Information and surveillance system of vesicular diseases in the Americas. Use of grid maps for monitoring, data collection and reporting

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Summary: Methods for collecting, recording and reporting epidemiological data on animal diseases were proposed. South American countries have used a quadrant system using geographical coordinates. Epidemiological information collected from local units by field veterinarians was recorded in code form and then transmitted to regional and national centres for analysis. Decisions in regard to surveillance and the prevention of animal diseases could then be taken.

This system essentially applies to foot and mouth disease and other vesicular diseases but cannot be applied to other animal diseases. Various examples are given to show the epidemiological advantages of such a system which is common to several countries.

INTRODUCTION

Veterinarians and epidemiologists of the national animal health services have been interested in the geographical distribution of animal diseases. In recent years veterinarians involved in foot and mouth disease (FMD) control programmes in South American countries have been concerned either with procedures for the collection and recording of animal disease distribution on maps to describe and summarize FMD occurrence as well as epidemiological patterns. Such maps provide evidence in support of hypotheses concerning the regional epidemiological behaviour of this disease (4).

The primary goal in this paper is to show experiences of South American countries in the development of mechanisms used to collect, record and report the spatial distribution as a basic component of the vesicular disease information systems. While developing of the methodology we tried to simplify the data collection processing on FMD and other vesicular diseases as much as possible to reduce the operational procedures to a minimum and to increase the reliability of FMD records.

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For this purpose we adopted a methodology based on subdivisions of the geographical maps for all countries according to the geographical coordinates. These subdivisions are called quadrants (3, 8). These map quadrants are the spatial unit for FMD collection, recording and reporting. Each quadrant is identified with a numerical code on the national, regional and local maps. The resulting lattice on the map is composed of quadrants with consistent size (5). After these quadrants have been established, any FMD episode notified is related to the respective quadrant for sequential steps (collecting, recording and communication).

The study of the spatial behaviour of many kinds of epidemiological events is basic for veterinarians and epidemiologists of the FMD control programmes. Much can be learned about the epidemiology of animal diseases by characterizing their patterns and having them represented on maps. Very often hypotheses are formulated on disease distribution related to the spatial behaviour of ecological, livestock and economical factors (9). These factors are instrumental in bringing about regional differences from an epidemiological point of view. The spatial aspects of these changes can be called epidemiological processes (regional characterization of a disease). It is helpful to consider these processes as tendencies for events occurring together in space (clustering) or spreading in space (diffusion). Any understanding of spatial process involves the inclusion of the time aspect, either explicitly or implicitly, and while time is continuous it is possible to recognize stages.

Consequently, we can characterize the disease behaviour in terms of the persistence of the disease (weekly, fortnightly or monthly) in quadrants of the map. Thus we might classify a persistent stage of any disease in one quadrant as endemic and an unpersistent stage as scarce or occasional (6).

**OPERATIONAL MECHANISM**

The actions which permit development of the information outputs should be implemented by operational components of the campaigns, consisting of the field administrative units already existing in the veterinary services, without adding new structures to the organization (1). The main components could be the following:

1. **Source of information.**

   The followings are among the main sources of information: farms, veterinary diagnosis laboratories, official veterinary services, quarantine stations, private veterinarians, livestock cooperatives, sanitary inspection in slaughterhouses, freezers and packing plants, dairy product plants, serum banks.

2. **Sensory mechanism.**

   This mechanism is formed of local or field veterinary units whose task is to collect the information and transmit it to receivers-users of the informa-
tion. The sensory mechanism mainly consists of the local veterinary units of the animal disease control programme. Each local veterinary unit is responsible for a well-delimited area and monitors the disease situation on a detailed map. Each local unit office has an office and an up-to-date list of ranches and farms in the area, giving location and the number of heads of cattle. The map is laid out in a grid system of numerically coded quadrants (see Fig. 2) which serves for communicating the occurrence of diseases to other levels of the veterinary service by transmitting the information according to the map coordinates (code).

The system provides means to transmit the information collected at service's lower levels through a very simple mechanism of phonograms, telegrams, radiograms or telex. The example given in Fig. 3 is taken from the working routine of the epidemiological information and surveillance system implemented in the State of Rio Grande do Sul, Brazil.

In each South American country the official veterinary services have a variable number of local field units for their FMD control programmes (Table I).

### Table I

**Number of the field informative units. Foot and mouth disease control programmes South American countries, 1981**

<table>
<thead>
<tr>
<th>Country</th>
<th>No. local units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>180</td>
</tr>
<tr>
<td>Bolivia</td>
<td>14</td>
</tr>
<tr>
<td>Brazil</td>
<td>943</td>
</tr>
<tr>
<td>Chile</td>
<td>68</td>
</tr>
<tr>
<td>Colombia</td>
<td>128</td>
</tr>
<tr>
<td>Ecuador</td>
<td>56</td>
</tr>
<tr>
<td>Paraguay</td>
<td>38</td>
</tr>
<tr>
<td>Peru</td>
<td>24</td>
</tr>
<tr>
<td>Uruguay</td>
<td>19</td>
</tr>
<tr>
<td>Venezuela</td>
<td>130</td>
</tr>
</tbody>
</table>

3. The receivers-users of the information.

Each user group utilizes the information according to its responsibilities, the type of decisions that should be made and the hierarchical level in the veterinary service.

At the operational level, the local veterinarian is the receiver-user of the information. At the strategic level (central unit of the veterinary services), a receiver-user of the information is an inter-disciplinary group that processes, analyzes and interprets the information and then prepares recommendations and options for solving eventual problems detected.
For operational decisions regarding measures to prevent the diffusion of a communicable disease, the information-gathering (sensing) unit and the decision-making unit (analysis-synthesis) are the same field veterinary unit (short-time loop for the successive steps: collection-analysis-decision-action).

Decisions involving strategic alternatives are developed at a multidisciplinary group at the central unit which systematically analyzes and interprets the results and formulates recommendations of the executives. Once the decision is made, it will be communicated to all the field units for implementation of the corresponding action (slower loop: information collection-analysis-decision-efferent information-action).

4. A communication network that links the sensory mechanism to the group of receivers-users.

The structure of the channels which convey the information about the occurrence of animal disease episodes of communication depends, among others, on the veterinary echelons and on the epidemiological status of each disease. In the South American countries these communication channels are customarily structured as shown in Figure 1.

**FIG. 1**

Channel of communication for diseases in endemic, occasional or disease free situations.

Figure 2 shows an example of the weekly communication functions (field unit-state laboratory-surveillance state unit-surveillance national unit) as used in Brazil.

The cablegram in Figure 3 provides information on the municipality of Bage (Brazil) for week 23, with coded information on occurrence of FMD, rabies, hog cholera, scabies and sheep lice (10). This information refers to the
FIG. 2
Grid maps for monitoring and data collection and reporting of animal diseases.
Bage, Rio Grande do Sul, Brazil.
ANIMAL HEALTH SERVICE STATISTICS GROUP, PORTO ALEGRE, RS

DURING WEEK NR-23 COMMA BAGE MUNICIPALITY COMMA 5 FMD EPISODES NOTIFIED 4 SYMPTOMATICALLY CONFIRMED COMMA FIELD REPORT FORM TO LABORATORY WITH SAMPLE 01971 STOP COORDINATES 34/34 COMMA 24/22 37/22 AND 31/31 STOP NO OCCURRENCE FOR RABIES COMMA HOG CHOLERA COMMA SCABIES AND SHEEP LICE STOP OUTBREAK PREVIOUS WITH SAMPLE MATERIAL COMMA FORM NUMBER 01702 STOP REGARDS.

code for the Bage map quadrants (coordinates) in which the episodes were detected as well as for the numerical code of the calendar week in 1980. The numerical code corresponding to the protocol data accompanying the samples to the laboratory is also given.

The Pan American Foot and Mouth Disease Center (PAFMDC) in Rio de Janeiro, Brazil is the international branch of the communication channels from each national FMD control programme in South American countries. An evaluation of the operation during the 1978-81 period of the collecting, recording and communication mechanism of the information system on livestock in South American countries was made with regard to a communication process between the countries and the PAFMDC with emphasis on (a) the timing of the receipt of national reports (weekly telexed to PAFMDC Data Bank) and, (b) the delay in the continental feed-back procedure through the Weekly Epidemiological Report, which is distributed to American countries and other receivers. The results are shown in Table II.

TABLE II

<table>
<thead>
<tr>
<th>Year</th>
<th>No. weeks</th>
<th>Reception</th>
<th>Feed-back</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Weeks received</td>
<td>Delay (mean, days)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No.(^a) (%^b)</td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>52</td>
<td>46.2 (89)</td>
<td>11</td>
</tr>
<tr>
<td>1979</td>
<td>52</td>
<td>50.3 (97)</td>
<td>11</td>
</tr>
<tr>
<td>1980</td>
<td>52</td>
<td>51.7 (99)</td>
<td>10</td>
</tr>
<tr>
<td>1981</td>
<td>53</td>
<td>50.8 (96)</td>
<td>10</td>
</tr>
</tbody>
</table>

\(^a\) Mean taking account all South American countries.

\(^b\) With respect to total number of weeks in which each year was subdivided, by the system.
PRODUCT OF THE SYSTEM

The countries of South America have organized epidemiological information systems for FMD control programmes which may serve as a starting point for other diseases. The success or failure of an animal disease control programme depends mainly on the quantity and quality of the information it is receiving, on its ability to discover changes and in particular on the timely forecasts of changes in the behaviour of the disease, as well as the orientation of action leading towards eradication of the disease (7). Some favourable results are given below:

1. Electronic or manual monitoring of FMD occurrence level in the quadrant map must constitute a priority concern of the veterinarians who administer FMD control programmes. Any omission, delay or lack of continuity in that function will have an impact on the programmes, reducing their control effectiveness. Until a short time ago, this activity was assigned a secondary importance and the necessary attention to this activity was only given when epidemic situations occurred.

The timely and adequate use of information through indicators that sense epidemiological behaviour enables these disease occurrences to be kept under surveillance. For monitoring the behaviour of the diseases, the central unit of the veterinary service is informed of the occurrence through a system of weekly telex communications from each of the local veterinary units. Each local unit has a grid map laid out according to the geographic coordinates. The telex indicates the code number of the quadrants where the occurrence of a disease is recorded during a given week. At the central unit this information is transferred weekly to the state or national map. In this way it is possible to characterize the spatial distribution of the disease each week, analyze the information and monitor the modifications of disease behaviour with time.

The spatial distribution of FMD can hardly be regarded as being of a typically random nature. In fact, its occurrence in an area increases the likelihood that it will occur in nearby zones. This is a property of the spatial distribution of communicable diseases forming clusters in space, groupings of affected units, whether referring to diseased animals or herds, or map quadrants where the disease appears. It is basic for those engaged in FMD control activities to study the manifestations of the spatial processes that result from opposite tendencies such as clustering and dispersion.

Figure 4 illustrates the application of the indicators (2) which provide a weekly summary of the FMD spatial distribution in a map grid of the Rio Grande do Sul State. When the affected map quadrants are considered regardless of the number of the affected herds, the following indicators can be used:

(a) 'H' the FMD affected area of the map;
(b) 'IC' the conglomerate of the affected quadrants in regions of the map.
When the map of the state of Rio Grande do Sul is considered according to geographical coordinates, a significant number of affected quadrants appear in the southwest sector during week No. 25. During week No. 27 the placement in the south is least evident but the placement in west is more pronounced.

2. Map quadrant studies can also be used to delimit the unaffected and low-affected regions for each animal disease and establish the operational indemnity and alarm mechanism and the respective protection procedures.

For this purpose the PAFMDC uses a PDP11/34 computer. The programme produces a report with the history of each quadrant infected in a particular week. For example, in the case of Brazil, when the information of quadrants affected in week No. 29 of 1982 was entered, a history of the epidemiological situation of these quadrants was obtained. It showed immediately that the disease appeared in quadrant No. 1071 for the first time:

<table>
<thead>
<tr>
<th>Quadrant</th>
<th>Year</th>
<th>Week</th>
</tr>
</thead>
<tbody>
<tr>
<td>1071</td>
<td>1982</td>
<td>29</td>
</tr>
<tr>
<td>1172</td>
<td>1979</td>
<td>42 - 45</td>
</tr>
<tr>
<td>1172</td>
<td>1981</td>
<td>27</td>
</tr>
<tr>
<td>1172</td>
<td>1982</td>
<td>18 - 20 - 25 - 29</td>
</tr>
</tbody>
</table>
This way it is possible to maintain the surveillance of the ‘free’ quadrants and it is also possible to report an alarm when these quadrants become affected. Also a warning can be given when the disease occurs in quadrants which were free for a certain period.

3. The system also serves to characterize the ecosystems of the disease. The study of the level of risk with regard to the occurrence of FMD in geographical subdivisions such as the quadrants in the animal population is a priority concern of the veterinary services in charge of the FMD control programmes.

FMD in the South American continent in general occurs in the endemic form. However, this endemicity is not uniform with regard to geographical distribution and it is possible to observe differences in time in several regions. In certain areas FMD is persistent all the time (endemic region), in other areas the occurrence is occasional (paraendemic regions or regions with sporadic occurrences). Finally, some regions can be considered free of the disease. In the endemic regions the persistence with time shows at least two forms: (i) regions with uniform persistence with time; (ii) regions where the persistence presents a certain regularity in time, that is, there are certain periods of the year in which the disease occurs more frequently. These levels of endemicity are shown in Fig. 5.

‘Regional models’ of FMD and other diseases can be elaborated once a chronological series of occurrences registered for various years is available for FMD in quadrants/week, and could provide important operative support for the epidemiological surveillance not only for FMD but for all other acute animal diseases.

On the basis of the information acquired through the weekly quadrant reports it is also possible to evaluate the global level of endemicity of the disease in a country and thus evaluate eventual changes which occur within long periods of time. In Fig. 6 a global indicator of endemicity in four South American countries is presented. Indicator λ is derived from statistical elaboration of the weekly quadrant reports. It can be said that when the curve in Fig. 6 is more ‘oblique’ there is a lower level of endemicity in a country. This procedure serves to evaluate the immediate effects of the control programmes in each country. However, this graph does not imply a comparison between countries because of some differences in the methodology between countries.

4. Finally, through the use of quadrants the characterization of the livestock population is important to recognize the sources and means of diffusion of the disease.

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REFERENCES

(see page 737)
FIG. 5
Regional characterization of FMD. Brazil, 1981.
FIG. 6
Endemicity levels. FMD, 1981.