such as diseases foreign to the country or diseases targeted by regulatory programmes. However, a complete epidemiological delivery system requires the corresponding screening of animals for endemic diseases which may have a major economic impact on the overall agricultural economy of the country. Apparently healthy animals and healthy herds must also be evaluated for the presence of subclinical disease and/or evidence of exposure to the agent.

Surveys to substantiate disease freedom, minimal prevalence and localization of disease will become increasingly important in support of international trade. In fact, many nations may prioritize surveillance activities on the basis of export importance, especially because of the role of national governments in regulating international trade. Regardless of the focus of surveillance activities, in a situation where a complete census and testing of all animals is impossible, scientifically-based surveys can be conducted.

Scientifically-based surveys incorporate statistical and epidemiological principles in order to generate accurate and reliable results which represent the true disease status of the country. Representative samples of animals are chosen so that the disease status of the entire population can be estimated from the sample of animals tested. The sampling design and the response rate are carefully evaluated to identify any bias which may affect the interpretation of the results. Statistical confidence intervals are calculated so that the true disease status of the population can be more reliably established.

Determining the true disease status of an animal population requires both active and passive surveillance. Routine sampling and testing of animals at market or slaughter provides active surveillance of animals entering the human food chain. Most countries have meat and poultry inspection systems for the identification of the presence of zoonotic diseases or animals which are unfit for human consumption. Slaughter surveillance can be expanded through the examination of animals for production-limiting diseases which are not zoonoses. An organized sentinel programme provides an alert mechanism for the re-emergence of specific diseases in high risk areas, or serological shifts or antigenic drift within endemic diseases. Sampling vectors for disease agent prevalence or vector competence is another approach for the surveillance of vector-borne diseases.

Ideally, national disease agent surveillance also includes specialized surveys to screen for the agent or disease in the entire livestock and poultry populations, including animals which do not enter the human food chain. Evaluation of the disease status of
animals from a statistically-based sample of producers provides a cost-effective alternative which measures the true disease status of all the animals in the country.

“Passive surveillance” is the compilation and review of test results accumulated through existing programmes, such as veterinary diagnostic laboratory records. Passive surveillance is particularly useful for identifying uncommon or rare diseases which would be referred to laboratories or veterinary hospitals for diagnosis. However, diagnostic records do not provide a measure of the true prevalence of a disease or agent, as denominator information (the size of the animal population from which the diagnoses were drawn) is rarely known. Another approach to passive disease surveillance – which has more relevance to disease prevalence – is the collection of diagnostic results from veterinary practices, provided the practice area can be defined.

The ideal surveillance system also incorporates wild animal populations. Examination of hunter-killed animals or road-kills is the most common surveillance system for wild animals, although limited population surveys have been conducted around the world. Trap and re-trap approaches, and other methods, have been developed for the statistically-based monitoring of population samples of wildlife.

Minimal surveillance activities would include all Office International des Epizooties (OIE) List A diseases and diseases with major zoonotic potential in the country. The ideal animal disease surveillance system also screens for the major production-limiting diseases in order to determine the relative importance and economic impact of specific diseases on the domestic agriculture industry.

Host monitoring

Host monitoring concentrates on the host factors, including intrinsic factors – such as genetics, demographics (age, sex, breed distribution) and physiological state (immature, sexually mature but unbred, gestating, geriatric) – as well as the extrinsic factors of animal use (draft, meat production, milk or egg production, pets) and management factors (level of husbandry, preventive medical practices). This responsibility may be shared with national agricultural census activities which are common in many countries.

Unfortunately, national agricultural statistics seldom include information on farm management and preventive medicine practices, which can be critical elements in determining risks. Furthermore, analysis of associations between animal disease and potential risk factors requires linkage of host characteristic records with disease records in terms of age, breed, sex, species, use, herd characteristics and location. The linkage of host monitoring with agent surveillance provides crucial information for predicting the potential spread of diseases or identifying optimal control measures.

Livestock producers and veterinarians also provide a valuable contribution to host monitoring and disease reporting. As the production of many commodities becomes more vertically integrated, veterinarians and other professionals are being employed by producers or groups of producers. Developing partnerships with producers increases the value of the national monitoring and surveillance systems in an era of diminishing government resources. Co-operative government/producer disease reporting schemes and health certification programmes contribute to the overall effectiveness of the national monitoring and surveillance initiative.
Environmental assessment

Environmental assessment constitutes the third element of the epidemiological triad. Physical environmental data include air and water quality, topography and meteorological data; however, vector distributions, feed industry characteristics and marketing and distribution practices are equally important. For veterinary epidemiology, the environment must also include farm level characteristics, such as housing and stocking rates, and feed management. Environmental assessment is currently the least frequently encountered component of national surveillance and monitoring systems.

The importance of environmental assessment as one component of national animal disease surveillance systems was clearly demonstrated by the Chernobyl nuclear accident and the subsequent impact on animal health and food quality throughout Europe. Environmental assessment activities related to animal health have been implemented after major natural disasters, such as volcanic eruptions and hurricanes or severe flooding; however, these programmes have tended to be temporary.

Extensive air and water quality monitoring, soil distribution maps and meteorological data are routinely collected in many countries, although these data are not directly correlated with animal health. Similarly, data on feed and slaughter industries, and marketing and distribution systems are widely available, even though these data are not readily accessible to support animal disease analyses.

Environmental assessment data allow the estimation of trends for the future, geographical shifts in animal production and processing, and more accurate characterization of disease risk and zoning concerns.

EPIDEMIOLOGICAL DELIVERY SYSTEM

A national Veterinary Services organization forms the foundation for the entire epidemiological delivery system. Historically, emergency response has been the most visible activity of national Veterinary Services. The preparedness to respond promptly to disease outbreaks with a wide range of intervention strategies is mandatory for an ideal epidemiological delivery system. These activities are typically reactive, responding to outbreaks by instituting emergency programmes of test and eradication. The transition of the national Veterinary Services to a proactive proponent of the epidemiological delivery system requires training, diagnostic laboratories, analytical capabilities and communication.

Trained field force

The Veterinary Services field force provides both the technical expertise for directing the surveillance activities and an infrastructure of trained personnel to collect data on animal health, to implement disease control and eradication activities, and to provide rapid investigation and response capabilities for the nation. Training in emergency response procedures and regulatory programme activities has dominated the training agenda for most nations. Through ongoing surveillance activities, field forces become more familiar with livestock and poultry operations, and this enhances the epidemiological delivery system.
Computer literacy is the other critical training objective for the epidemiological delivery system. Computers facilitate the collection, compilation and analysis of data into usable information. Information is a key ingredient for a successful national animal disease surveillance system.

**Diagnostic laboratories**

Coordinated surveillance and monitoring of animal health depends on diagnostic laboratory support. Laboratory services must include quality control procedures and internal consistency checks, as well as a broad spectrum of diagnostic capabilities and rapid processing of samples to be tested. International efforts are underway to ensure consistency in veterinary diagnostics through the establishment of international reference centres for specific diseases.

**Data collection and retrieval**

The collection of data is an integral component of the ideal national surveillance system. In addition, the system must have access to existing data collected by other ongoing programmes, both public and private. The ideal system collects data internally and accesses data from such diverse organizations as the veterinary diagnostic laboratories, industry organizations, agricultural statistics services and meteorological offices.

**Analytical capabilities**

The collection of data alone does not constitute an effective epidemiological delivery system. Analysis of the data and public disclosure of the resulting information are absolute necessities for worldwide credibility. Analyses must include both descriptive summaries and statistical analyses.

Descriptive statistics are the most widely available form of animal health information in the world. Serosurvey results present the percentage of animals tested which yield positive results. Slaughter statistics present the number of condemned carcasses for a given month. The most significant limitation of current descriptive statistics is the lack of reliable denominators and the limited ability to correlate agent, host and environmental data relating to animal health and disease. Serosurveys must be designed so that results can be extrapolated to the entire population at risk or the targeted population being sampled. Condemnations must be compared to the total number of animals slaughtered.

Descriptive statistics summarize historical data; in other words, they describe the past. The ideal epidemiological delivery system uses historical data to create models which forecast or predict future trends. Analysis of weather patterns, animal populations and vector demographics may provide clues for predicting outbreaks of arboviral encephalitides. Major changes in the demographics of a particular class of livestock, such as the development of a poultry industry in a new area, can be coupled with an evaluation of the impact which the new industry will have on existing animals, and the disease problems which could be expected to be most important for the new industry.

The evaluation of potential impacts has fostered the development of risk assessment techniques. Risk assessment is assuming growing importance as a tool for interpreting the relative importance of animal disease patterns and animal health trends. Most current import regulations are based on a zero risk philosophy. Increasingly, experts are recognizing that zero risk is unattainable. Risk management therefore becomes the
operational function of the epidemiological delivery system. Risk assessment allows a rational prioritization of risks.

Communication

The regular dissemination of analyses of endemic disease patterns and trends substantiates the capabilities of the national surveillance and monitoring system. Outbreaks of foreign animal disease must be reported promptly. Timely and accurate reporting create confidence in the ability of the system to accurately document the health status of the national livestock and poultry populations.

Timely and accurate reporting activities occur on both the national and international levels. The OIE is continually improving the international communication of animal health information, in order to support national animal health surveillance systems.

Legal authority

The final component of the ideal national epidemiological delivery system is the legal authority to implement and enforce regulations concerning animal health. The ideal system includes: mandatory animal and herd identification suitable for use on the farm; slaughter facilities; provisions for identifying notifiable diseases; the ability to quarantine affected animals and herds, and restrict animal movement; and the power to enforce disease control measures, including slaughter and disposal of affected animals. The systems must be able to identify specific areas within the country which are free of specific diseases of interest. This process of zoning will require internal reference points and the establishment of jurisdictional boundaries with regard to animal health.

ASSESSMENT OF NATIONAL SURVEILLANCE AND MONITORING SYSTEMS

The ideal national surveillance and monitoring system serves as a goal; however, many countries will not have sufficient resources to deliver all the programme components within the ideal epidemiological delivery system. Nevertheless, the formulation and implementation of import requirements and risk assessments for specific countries or regions depends on the depth and reliability of the surveillance and monitoring information emanating from the exporting country. Description of the ideal system allows for the development of standardized categories describing the extent of the surveillance and monitoring systems in place.

An assessment of national surveillance and monitoring systems would begin with a complete cataloguing of existing capabilities for disease agent surveillance, host monitoring and environmental assessment, along with an evaluation of other attributes of the epidemiological delivery system. A five-step scale is proposed, with scores ranging from 0 to 4. The assessment of 0 would be assigned to countries with no system in place, or countries which have not been assessed. A score of 1 represents a minimal, basic system and a score of 4 represents a complete system which incorporates all aspects of the ideal described in this paper. Proposed assessment guidelines are presented in Table I. Countries achieving a score of 1 must possess the capabilities listed in column 1 while countries achieving a score of 4 would need to display all the capabilities listed.
<table>
<thead>
<tr>
<th>Programme activities</th>
<th>Scoring *</th>
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**Agent surveillance**

Early detection and investigation of clinical disease

- OIE List A diseases
  - X X X X X
- Diseases exotic to country
  - - X X X
- OIE List B diseases
  - - X X
- New and emerging diseases/syndromes
  - - - X

Screening for agent and disease prevalence

- Screening slaughter/laboratory submissions
  - - X X X
- Special surveys (statistically-based)
  - - - X X
- Ongoing sampling and testing
  - - - X
- Organised sentinel programme
  - - - X
- Banking of sera allowing retrospectives
  - - - X

**Host monitoring**

Livestock, poultry and wildlife demographics

- - X X X

Production practices

- General management practices
  - - X X X
- Preventive medicine practices
  - - X X
- Biosecurity (including dead disposals)
  - - - X

Co-operative government/producer programmes

- Disease reporting
  - - X X
- Health certification
  - - - X

**Environmental assessment**

Physical factors

- Geography/topography
  - - X X X
- Hydrology/soil types/geology
  - - - X X
- Weather patterns
  - - X X
- Air and water quality
  - - - X

Biological factors

- Vector distribution
  - - X X X
- Vector competence
  - - X X

Industry characteristics

- Slaughter
  - - X X X
- Rendering
  - - - X
- Feed
  - - - X
- Biologicals
  - - X X
- Pharmaceuticals
  - - - X
TABLE I (contd)

Proposed assessment for national surveillance and monitoring systems

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<thead>
<tr>
<th>Programme activities</th>
<th>Scoring *</th>
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<tr>
<th>Epidemiological delivery system</th>
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<tbody>
<tr>
<td>Trained field force</td>
<td>X</td>
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<tr>
<td>– Strategically located</td>
<td>X</td>
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<tr>
<td>– Investigation skills</td>
<td>X</td>
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<tr>
<td>– Veterinary co-ordination capability</td>
<td>X</td>
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<tr>
<td>– Computer literacy</td>
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<tr>
<th>Diagnostic laboratories</th>
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<tbody>
<tr>
<td>– Sample collection/submission protocol</td>
<td>X</td>
</tr>
<tr>
<td>– Diagnostic capabilities: OIE List A diseases</td>
<td>X</td>
</tr>
<tr>
<td>– Diagnostic capabilities: OIE List B diseases</td>
<td>-</td>
</tr>
<tr>
<td>– Extensive diagnostic capabilities</td>
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<table>
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<tr>
<th>Data collection/retrieval/analysis</th>
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<tbody>
<tr>
<td>– Standardized data collection protocol</td>
<td>X</td>
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<tr>
<td>– Data validation/quality control</td>
<td>-</td>
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<tr>
<td>– Automated data capture and storage</td>
<td>-</td>
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<tr>
<td>– Statistical analysis capabilities</td>
<td>-</td>
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<tr>
<td>– Multidisciplinary analysis team</td>
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<tr>
<td>(epidemiologist, economist, statistician field veterinarian)</td>
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<tr>
<th>Communications</th>
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<tbody>
<tr>
<td>– Communications within one day</td>
<td>X</td>
</tr>
<tr>
<td>– Extensive telephone and radio</td>
<td>-</td>
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<tr>
<td>– Computer links nationwide</td>
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<tr>
<th>Legal authorities</th>
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<tr>
<td>– Movement control/restrictions</td>
<td>X</td>
</tr>
<tr>
<td>– Authority for control programmes</td>
<td>-</td>
</tr>
<tr>
<td>– Permanent identification of animals</td>
<td>-</td>
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<tr>
<td>– Structure for zoning</td>
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* levels represent the completeness of the national surveillance and monitoring system, from a score of 1 for a basic system to 4 for a complete system; "X" indicates existing national capability

OIE: Office International des Epizooties
ÉVALUATION DES SYSTÈMES NATIONAUX DE SURVEILLANCE ET DE CONTRÔLE DE LA SANTÉ ANIMALE. — W.D. Hueston.

Résumé : La croissance constante des échanges internationaux et le développement des notions de régionalisation et d’estimation des risques impliquent une bonne évaluation des services nationaux de surveillance et de contrôle en santé animale. Un système de services épidémiologiques idéal au plan national doit assurer à la fois la surveillance des agents pathogènes, le contrôle des hôtes et l’étude de l’environnement. Un tel système nécessite une importante infrastructure vétérinaire. Devant le large éventail de services épidémiologiques existants dans le monde, l’auteur propose une méthode standardisée pour l’évaluation des systèmes nationaux de surveillance et de contrôle, de sorte que les réglementations relatives aux importations soient fondées sur des bases scientifiques, comme cela est de plus en plus demandé.

MOTS-CLÉS : Commerce international — Surveillance nationale — Systèmes de contrôle — Systèmes épidémiologiques.

* *


Resumen: El crecimiento sin pausa de los intercambios internacionales y el desarrollo de los conceptos tanto de regionalización como de análisis de riesgos implican la necesidad de una buena evaluación de los servicios nacionales de vigilancia y de monitoraje de la sanidad animal. Un sistema de servicios epidemiológicos ideal a nivel nacional debiera garantizar al mismo tiempo la vigilancia de los agentes patógenos, el monitoraje de sus huéspedes así como el estudio del medio ambiente. Para cumplir estos propósitos, una amplia infraestructura veterinaria es necesaria. El autor propone, dado el amplio espectro de servicios epidemiológicos que existen en el mundo, un método estandarizado para la evaluación de los sistemas nacionales de vigilancia y de monitoraje de la sanidad animal, lo que permitiría dar una base científica a las reglamentaciones sobre importaciones, cuya necesidad es ahora bien reconocida.

PALABRAS CLAVE: Comercio internacional — Sistemas de monitoraje — Sistemas epidemiológicos — Vigilancia nacional.