A proposed classification of veterinary epdemiosurveillance networks

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Summary
With the signing of the General Agreement on Tariffs and Trade and the establishment of the World Trade Organisation, the trading environment for animal products has changed. Disease control measures can no longer be applied as trade barriers unless supported by scientific epidemiological data. In this context, it has become necessary, if not obligatory, to gain accurate and up-to-date knowledge about the epidemiological status of important infectious animal diseases. The role of veterinary epdemiosurveillance networks is therefore gaining importance.

Furthermore, epdemiosurveillance contributes to the protection of animal populations from exotic or emerging diseases, as well as to the development and evaluation of disease control programmes.

Despite the large diversity of surveillance networks, the authors propose a method of network classification. The criteria for classification are as follows:
- the type of disease being monitored (i.e., surveillance of exotic versus endemic diseases)
- the number of diseases concerned (i.e., focused networks versus broad-based networks)
- the area being covered (i.e., local, national or international networks)
- the population being monitored (i.e., whether the network is targeted at suspect or susceptible animals)
- the sampling strategy of the network (i.e., sample-based networks versus exhaustive networks)
- the method of collecting data (i.e., passive data collection versus active collection)
- the type of network management (i.e., autonomous management versus that which is integrated with other programmes).

This classification is discussed and illustrated by examples published in the literature. It may aid in the future development of a grid for the evaluation of veterinary epdemiosurveillance networks.

Keywords
Disease surveillance – Epidemiosurveillance – Epidemiovigilance – Networks – Veterinary epidemiology.

Introduction
Since the opening of the European market in 1993, the volume of trade in animals and animal products has increased as a result of the liberalisation of trade among European countries. The signing of the General Agreement on Tariffs and Trade (GATT) and the establishment of the World Trade Organisation (WTO) have recently further extended this zone of trade.

Within this new trade environment, the objective of the Sanitary and Phytosanitary Agreement (37) is to establish scientifically based principles to ensure transparent and safe agricultural trade. The WTO has recognised the Office
International des Epizooties (OIE), the Codex Alimentarius and the International Plant Protection Convention (IPPC) as the bodies which should set the standards for animal health, food safety and public health and plant health. Such standards are the only remaining legitimate non-tariff trade barriers to the movement of animals and animal products (19). Restrictive measures will be permitted only when supported by scientific data. In addition, valid epidemiological data are crucial to substantiate any claim of freedom from specific infections or diseases, and to implement appropriate animal import risk analyses.

Consequently, accurate and up-to-date knowledge about the epidemiological status of important infectious animal diseases has become essential. The quality of this information depends on many factors associated with the organisation and management of Veterinary Services in the country or region concerned, as well as on the types of epidemiological networks in place (23). Transparent descriptions of both the Veterinary Services and the epidemiological surveillance methods employed will thus become increasingly important in the near future.

In addition to their importance as a tool in gaining access to, and preserving, international markets, epidemiosurveillance networks are essential for the protection of animal populations from exotic or emerging diseases, as well as for the development and evaluation of disease control programmes.

There is a great diversity among surveillance networks resulting in difficulties in classification (6). This paper proposes a method of classification which can be used to describe surveillance networks with a standardised approach. Classification criteria are illustrated by examples published in the literature.

**Epidemiosurveillance within the context of veterinary epidemiology**

**Definitions**

Epidemiosurveillance was defined more than two decades ago by Langmuir (26), as 'an orderly method of collecting new information promptly and systematically, screening, sorting and evaluating it, and of disseminating it regularly in appropriate and assimilable forms to those who need to know, including the general public'. More recently, epidemiosurveillance has been defined in the veterinary field as 'a method of observation based on the continuous recording of the health status or risk factors within a defined population, in particular to detect the emergence of pathological processes and to study their development in time and space, in order to adopt appropriate control measures' (33). The words 'new information' (26) and 'pathological processes' (in French, 'processus pathologiques') (33) are understood by the authors to mean actual data related to infections or diseases. For simplicity, the word 'disease' is often used in this paper, but the reader will understand that it refers also to infections.

While the definition of Langmuir (26) describes the basic concept of surveillance, which has also been recently described by Dufour (12), the definition by Toma et al. (33) contains three important ideas, i.e., epidemiosurveillance is a descriptive process as well as a continuous process, and the results of epidemiosurveillance lead to action, as follows:

- epidemiosurveillance forms a part of descriptive epidemiology, as its objective is to facilitate the evaluation of the true status of one or more diseases
- epidemiosurveillance is conducted continuously, whatever the prevalence of the infection(s) or disease(s) in the country or region concerned. This allows trends to be established, using up-to-date epidemiological data, so that the diseases concerned can be better prevented and/or controlled
- finally, epidemiosurveillance may also be conducted with the aim of controlling the disease.

Where diseases are exotic to the country or region concerned or emerging (e.g., antibiotic resistance [27]), the identification of cases is associated with another type of surveillance. This is because increased vigilance is required to detect the development of diseases which are often unfamiliar (because they are rarely seen) to field observers (e.g., farmers or veterinarians). This type of epidemiosurveillance could be defined as 'epidemiovigilance', and will be referred to as 'epidemiosurveillance of exotic diseases' in this article.

The personnel and institutional infrastructure assembled to conduct surveillance of one or more diseases over a given area form an epidemiosurveillance network (33). The exchange of information within these networks is usually centralised, i.e., data are sent to a managing centre to be managed and analysed, and the resulting epidemiological information is redistributed to the participants in the networks.

**Epidemiosurveillance objectives**

The principal objectives of veterinary epidemiosurveillance networks have been presented by Morris (29) and form part of an information system for animal health.

The objectives of epidemiosurveillance in regard to endemic diseases are as follows:

- to allow the economic and disease control significance of various diseases which occur in the same animal population to be ranked, so that priorities for taking action may be set. Some local networks, such as VEGA (5) or VIALLINE (14), have these objectives
incidence, prevalence, economic losses) and to follow its evolution so as to decide and perhaps evaluate which prevention or control method is the most appropriate (e.g., prevention, doing nothing, controlling the disease or eradication) or how effective a continuing control programme is. For instance, in the control of rinderpest in Africa, epidemiosurveillance has allowed identification of the geographical distribution of the virus strains isolated from the field, the detection of seroconversion of non-vaccinated animals and the continuous evaluation of the immune status of animals in the risk areas (30).

The objectives of epidemiosurveillance for exotic diseases are as follows:

- to estimate the absolute importance of a disease (e.g., incidence, prevalence, economic losses) and to follow its evolution so as to decide and perhaps evaluate which prevention or control method is the most appropriate (e.g., prevention, doing nothing, controlling the disease or eradication) or how effective a continuing control programme is.

The distinction may also be difficult to make when a longitudinal descriptive study is conducted over a particularly long period of time, such as the continuous ecopathological study of health and production in dairy cattle. Such a study (3) was conducted over a five-year period, during which a considerable amount of data was collected from approximately 100 farms. In such a case, it may be better to distinguish between ‘research networks’ and ‘epidemiosurveillance networks’, as described in Table I.

### Table I

<p>| Criteria used to distinguish between epidemiosurveillance and research networks (21, 33) |
|---------------------------------|---------------------------------|---------------------------------|</p>
<table>
<thead>
<tr>
<th>Criteria</th>
<th>Epidemiosurveillance networks</th>
<th>Research networks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectives</td>
<td>Descriptive epidemiology</td>
<td>Detailed description of a health problem</td>
</tr>
<tr>
<td>Frequency of data collection</td>
<td>Continuous</td>
<td>Analytical epidemiology (study of risk factors)</td>
</tr>
<tr>
<td>Method of data collection</td>
<td>Fixed protocol</td>
<td>Protocol adapted to hypotheses</td>
</tr>
<tr>
<td>Quantity of data collected</td>
<td>Limited and repetitive</td>
<td>Important and detailed</td>
</tr>
<tr>
<td>Data analysis</td>
<td>Often simple</td>
<td>Often complex</td>
</tr>
<tr>
<td>Distribution of results</td>
<td>Usually rapid and regular</td>
<td>Irregular and slower</td>
</tr>
<tr>
<td>Examples</td>
<td>Surveillance of rabies in France (2)</td>
<td>Ecopathological study on dairy farms (3)</td>
</tr>
</tbody>
</table>

#### Difference between epidemiosurveillance and descriptive epidemiological studies

The principal difference between epidemiosurveillance and descriptive epidemiological studies is that epidemiosurveillance is conducted continuously, whereas descriptive studies or surveys are either cross-sectional (conducted at a given point in time) or longitudinal but limited in duration.

It may be difficult to make such a distinction when descriptive studies are repeated at regular intervals, such as in the case of the surveillance of infectious bovine rhinotracheitis, enzootic bovine leukosis, bovine brucellosis and bovine tuberculosis in Switzerland, which is performed through yearly screening of the population of bovine herds (32). Each investigation by itself could be described as a descriptive study (survey). However, as such surveillance is conducted year after year, it may be considered by some people to be an epidemiosurveillance activity. To make the distinction, however, one must consider that, in principle, the protocols of surveillance networks should be stable and generally do not change greatly over time, whereas, in the case of surveys or studies which are repeated, protocols can change from time to time. To evaluate changes in the status of diseases over time, one must take care that the data have been collected and managed in the same way.
Structure of epidemiomosurveillance networks and proposed criteria for a classification

Structure of epidemiomosurveillance networks

Whatever the disease being monitored, the activity within epidemiomosurveillance networks is composed of several sequential steps (12, 34), which are summarised below, as follows:

a) collection of data relevant to the disease in question, in accordance with a predetermined protocol which takes into account the objectives of the network
b) transfer of data to the central unit using standardised methods
c) data analysis
d) distribution of information to network participants (internal distribution) and to other interested parties (external distribution).

Network objectives must be clearly defined. It is neither possible nor cost-effective to monitor all diseases, so it is necessary to select which diseases should be monitored. This should be done according to various criteria, such as the severity of the disease, the feasibility of prevention programmes and the national and international regulations concerning this disease.

Careful standardisation of the data collected (i.e., the type of data and the collection methods) is essential. This phase is difficult when the number of field observers is large and their working habits are diverse and ingrained. However, networks should be flexible enough to adapt to possible changes in the epidemiological status of diseases (6). The collected data should be able to be converted to information which is appropriate for the users and valid enough to be published in regular reports (7). Regular distribution of such information, as well as feedback, is essential to maintain the motivation of the observers in the field, so that the network can fulfil its obligations and objectives.

Proposed criteria for a classification

There are several possible types of classifications. The authors have retained and further developed the one initially proposed by Dufour (12). The criteria used for this classification are presented in Table II, while descriptions of the networks employed to illustrate the classification are presented in Table III. The names of these networks and the agencies managing them are also given.

### Table II

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Possible classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Objective</td>
<td>Exotic or emerging diseases (epidemiovigilance)/endemic diseases</td>
</tr>
<tr>
<td>2. Number of diseases</td>
<td>Focused (one or more defined diseases)/broad-based (all diseases and syndromes)</td>
</tr>
<tr>
<td>3. Area of surveillance</td>
<td>Regional/national/international</td>
</tr>
<tr>
<td>4. Population monitored</td>
<td>Surveillance of suspect cases/surveillance of susceptible animals</td>
</tr>
<tr>
<td>5. Sampling strategy</td>
<td>Sample-based/exhaustive (census)</td>
</tr>
<tr>
<td>6. Method of data collection</td>
<td>Passive/active</td>
</tr>
<tr>
<td>7. Type of management</td>
<td>Autonomous/integrated</td>
</tr>
</tbody>
</table>

Type of disease monitored

Monitored diseases may be endemic in the area under surveillance or exotic. There are intrinsic differences in the way networks are implemented in these two situations. In particular, epidemiomovigilance networks (e.g., the network for FMD in France) usually rely on the reporting of suspected cases followed by laboratory confirmation. Epidemiomosurveillance networks for endemic diseases may rely on the identification of both clinical cases (through routine veterinary diagnosis) and subclinical cases (through the screening of apparently healthy animals). For instance, surveillance of bovine brucellosis in France is conducted both through the registration of causes of abortions and serological screening of the population (12).

Number of diseases

Epidemiomosurveillance is defined as ‘focused’ when it is targeted towards one disease, or to a limited number of well-defined diseases. For instance, networks for the surveillance of rabies or bovine spongiform encephalopathy (BSE) in France (2, 9) and BSE in Switzerland (32) are focused. Epidemiomosurveillance is defined as ‘broad-based’ when many diseases or syndromes are monitored through a single network, such as RNOEA for poultry (10), or when the objectives of surveillance are very broad and the surveillance activities result in a combination of several networks, such as the NAHMS in the USA (7, 22).

Area of surveillance

Surveillance can be ‘regional’, such as in the networks VEGA in France (5) and Réseau d’Alerte et d’Intervention Zoosanitaire Québécois (RAIZO: Animal Health Warning and Intervention Network) in Quebec (11); ‘national’, such as the Equinella network in Switzerland (28) or NAHIS in Australia (18); or ‘international’, such as the surveillance network for diseases on Lists A and B of the OIE (8). By ‘regional’, the authors do not imply that the area always has administrative boundaries.
<table>
<thead>
<tr>
<th>Network name</th>
<th>Objectives and type of disease monitored</th>
<th>Number of diseases</th>
<th>Area of surveillance</th>
<th>Population monitored</th>
<th>Sampling strategy</th>
<th>Data collection method</th>
<th>Type of management</th>
<th>Central unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rabies (2)</td>
<td>Detection of cases</td>
<td>Focused</td>
<td>National (France)</td>
<td>Suspect animals</td>
<td>Census</td>
<td>Passive</td>
<td>Integrated</td>
<td>CNEVA, Nancy</td>
</tr>
<tr>
<td>SAGIR (4)</td>
<td>Estimation of causes of mortality in wild animals</td>
<td>Broad-based</td>
<td>National (France)</td>
<td>Suspect animals</td>
<td>Convenience sample (volunteer hunters)</td>
<td>Passive</td>
<td>Autonomous</td>
<td>CNEVA, Nancy</td>
</tr>
<tr>
<td>VEGA (5)</td>
<td>Surveillance of major health problems of sheep and cattle</td>
<td>Broad-based (several syndromes and diseases)</td>
<td>Regional (France)</td>
<td>Susceptible animals</td>
<td>Convenience sample (volunteer veterinarians)</td>
<td>Active</td>
<td>Partly integrated and partly autonomous</td>
<td>Regional association</td>
</tr>
<tr>
<td>NAHMS (6) (7)</td>
<td>Surveillance of animal health</td>
<td>Broad-based (includes several networks)</td>
<td>National (USA)</td>
<td>Susceptible and suspect animals</td>
<td>Statistical sample (numerous sources)</td>
<td>Passive and partly active</td>
<td>Integrated and partly autonomous</td>
<td>APHIS/USDA</td>
</tr>
<tr>
<td>Office International des Epizooties (8)</td>
<td>Surveillance of infectious diseases (OIE Lists A and B diseases)</td>
<td>Broad-based (more than 100 diseases)</td>
<td>International (149 Member Countries)</td>
<td>Susceptible and suspect animals</td>
<td>Sample-based (all Member Countries)</td>
<td>Passive (regular reporting and active annual report)</td>
<td>Integrated</td>
<td>Office International des Epizooties</td>
</tr>
<tr>
<td>Bovine spongiform encephalopathy (9)</td>
<td>Detection of cases</td>
<td>Focused</td>
<td>National (France)</td>
<td>Suspect animals</td>
<td>Census</td>
<td>Passive</td>
<td>Integrated</td>
<td>CNEVA, Lyons</td>
</tr>
<tr>
<td>RVNOEA (10) (10)</td>
<td>Surveillance of poultry pathology</td>
<td>Broad-based (all diseases and syndromes)</td>
<td>National (France)</td>
<td>Suspect animals</td>
<td>Sample-based (volunteer veterinarians)</td>
<td>Active</td>
<td>Integrated</td>
<td>CNEVA, Ploufragan</td>
</tr>
<tr>
<td>RAIZO (11)</td>
<td>Surveillance of defined animal diseases of cattle, poultry, etc.</td>
<td>Broad-based</td>
<td>Regional (Québec, Canada)</td>
<td>Susceptible animals</td>
<td>All veterinarians</td>
<td>Passive</td>
<td>Integrated</td>
<td>Ministry of Agriculture</td>
</tr>
<tr>
<td>Bovine and ovine brucellosis (12)</td>
<td>Surveillance of control effects</td>
<td>Focused</td>
<td>National (France)</td>
<td>Suspect and susceptible animals</td>
<td>Census</td>
<td>Active</td>
<td>Integrated</td>
<td>Ministry of Agriculture</td>
</tr>
<tr>
<td>Foot and mouth disease (12)</td>
<td>Detection of clinical cases of FMD (epidemiological)</td>
<td>Focused</td>
<td>National (France)</td>
<td>Suspect animals</td>
<td>Census (investigation of suspected cases)</td>
<td>Passive</td>
<td>Integrated</td>
<td>CNEVA, Maisons-Alfort</td>
</tr>
<tr>
<td>RESSAB (13)</td>
<td>Surveillance of suspicious cases of clinical bovine salmonellosis</td>
<td>Focused</td>
<td>Regional (France)</td>
<td>Suspect animals</td>
<td>Sample-based (volunteer veterinarians)</td>
<td>Passive</td>
<td>Partly integrated and partly autonomous</td>
<td>CNEVA, Lyons</td>
</tr>
<tr>
<td>Salmonella network (13)</td>
<td>Surveillance of Salmonella spp. in animals</td>
<td>Focused</td>
<td>National (France)</td>
<td>Suspect animals</td>
<td>Sample-based (volunteer laboratories)</td>
<td>Passive</td>
<td>Partly integrated and partly autonomous</td>
<td>CNEVA, Paris</td>
</tr>
<tr>
<td>APHIS/USDA</td>
<td>NAHIS</td>
<td>NAHMIS</td>
<td>NAI</td>
<td>NAFIS</td>
<td>NAHMS</td>
<td>RAV2D</td>
<td>RESAN</td>
<td>VIAINE</td>
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</tr>
<tr>
<td>Surveillance of infectious diseases of cattle (IBR, paratuberculosis, listeriosis)</td>
<td>Broad-based (several infectious and non-infectious diseases)</td>
<td>Regional (France)</td>
<td>Susceptible animals</td>
<td>Sample-based (volunteer farmers)</td>
<td>Passive</td>
<td>Integrated</td>
<td>Regional association</td>
<td></td>
</tr>
<tr>
<td>Surveillance of bee diseases</td>
<td>Focused (5 diseases)</td>
<td>National (France)</td>
<td>Susceptible animals</td>
<td>Statistical sample</td>
<td>Passive</td>
<td>Autonomous</td>
<td>Ministry of Agriculture</td>
<td></td>
</tr>
<tr>
<td>Surveillance of animal health</td>
<td>Broad-based (including OIE List A diseases)</td>
<td>National (Australia)</td>
<td>Susceptible and suspect animals</td>
<td>Sample-based (numerous sources)</td>
<td>Passive</td>
<td>Integrated and partly autonomous</td>
<td>Animal Health Authorities</td>
<td></td>
</tr>
<tr>
<td>Detection of FMD in wild pigs (epidemiological vigilance)</td>
<td>Focused</td>
<td>National (Australia)</td>
<td>Susceptible animals</td>
<td>Sample-based (volunteer hunters in representative zones)</td>
<td>Passive</td>
<td>Autonomous</td>
<td>Ministry of Agriculture and University of Canberra</td>
<td></td>
</tr>
<tr>
<td>Surveillance of antibiotic resistance</td>
<td>Focused</td>
<td>National (France)</td>
<td>Susceptible animals</td>
<td>Sample-based (volunteer laboratories)</td>
<td>Passive</td>
<td>Integrated</td>
<td>CNEVA, Lyons</td>
<td></td>
</tr>
<tr>
<td>Surveillance of seven notifiable equine diseases and other diseases</td>
<td>Broad-based</td>
<td>National (Switzerland)</td>
<td>Susceptible animals</td>
<td>Sample-based (volunteer veterinarians and laboratories)</td>
<td>Passive</td>
<td>Autonomous</td>
<td>Swiss Federal Veterinary Office</td>
<td></td>
</tr>
<tr>
<td>Surveillance of swine pathology</td>
<td>Broad-based</td>
<td>National (Denmark)</td>
<td>Susceptible animals</td>
<td>Census (all abattoirs)</td>
<td>Passive</td>
<td>Integrated</td>
<td>Royal Veterinary University</td>
<td></td>
</tr>
<tr>
<td>Surveillance of the immune status of cattle</td>
<td>Focused</td>
<td>National (Kenya)</td>
<td>Susceptible animals</td>
<td>Sample-based (representative sample)</td>
<td>Active</td>
<td>Integrated</td>
<td>National Centre of Veterinary Research</td>
<td></td>
</tr>
<tr>
<td>Surveillance of bovine facial eczema</td>
<td>Focused</td>
<td>Regional (North of New Zealand)</td>
<td>Susceptible animals</td>
<td>Sample-based (volunteer farmers)</td>
<td>Active (by phone)</td>
<td>Autonomous</td>
<td>Ministry of Agriculture</td>
<td></td>
</tr>
<tr>
<td>Surveillance of certain notifiable diseases</td>
<td>Focused</td>
<td>National (Switzerland)</td>
<td>Susceptible animals</td>
<td>Sample-based (representative sample)</td>
<td>Active</td>
<td>Autonomous</td>
<td>Federal Veterinary Office</td>
<td></td>
</tr>
<tr>
<td>Rabies</td>
<td>Focused</td>
<td>National (England)</td>
<td>Susceptible animals</td>
<td>Sample-based (captured bats)</td>
<td>Passive</td>
<td>Autonomous</td>
<td>Central Veterinary Laboratory</td>
<td></td>
</tr>
</tbody>
</table>

APIHS/USDA: Animal Plant and Health Inspection Service/United States Department of Agriculture  
CNEVA: Centre National d'Études Vétérinaires et Alimentaires  
DPhS: Danish Pig Health Scheme  
NAHS: National Australian Health Information System  
NAHMIS: National Animal Health Monitoring System  
RAV2D: Réseau d'Alerte et d'Intervention Zoosanitaire  
RESAN: Réseau d'Épidémiomonitoring Apicole National  
RESSAB: Réseau d'Épidémiomonitoring des Suspects Cliniques de Salmonelloses Bovines  
RNIOA: Réseau National d'Observations Épidémiologiques en Aviculture  

FMD: foot and mouth disease  
IBR: infectious bovine rhinotracheitis  
NAHMS and NAHIS are animal information systems, composed of several epidemiological surveillance networks for endemic, exotic and emerging infections and diseases  
a) Network focused on endemic and exotic as well as emerging diseases
Populations monitored

Surveillance networks may be restricted to the monitoring of 'suspect animals' within the population concerned, or to monitoring all 'susceptible animals'. For instance, some surveillance networks for BSE are targeted towards cattle which show progressive neurological clinical signs of the disease (9). A network aimed at the surveillance of bovine brucellosis may be composed of two sub-networks, i.e., one restricted to the monitoring of cattle which have aborted, and another based on the serological screening of all clinically normal susceptible cattle (12). Whether a network is restricted to suspect animals depends on the epidemiology of the disease concerned, and on other criteria, such as the availability, practicability and cost of screening tests.

Sampling strategy

Epidemiosurveillance of a disease can be 'exhaustive', i.e., the entire targeted population or census is monitored, such as in the case of bovine brucellosis in France (12). More often, the monitored population is 'sample-based' from the target population, such as occurs with the National Epidemiosurveillance Network of Bee Diseases (Réseau d'Epidémiosurveillance Apicole National or RESAN) (15), which monitors bee diseases by analysing samples from producers. Sentinel farms have been used to monitor the epidemiology of clinical diseases (31). A sample of animals within farms may also be considered, in particular for screening purposes. For obvious economic reasons, but also because of the nature of diseases, most epidemiosurveillance networks are not exhaustive, but are limited to a sample of the population. Sampling strategy should be well documented in the network protocol.

This sample should ideally be representative of the target population, i.e., it must be chosen according to statistical and epidemiological principles so that the resulting information can be extrapolated to the population as a whole. Thus, the information will give an unbiased estimate of the true epidemiological status of the disease concerned. However, there are often situations when this is not practical or not possible, resulting in the samples being chosen by convenience. It is, for instance, intrinsic to epidemiosurveillance networks for diseases or infections in wild animal populations that only a fraction of all cases can be registered (4, 20), such as for the surveillance of rabies in foxes in France (2) and in bats in the United Kingdom (UK) (35). Such a sample, based on suspected cases, is often biased and not truly representative of all cases in the monitored population. Other networks based on non-random samples are those in which only volunteers take part (4, 5, 10, 13, 14, 27, 28, 31).

Data collection methods

The collection of data can be either 'active' or 'passive' (1, 21). It is active when the central unit specifically requests data at regular intervals from field personnel. This active query can be conducted by questionnaire or by other means, and its frequency can vary according to many factors, such as the diseases concerned and the workloads of the central unit or field staff.

Data collection is passive when field data are sent to the central unit without the unit needing to ask for them. Most epidemiovigilance networks use passive data collection methods. It would neither be cost-effective nor necessary to query each of the 2,500 field veterinarians in France weekly or monthly to discover if they suspect the presence of FMD in their practice.

However, one may distinguish between networks which use 'purely passive' data collection, i.e., in which the information is sent only if suspected cases have been noticed (e.g., the network for FMD in France), and networks which use 'passive-active' data collection, in which field observers must always send regular reports to the central unit, whether or not they have observed cases of disease, e.g., the Equinella network in Switzerland (28).

Passive data collection necessitates high motivation and vigilance on the part of the field staff, maintained through regular contact, such as meetings. Without such stimulation, there is the risk of a spontaneous reduction in the rate of reported cases, and thus a corresponding reduction in the effectiveness of the network in identifying diseased animals.

Types of network management

Epidemiosurveillance networks may be associated with pre-existing disease prophylaxis or diagnostic activities. In this case, they are a sub-product of these activities and are defined as 'integrated'. Conversely, they may be developed independently and implemented regardless of any other action; such networks are defined as 'autonomous'.

Integrated epidemiosurveillance networks, such as the network for bovine brucellosis in France (13), which uses data collected in the context of the prophylaxis for this disease, are usually cheaper than autonomous networks, which must pay for the collection of the required data (e.g., sample collection, laboratory analyses, etc.).

Some examples of epidemiological networks to illustrate the proposed classification

This article does not attempt to list all the existing epidemiosurveillance networks, or even all those that have been noted in publications. It appears that epidemiovigilance networks are not described in the scientific literature as often as surveillance networks for endemic diseases. It is probable
that most countries (if not all) have surveillance programmes in place for exotic diseases, but these may be managed by the Veterinary Administration, and not by scientists, who would be more likely to publish. To illustrate the proposed classification criteria, a range of epidemiological networks are presented below.

**An epidemiovigilance network**

The RNOEA (10) was established in 1987 by the Centre National d'Études Vétérinaires et Alimentaires (CNEVA) at Ploufragan, after a request from private veterinarians specialising in avian pathology. Its initial objective was to detect the development of new diseases or syndromes (epidemiovigilance). Later, surveillance of the most important endemic diseases became the main objective of this broad-based and national network.

The RNOEA is in fact composed of two sub-networks; one comprising 35 sentinel veterinarians, the other composed of 27 diagnostic laboratories. These veterinarians and laboratories specialise in avian pathology; they are spread throughout France and participate on a voluntary basis. Every three months they receive a questionnaire from CNEVA, asking them to report their observations on defined as well as on rarely seen diseases. These epidemiovigilance networks are thus broad-based, sample-based, integrated within the usual client and diagnostic work, targeted at suspect animals and use active data collection methods. The resulting information is distributed in a quarterly bulletin by CNEVA in Ploufragan and is sent only to the participants.

**A focused epidemiosurveillance network**

The French epidemiosurveillance network for animal rabies started in 1968 (2), when this zoonosis reappeared in France. Its objectives are to monitor the evolution of the incidence of rabies in domestic and wild animal populations over the entire French territory and to evaluate the effectiveness of the control programme which has been implemented. This network is thus national.

Ideally, all rabies cases should be reported. In fact, only cases for which a field sample has been sent to the laboratory can be registered. This network is integrated because the laboratory analyses are associated with the diagnostic activities of the rabies control programme.

When a domestic or wild animal is suspected to have rabies, the head is sent by an officer of the Direction des Services Vétérinaires to the CNEVA in Nancy, as long as the animal has not infected a human being. Otherwise, it is sent to one of the three laboratories certified by the Health Ministry (the Pasteur Institutes in Lyons and Paris or the Strasbourg Laboratory). The CNEVA at Nancy receives monthly reports from these laboratories (this is a network with passive data collection) for analysis and interpretation. Distribution of the resulting information occurs through a monthly bulletin, which has been widely distributed without interruption since 1970, so that the evolution of the epidemiological status of rabies in France can be appropriately studied.

The reduction in the number of rabies cases registered from domestic and wild populations allows certain inferences to be drawn, e.g., on the effectiveness of the oral vaccination of foxes, which has been implemented in French territory for several years.

**Broad-based epidemiosurveillance networks**

The Animal Health Warning and Intervention Network of Quebec

The RAIZO Network of Quebec (11) was created in 1992 by the Quebec Ministry of Agriculture, and thus can be considered a regional (provincial) network.

On one hand, this network aims at monitoring numerous diseases recognised as important for Quebec (epidemiosurveillance), such as rabies in all domestic species, salmonellosis, scabies and varroosis of bees, bovine virus diarrhoea, and abortions caused by Neospora. On the other hand, its objective is also to detect the development of syndromes or important diseases (epidemiovigilance) which may require the intervention of veterinarians. It is, therefore, a broad-based network (11).

Clinical and laboratory data relevant to these diseases are collected by all practising veterinarians and diagnostic laboratories in Quebec, and sent to the central unit once a month. This network is thus exhaustive, it is integrated with the usual veterinary clinical and diagnostic work (thus targeted at suspect animals), and uses passive data collection. The resulting information is reported monthly to all participants.

The Health and Production Surveillance System in Denmark

The Health and Production Surveillance System (HEPS) (36) is a broad-based surveillance network for infectious and non-infectious swine diseases in Denmark. It aims to conduct descriptive and analytical studies.

HEPS includes two sub-networks. One is the Danish Pig Health Scheme (DPHS), created in 1982 by the Veterinary Authorities to collect health-related data at the abattoirs. After a few years, 97% of the entire pig population was under surveillance. This sub-network is therefore national, almost exhaustive, partly integrated (with disease control measures at slaughter), partly autonomous for specific investigations (e.g., serological surveillance of Aujeszky’s disease) and uses passive data collection. Indices of pathological lesions are calculated and, if a given farm is above a certain threshold, a disease control visit to that farm is proposed (36).

The other sub-network, created in 1989, is composed of sentinel veterinarians to complement the data collected at abattoirs. A sample of volunteer veterinarians, albeit
geographically representative, report health and production data every three months. This is, therefore, an integrated surveillance sub-network using passive data collection.

**Epidemiosurveillance systems**

The National Animal Health Monitoring System in the United States of America

Created in 1979, the Center for Animal Health Monitoring (CAHM) at Fort Collins (Colorado) manages NAHMS in the USA (7, 16, 17, 22, 24, 25). This system is composed of a team of epidemiologists, agricultural economists, statisticians and computer specialists.

The objectives of the NAHMS are broad and diversified, and aimed at the protection of animal and human health by collecting, analysing and diffusing information about the epidemiology and the economy of animal health and production. The analysts conduct not only descriptive but also analytical and modelling analyses. The NAHMS is broad-based and national. To fulfil its objectives, several networks have been developed, such as the Sentinel Feedlot Monitoring network (SFM) and the Veterinary Diagnostic Laboratory Reporting System (VDLRS), in addition to several specific studies such as the project 'Swine 95'.

The SFM network (16) consists of six sentinel veterinary practitioners who monitor 60 feedlots, comprising approximately 1.2 million head of cattle (i.e., about 15% of the national production from feedlots). These sentinel veterinarians send their observations on health problems, including causes of mortality, to CAHM in monthly reports. CAHM analyses these data and returns the information on a monthly basis. This network is therefore national, integrated with the routine work of the veterinarians, based on a selection of veterinarians and feedlots, and uses passive data collection.

The VDLRS is composed of 29 collaborating laboratories, located in 26 States. Each of these laboratories sends the results of the analyses conducted in disease control programmes to CAHM, as well as those results which concern a number of rare and serious diseases. Data collection is therefore passive, and the network is integrated with routine diagnostic work. The information is published three-monthly in a technical review.

The programme 'Swine 95' (17) was composed of a network of approximately 3,000 swine production units, and could almost be considered exhaustive as it covered 70% of the national population. Trained investigators collected a large amount of data regarding health problems, farm characteristics and management practices (nutrition, quality assurance, marketing). Blood samples were taken for serological studies (the building of a serum bank). These data were sent to CAHM to be processed for descriptive and analytical studies (risk factor analyses). Results were distributed to the swine producers. This network, which resembles a research network more than a true epidemiosurveillance network, is an example of an autonomous network with active data collection methods.

**The National Animal Health Information System in Australia**

Created in 1975, NAHIS in Australia (18) has the following objectives:

a) To acquire better knowledge of the disease control status of the Australian animal population. Twenty-one endemic diseases have been focused on, such as anthrax, bluetongue, infectious bovine rhinotracheitis, paratuberculosis, mucosal disease, ovine epididymitis (Brucella ovis), tuberculosis, etc.

b) To confirm freedom from disease status with regard to several defined diseases (epidemiovigilance). Fifteen exotic diseases were monitored, such as Aujeszky's disease, foot and mouth disease, rabies, maedi-visna, BSE, etc.

c) To demonstrate to international organisations that Australia has on hand an effective tool for the diagnosis and control of animal diseases.

This system is national, broad-based and has both the objectives of epidemiosurveillance and epidemiovigilance. It was initially aimed at gathering information from multiple sources but within this national system several epidemiosurveillance networks can be identified. These networks include the Northern Australian Quarantine Strategy (NAQS), which is a surveillance programme based on serological investigations at quarantine stations; the National Granuloma Submission Program (NGSP), which is a surveillance network for tuberculosis lesions at abattoirs, and the National Arbovirus Monitoring Program (NAMP), which is a surveillance programme for arbovirus through the sampling of sentinel animals in at-risk zones.

NAHIS is therefore based to a large extent on passive data collection, and is integrated with various national programmes.

**Conclusion**

Animal epidemiosurveillance networks are developing in many countries. The objectives of these networks and the methods used to implement them are numerous, as has been shown in this paper. The acquisition of valid and reliable information which is representative of the true state of animal health is a desired outcome shared by all these networks.

There are a great many epidemiosurveillance networks in animal health, so it would be difficult to describe each of them. Furthermore, only some have been described in the scientific literature. However, from the amount of published information, it appears necessary to develop a standardised method of description. The method of classification presented in this paper is based on the major characteristics of
epidemiosurveillance networks, and attempts to aid in future descriptions, comparisons and evaluations of different networks. It is hoped that this paper will contribute to the development of an evaluation grid.

The authors can only encourage the managers of specialised networks to share their experience in the scientific literature. This would also contribute to the necessary transparency of the surveillance methods used.

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Propositions pour une classification des réseaux de surveillance épidémiologique

B. Dufour & L. Audigé

Résumé
Avec la signature des accords du GATT (General Agreement on Tariffs and Trade) et la mise en place de l’Organisation mondiale du commerce (OMC), les règles régissant les échanges internationaux d’animaux et de produits d’origine animale ont été modifiées. Les mesures sanitaires ne peuvent dresser des barrières aux échanges qui si elles sont fondées sur des bases scientifiques et épidémiologiques. Dans ce contexte, il est devenu nécessaire d’avoir une connaissance précise de la situation épidémiologique des principales maladies animales infectieuses. Le rôle des réseaux d’épidémiowigilence des maladies animales est donc renforcé. Par ailleurs, l’épidémiosurveillance contribue à la protection des populations animales vis-à-vis des maladies exotiques ou nouvelles, ainsi qu’au développement et à l’évaluation des programmes de lutte contre les maladies. Malgré une grande diversité des réseaux d’épidémiosurveillance, un mode de classification des réseaux est proposé. Les critères de cette classification sont:
- le type de maladie surveillée (maladie exotique ou maladie endémique);
- le nombre de maladies concernées (réseaux focalisés ou globaux);
- l’aire géographique couverte (réseau régional, national ou international);
- la population surveillée (animaux suspects ou susceptibles);
- l’exhaustivité du réseau (sur la base d’un échantillon ou d’une population entièrement couverts);
- le mode de collecte des données (passif ou actif);
- le mode de fonctionnement (intégré à une action de lutte ou autonome).
Cette classification est discutée et illustrée par quelques exemples publiés. Elle peut servir au futur développement de grilles d’évaluation de la qualité des réseaux d’épidémiosurveillance animale.

Mots-clés
Propuesta de clasificación de las redes de vigilancia epidemiológica veterinaria

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Resumen
Con la firma del Acuerdo General sobre Aranceles Aduaneros y Comercio (GATT) y la creación de la Organización Mundial del Comercio (OMC), el marco para los intercambios internacionales de productos animales se ha visto modificado. Ya no es posible aplicar medidas de control sanitario a modo de barreras comerciales, a menos que estas medidas vengan respaldadas por datos epidemiológicos científicos.

En tal contexto, resulta cada vez más necesario, e incluso obligatorio, obtener un conocimiento preciso y actualizado de la situación epidemiológica de las principales enfermedades infecciosas de los animales. La función de las redes de vigilancia epidemiológica veterinaria está cobrando en este sentido una importancia creciente.

Por otro lado, la vigilancia epidemiológica contribuye a proteger a las poblaciones animales de enfermedades exóticas o de reciente aparición, además de ayudar a la creación y evaluación de programas de control sanitario.

Pese a la gran diversidad de redes de vigilancia que existen, los autores proponen un método para clasificarlas con arreglo a los siguientes criterios:
- tipo de enfermedad sometida a seguimiento (distinguiendo entre enfermedades exóticas y endémicas);
- número de enfermedades controladas (a través de redes especializadas o redes de tipo general);
- área cubierta (es decir, redes locales, nacionales o internacionales);
- población sometida al seguimiento (esto es, si la red se centra en los ejemplares sospechosos o en los animales sensibles);
- sistema de muestreo utilizado (redes basadas en muestreos o bien en análisis generalizados);
- método de obtención de datos (obtención pasiva o activa de los datos);
- tipo de gestión por el que se rige la red (es decir, gestión autónoma o gestión integrada en otros programas).

Tras algunas reflexiones sobre este sistema de clasificación se ofrecen ejemplos que lo ilustran, obtenidos a partir de bibliografía publicada. Este sistema puede resultar de ayuda en un futuro para elaborar una tabla de evaluación de las redes de vigilancia epidemiológica veterinaria.

Palabras clave
References


