An integrated web system to support veterinary activities in Italy for the management of information in epidemic emergencies

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A R T I C L E   I N F O

Article history:
Received 6 May 2013
Received in revised form 7 January 2014
Accepted 10 January 2014

Keywords:
Animal health
Animal disease outbreaks
Early detection
Modelling
Network analysis
Risk maps
Surveillance system

A B S T R A C T

The management of public health emergencies is improved by quick, exhaustive and standardized flow of data on disease outbreaks, by using specific tools for data collection, registration and analysis. In this context, the National Information System for the Notification of Outbreaks of Animal Diseases (SIMAN) has been developed in Italy to collect and share data on the notifications of outbreaks of animal diseases. SIMAN is connected through web services to the national database of animals and holdings (BDN) and has been integrated with tools for the management of epidemic emergencies. The website has been updated with a section dedicated to the contingency planning in case of epidemic emergency. EpiTrace is one such useful tool also integrated in the BDN and based on the Social Network Analysis (SNA) and on network epidemiological models. This tool gives the possibility of assessing the risk associated to holdings and animals on the basis of their trade, in order to support the veterinary services in tracing back and forward the animals in case of outbreaks of infectious diseases.

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1. Introduction

In epidemic emergencies, an efficient management of outbreaks of animal diseases can be obtained only if the competent authority has access to updated and reliable information. In such situations, a quick generation and processing of information is required for a timely and efficient delivery of control and eradication activities. The impact of emerging diseases can be minimized through a well-prepared and strong surveillance system (Merianos, 2007).

The main challenge faced by surveillance systems is the ability to expedite the process of collection and analysis of data. Following the confirmation of an outbreak of a contagious animal disease, a pressing question is the identification of the most likely sources of infection and of the animals that might have further spread the disease. The efficiency of surveillance systems in case of epidemic emergency is strongly dependent on the efficiency of their underlying information systems. The efficiency can be increased by using specific software for data collection and analysis to provide the competent authorities with tools for better focusing the surveillance activities and the disease control measures. Information systems are the crucial tool for making information available for risk analysis.

Also in the absence of infection, surveillance systems and information systems are indispensable tools for the veterinary services. From one side, the probability of introduction of infectious diseases in different geographical areas and the likelihood of spread after an incursion need to be assessed, and this assessment depends on the existence of early warning systems. On the other side, the absence of
a disease in a given territory needs to be demonstrated and documented for trade purposes.

Several information systems have been developed at international and national levels, with the aim of helping the veterinary services in the prevention and management of epidemic emergencies.

At the international level, the World Animal Health Information System (WAHIS) of the World Organisation for Animal Health (OIE) is the reference for all national or regional systems. Through its web interface and e-alert system, WAHIS collects and disseminates a large quantity of information on animal disease outbreaks occurring worldwide (Ben Jebara, 2007).

In the European Union, the Animal Disease Notification System (ADNS), instituted by the Council Directive 82/894/EEC (subsequently amended by Commission Decision 2008/650/EC), provides the rapid exchange of information on outbreaks of contagious animal diseases between the national authorities competent for animal health and the Commission. The system allows the coordination and monitoring of outbreaks of contagious animal diseases and enables Member States and Commission services to take immediate measures to prevent the spread of the diseases in question.

Detailed information on each outbreak in a Member State of an infectious disease in animals, listed in Annex I of Council Directive 82/894/EEC, is sent by the Member States to the European Commission via the Animal Disease Notification System (ADNS). A weekly (every Friday at 3:30 pm) e-mail message is sent to all the ADNS members summarizing all primary and secondary outbreaks that have been entered into the system. However, when the first outbreak of a contagious animal disease occurs (i.e. classical swine fever or foot-and-mouth disease), the situation has to be considered extremely urgent. In some cases, due to the fast spread of some diseases, the reaction has to be immediate. For this reason round the clock control on these notifications is needed. In view of this, the Head of Unit in the Directorate General for Health and Consumers (DG Sanco) can be contacted via GSM/mobile telephone and in case of disease outbreaks, the Head of Unit and/or other colleagues can then come to the office to cover the epidemic event.

The on-going evolution of ADNS is the development of an Animal Disease Information system (ADIS), compatible with the World Animal Health Information System (WAHIS) of the World Organisation for Animal Health (OIE), providing key information to the general public on the animal health situation in Europe. The implementation of this new system started in 2009 and is now in the transition stage, to ensure that the software is available for its end users (Mesman, 2011).

At the national level, in Italy the veterinary services have at their disposal a variety of disease specific and non-disease specific information systems.

Examples of disease specific systems in Italy are the sentinel system for the early detection of the circulation of bluetongue virus (BTV) (Giovannini et al., 2004, 2008; Savini et al., 2007; Conte et al., 2005) and the surveillance system for West Nile Disease (WND) virus in wild birds for early detection WND virus circulation (Calistri et al., 2010).

A non-disease specific system is the Information System for the notification of animal diseases (SIMAN), which collects data on outbreaks and has been in place since 2008. This system was developed in Italy by the Istituto Zooprofiliattico Sperimentale dell’Abruzzo e del Molise “G. Caporale” (IZSAM) to collect and make data available to the national veterinary services, and to dispatch data on outbreaks to the international Authorities (European Commission and OIE).

The computerization of the Italian notification system was the first step for the quick generation and processing of information required for a timely and efficient delivery of control and eradication activities. As a further improvement of this system, a web application for the tracing of animal movements between cattle herds has been recently developed. This application, called EpiTrace, extracts information on holdings and animal movements from the National Animal Database and is based on the Social Network Analysis (SNA) and on network epidemiological models (Duncan et al., 2012; Martinez-Lopez et al., 2009; Wasserman and Faust, 1994). It has been developed at the IZSAM in collaboration with the Institute for the Protection and Security of the Citizen of the European Commission (Natale et al., 2009, 2011).

The aim of this paper is the description and evaluation of the integrated system produced by the incorporation of the tracing utilities (EpiTrace) in the National Animal Database of Animals and Holdings (BDN) and the Information System for the notification of animal diseases (SIMAN).

2. Description of the integrated system

2.1. SIMAN

SIMAN has been designed to collect data on notification and follow-up of outbreaks of animal diseases and makes them available and analysable to the veterinary services all over Italy. Several tools for data analysis have been incorporated into the system. The structure of the system is described in detail in Colangeli et al. (2011).

In case of outbreaks, the Ministry of Health, using SIMAN, is able to immediately report to the European Commission through the Animal Disease Notification System (ADNS) and to the OIE’s WAHIS all information requested by each system.

SIMAN has been designed to report data on outbreaks for all the OIE listed diseases. In other words, since not all OIE listed diseases are subject to notification to ADNS, this means that SIMAN has already implemented one of the functions foreseen for the future ADIS system of the European Union. In addition, the authorized users can download reports showing the updated situation of the infected holdings, including the number of susceptible, infected, sick, dead, slaughtered/killed and destroyed animals.

Recently, the SIMAN website has been updated with a dedicated section for the contingency planning in case of epidemic emergency. In particular, it is possible to look at each component of the contingency. More in depth, the plan describes the organization of the national centre for animal disease emergency management of the Ministry of health and its tasks. Moreover, the plan provides a detailed
of the different steps to put in place by the national centre for animal disease emergency management and by the regional and local veterinary services, identifying and planning the activities, partnerships, procedures and all the measures to be applied during both the routine and the emergency activities to protect the public health, improve animal health and reduce the risk of spread of animal diseases. The aim is to provide unique intervention protocols to be adopted in the whole country that allow the rapid identification of the source of infection and the implementation of all measures necessary to a rapid extinction or containment of infection.

Another tool included in the system is the assisted compilation of an epidemiological investigation report. Given a certain herd, the system automatically accesses the BDN and fills all the fields concerning the ownership, the animal populations registered in the holding, the other holdings belonging to the owners of that herd, all animal movement recorded from and to the herd in a given timespan. The veterinarian can input the other information required into the relevant fields presented by the tool.

Besides the production of the reports required by the international competent authorities (European Commission and OIE), already foreseen among the functions of the system, SIMAN has also been designed to provide automatically the annual report on the health status of livestock and is the source of information and data for the National Veterinary Epidemiological Bulletin. Finally, SIMAN has been designed to produce reports and interactive thematic maps using the WebGIS application (see Figs. 2–10 in the Supplementary document S1).

Further developments of SIMAN have been the integration of the veterinary legislation and the contingency plan for epidemic emergencies. In a dedicated section of SIMAN the epidemiological investigation model, the ordinance of establishment of protection and surveillance zones, and other documents related to each phase of the emergency can be downloaded. Moreover, all the phases and the roles played by the actors of the emergency plan are described in detail.

2.2. EpiTrace

The other tool, EpiTrace (https://www.vetinfo.sanita.it/p_epitrace/), integrates the application of Social Network Analysis (SNA) and network-based epidemiological models in relation to livestock movements (derived from BDN), giving the possibility of quickly and more efficiently performing automatic trace-back and trace-forward activities, aimed at identifying the possible origin of a disease outbreak and possible secondary outbreaks. EpiTrace also assesses the risk associated to all relevant holdings on the basis of their trade patterns. In this way, the veterinary service can plan the inspections of herds in contact with the outbreak according to their level of risk, so expediting the process of disease control and eradication.

More in depth, EpiTrace performs the following activities:

- It ‘downloads’ livestock movement data by querying BDN remotely and in real time and also allows an interactive graphical exploration of the resulting networks (either backwards or forwards in time, with respect to the suspect date of infection of a farm) (Fig. 1a and b).
- It ‘runs’ two different network-based epidemic models in order to evaluate the different roles of holdings in respect of disease spread (Fig. 2a and b).

It is possible to dynamically explore a network, using a local application for network visualization.

This exploration, by estimating various centrality measures for each node (holding) of the network can provide a classification of the vulnerability and the risk posed by each holding to the entire system. This classification may be used as an objective scale of priority for risk-based surveillance activities. More in depth, the movement of animals between premises can be represented as a network where the premises of origin and destination of the movement are defined as nodes and the movements of animals between premises are defined as relations or edges. In this type of network edges have a direction from the holding of origin to that of destination and the weight of the relation may be quantified on the basis of the number of animals moved. The movement of animals along the edges of the network represents a major source of contact between populations of animals in the premises of origin and destination and can be considered as a path for the diffusion of a disease, in particular when infectious diseases transmissible by direct contact are considered (Konschake et al., 2013; Dubé et al., 2011; Danon et al., 2011; Keeling and Eames, 2005).

For each node the following centrality measures are calculated: the “degree”, the “in-degree”, the “out-degree”, the “closeness” and the “betweenness”. The “in-degree” and “out-degree” consider the number of times a node is the potential responsible of the infection of a neighbouring node evaluating the in-coming and out-coming movements respectively. Highly central nodes in term of their outgoing movement may also be highly central in terms of incoming movements. The “closeness” value considers the distance between a node and all other reachable nodes. A disease spreading from a node with high “closeness” value would reach all other connected nodes in a shorter number of steps. The “betweenness” centrality is computed as the number of shortest paths of the network that pass through a node divided by the number of shortest paths of the network (Freeman, 1977). In terms of infection spreading a node with high “betweenness” value, has a high probability to be traversed by a disease (Natale et al., 2009). The centrality measures, previously listed, are calculated to analyse a static network. Real-world networks are never static and the connections between nodes are strictly dependent on the time. The measures of centrality in a static network do not take into consideration the proper timing necessary for the spread of a disease along the subsequent edges forming a path. In other words, a connection between nodes B and C, followed in a subsequent time by a connection between nodes A and B give rise, in a static network, to the same values for the centrality measures as a connection between nodes A and B followed by a connection between B and C. This first set of connections, in the real world, would never produce the spread of the disease from...
A to C. This is only possible if a correct time sequence (A → B → C) is respected. To overcome this problem, the Disease Flow Centrality (DFC) measure represents the ideal solution because it takes into account the dynamic nature of the network of the animal movements and not only the position of the node with respect to the entire network (as in the classical betweenness of static networks). These DFC values are highly unstable over time since a node may be in a strategic position for controlling disease flow only within a specific time window, after which it may cease to play any significant role.

In countries where systematic notification of animal movements is foreseen, the DFC values provide veterinary authorities with useful information for targeting preventive and control measures in the case of diseases transmissible by animal movement (Natale et al., 2011).

EpiTrace is a utility that allows to quickly extracting from the BDN all animal movements chains originating from or ending to a specified holding (e.g. an infected holding), during a specified time period. These contacts are represented as a network and details about the identity of premises and the dates and number of animals transported are also visualized by the application. EpiTrace can be used interactively, querying the database of animal movements in real time and expanding or focusing the portion of the database submitted to analysis or the time scope of the analysis (Natale et al., 2009). Now EpiTrace is integrated
into the BDN, including a search engine, which calls a web service, and a Java applet for the visualization of the network of movement data. Epidemic simulations may also be performed. EpiTrace may run two different network-based epidemic models in order to evaluate the different roles of holdings in respect of disease spread:

- The first epidemic model is a generic network traversal, mirroring a disease flow (Disease Flow Centrality – DFC) model. The DFC model takes into account the temporal dynamics of the livestock trade relations and reflects a disease flow process on a dynamic network. The calculation of DFC is based on the idea of traversing a network and counting the number of times each node (holding) is reached or traversed (‘vulnerability measure’), or the number of times that it is at the origin of this process (‘risk measure’ in spreading the disease) (Natale et al., 2011).
- The second model is a state transition model without vital dynamics (meta-population model) based on the three compartments Susceptible–Infected–Removed (SIR). In the case of the SIR meta-population model, the epidemic spread in the network is modelled on the basis of specific disease parameters, using a combination of a component describing the epidemic dynamics at the single premises level (intra-population) and a transport component, describing the movement of animals (possibly including infected animals) within the network structure (inter-populations) (Natale et al., 2009).

2.3. Methods for evaluation of the system

The system was evaluated considering its performance at three different levels:

1. The collection of outbreak data and the output produced on the presence and distribution of animal diseases (SIMAN component of the system). To evaluate this component, a vector-borne disease has been taken as an example.
2. Acceptance of the system by the intended users. Given the complexity of the system, given its dependence on a proper feeding of relevant data, and given the lack of a previous system with similar functions, the evaluation of SIMAN cannot be based on a comparison with any kind of “gold standard” or with the performance of an already existing system. Before the implementation of SIMAN, regional systems existed, many of them based on paperwork, and the flow from the regional to the central level concerned only aggregated data. Among the objectives of SIMAN, in addition to a more efficient, more detailed and timely flow of data to the central level was that of providing the local and regional services with a tool useful for their daily activity. Therefore, the evaluation of SIMAN was based on its acceptance by the peripheral users, measured by their access to the various sections of the website and by the changes with time of the number of accesses.
3. The tool to assist the veterinary services in the investigation of disease outbreaks (EpiTrace component). The DFC model in EpiTrace component has been evaluated, using an investigation of a real-life outbreak of disease as an example. Since EpiTrace is still a beta version, it is under trial to be optimized, therefore its ease of use by field veterinarians was not evaluated. This evaluation will be performed as soon as EpiTrace will be in its definitive version.

3. Results

3.1. Evaluation of the system put in place – SIMAN

SIMAN is available on the website of the veterinary information systems of the Italian Ministry of Health (https://www.vetinfo.sanita.it), together with BDN and other National Information Systems.

SIMAN is accessed by veterinary services of the local and regional levels, National Reference Laboratories, Italian Ministry of Health and Public Health Institutes.

3.1.1. Collection of outbreak data and the output produced on the presence and distribution of animal diseases (SIMAN component of the system)

This part of the system was evaluated using the outbreaks of West Nile Disease as an example.

Through SIMAN, real time data were available and immediately accessible to local and national authorities in a unique and integrated information system. Since the first reported case of WND in 2008, SIMAN rapidly became an essential tool for the management of both WND surveillance activities and in case of outbreaks.

The system helped the veterinary services to perform epidemiological analyses, which are essential for WND surveillance and control: more in depth, SIMAN collected data related to all the components of the WND national programme, including those coming from the surveillance activities carried out on wild birds and mosquitoes. Regarding the outbreaks, the system allowed the veterinary services to manage all the activities to be put in place during an outbreak, from the epidemiological investigation to the data reporting. In addition, thanks to the tools integrated in SIMAN, the veterinary services were able to collect data and report information on suspected and confirmed outbreaks by a web interface, instead of paperwork, in the framework of the e-government process, which is being implemented throughout the Italian public administration. Examples of the outputs provided by SIMAN are available at the supplementary document S1.

3.1.2. The access to the components of SIMAN by the final users and the inclusion of the system in the national legislation (General evaluation of the system and of its acceptance by the intended users)

3.1.2.1. General description of the users of the system and their accesses. The number of registered users of SIMAN subdivided by territorial competence and privileges of the user are shown in Table 1. Overall 80% of the users are field veterinarians working at local level (Local Health Units) and almost all of them are providers of information to the system. At higher territorial levels, most accounts are only passive users, which consult without feeding the system.
Table 1
Number of registered SIMAN users subdivided by territorial competence and privileges of the user.

<table>
<thead>
<tr>
<th>Territorial competence</th>
<th>Total number of users</th>
<th>Privileges</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Read only</td>
</tr>
<tr>
<td>National</td>
<td>63</td>
<td>36</td>
</tr>
<tr>
<td>Regional</td>
<td>59</td>
<td>48</td>
</tr>
<tr>
<td>Regional Laboratories</td>
<td>31</td>
<td>30</td>
</tr>
<tr>
<td>National Reference</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Centers and Laboratories</td>
<td>660</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>815</td>
<td>156</td>
</tr>
</tbody>
</table>

The geographical subdivision of users is shown in Fig. 3. Most regions have less than 5% of the total number of users (the Italian regions are 21, therefore the expected relative frequency per region would be about 5%), one region (Calabria, the toe of Italy) has 5.7% of the total users, Lombardy (the northernmost region) has 10% of users, Lazio (the region on the west coast of central Italy) has 11.3% of users, Sicily (the southernmost island) has 19.3% of users, and Campania (the darkest region on the west coast of southern Italy) has 28.2% of users. The high frequency of southern regions with high number of users (Campania, Calabria and Sicily) is due to the obligation of these regions to provide detailed information on the eradication programme for bovine and small ruminants brucellosis and bovine tuberculosis. Central and northern Italian regions are almost all officially free from these diseases and are not obliged to provide the same amount of information requested to the southern infected regions.

The total number of monthly accesses to SIMAN in the first semester 2012 ranged from a minimum of around 1000 to a maximum of around 1700. The reasons for these accesses, expressed as the number of visits to the various sections of the system are summarized in Table 2. About 60% of accesses are made to upload data or information to the system; the remaining 40% are made for consultation. Only about 1.3% of accesses are made for mapping of infected holdings, of buffers, listing of holdings in a buffer (Web-GIS utility). The most frequent reason for consulting the system (28% of all accesses) is to perform statistical queries or to print reports, forms and standardized lists of dispositions given to the owner or the animal keeper in case of outbreaks of notifiable diseases. The second most frequent reason for consultation is the querying on laboratory results (7%).

Table 2
Relative frequency of accesses to the various sections of SIMAN.

<table>
<thead>
<tr>
<th>Section</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uploading of notification and update of outbreaks data</td>
<td>55.98</td>
</tr>
<tr>
<td>Statistical queries and print of reports, forms and dispositions in case of outbreaks</td>
<td>27.65</td>
</tr>
<tr>
<td>Querying on laboratory results</td>
<td>7.22</td>
</tr>
<tr>
<td>Query of data on holdings and herds</td>
<td>2.47</td>
</tr>
<tr>
<td>Uploading of information in XML format (mainly laboratory results data)</td>
<td>2.30</td>
</tr>
<tr>
<td>Compilation and update of epidemiological investigation data</td>
<td>1.45</td>
</tr>
<tr>
<td>Mapping of infected holdings, of buffers, listing of holdings in a buffer, etc. (Web-GIS utility)</td>
<td>1.28</td>
</tr>
<tr>
<td>Consultation of online help</td>
<td>1.05</td>
</tr>
<tr>
<td>Uploading of notification of disease cases in wild and synanthropic animals</td>
<td>0.38</td>
</tr>
<tr>
<td>Consultation of legislation and other relevant documents on diseases</td>
<td>0.22</td>
</tr>
</tbody>
</table>

3.1.2.2. Time evolution of the use of the system by peripheral veterinary services. The system started as a voluntarily adopted information system. It was first implemented in 2008, and it was voluntarily used by the veterinary services until August 2013, when the Ministry of Health made its use mandatory.

The assessment of its acceptance, therefore, has been based on the evaluation of the evolution of accesses to the system during the calendar years 2009–2012. Data for 2013 cannot be used to assess the acceptance by the users for two reasons: (1) it became mandatory and this would bias the number of accesses, and (2) a new epidemic of bluetongue started in Italy, with a dramatic increase of the number of outbreaks and a change of the pattern of use of the system by the veterinary services. The evaluation of this change of the pattern of use will be possible only after the epidemic phase of this emergency will be over and the use of the system will be stabilized again.

The number of outbreaks notified to SIMAN by year from 2009 to 2012 is shown in Fig. 4.
Since it is not yet known the level of use of the system during the years, the evaluation of the accesses to SIMAN has been assessed as number of accesses per notified outbreak. In Table 3, the accesses to the various pages of SIMAN divided by the total number of outbreaks are shown by year.

The most relevant sections of SIMAN are those concerning:

- • Uploading of notification and update of outbreaks data.
- • Compilation and update of epidemiological investigation data.
- • Uploading of information in XML format (which mainly concerns laboratory results data).
- • Statistical queries and print of reports, forms and dispositions in case of outbreaks.
- • Querying on laboratory results.
- • Mapping of infected holdings, of buffers, listing of holdings in a buffer, etc. (WebGIS utility).

These sections are concerned with the uploading and downloading of data relevant for the epidemiologic management of outbreaks. The other sections are mainly service sections (consultation of online help, legislation, etc.) and are not directly related to the management of outbreaks.

For all accesses to the relevant sections, with the only exception of the section on mapping, an increase (between 1.52 and 4.03 times) can be noticed in the number of accesses by time. The assessment of epidemiological investigations is interesting since investigations of notifiable diseases do not all have the same relevance. The number of epidemiological investigations made with the support of SIMAN procedures, for bovine and for sheep and goat brucellosis doubled (from 23% to 46% of notified outbreaks) from 2011 to 2012. In the same two years, the number of epidemiological investigations increased from 20% to 36% of notified outbreaks in case of bovine tuberculosis, from 0% to 20% for salmonellosis in the various domestic species, from 4% to 23% for enzootic bovine leucosis, from 0% to 67% for bluetongue. In 2012, 94% of notified outbreaks of Schmallenberg disease were investigated using SIMAN procedures.

The acceptance of the system by the users is also demonstrated by its adoption by the Italian Government on August 19, 2013 as the sole official system for outbreak notification (Italian Veterinary Epidemiological Bulletin, 2013).

3.1.3. The tool to assist the veterinary services in the investigation of disease outbreaks (EpiTrace component)

The DFC model in EpiTrace component has been evaluated, using an investigation of a real-life outbreak of bovine brucellosis as an example. The use of EpiTrace allowed identifying the likely source of infection, which sent animals to the investigated farm with an intermediate passage through a collecting centre. A further complicating factor was that the infection was very likely due to a cross-reacting agent, therefore the identification of the source of infection required to integrate movement data with those on the qualification of holdings for brucellosis and with the laboratory results. Notwithstanding the complexity of the problem, all the investigation activities were performed in one single working day, whilst their completion using traditional methods (even if based on computer recorded data) without the help of EpiTrace would have required several working days. The details of the investigation are described in Supplementary document S2.

4. Discussion

Any tool helping for better focusing the surveillance actions is fundamental, and the identification of points at major risk for the introduction and spread of infectious diseases has become a priority. The epidemiological analysis of the available data on animals' trade allows estimating the probability of introduction and spread of infectious diseases in different geographical areas. Similarly, the immediate notification to the competent authority of information related to the onset of suspected outbreaks of animal diseases is essential for implementing control measures. Efficient information systems, therefore, must
be in place to assist the veterinary services in case of epidemic emergencies.

In case of epidemic emergency the accuracy and the quickness of the information transmitted at national and international levels is of fundamental importance:

- The command chain must be as short as possible, with a clear distribution of competence and activities, and there will be a need for well-trained personnel, appropriate equipment, adequate diagnostic materials and consistent financial resources in order to put in place an efficient surveillance system, able to prevent the spreading of the disease.
- The use of SIMAN shortens the command chain as data are inputted by local veterinary services and diagnostic laboratories, and are immediately available at regional and central levels, without the need for specific transmission activities (be their paperwork or e-mails).
- This shortening of the command chain is obtained not only for ex-list A diseases, but also for chronic and endemic diseases. This allows the regional and central authorities to perform more efficiently their tasks of supervision of the peripheral activities and allows detecting more quickly possible situations of widespread risk.

The risk of introducing infectious disease agents into Italy is very high, due to the geographical location of the country and the regular import of large quantities of animals and animal products. Many of the OIE ex-list A diseases have either never been detected in Italy or have been eradicated and the use of vaccines prohibited. As a consequence, if introduced into Italy, these infections could spread very rapidly, since animal populations are fully susceptible. The consequences of outbreaks for animal welfare, livestock production, export of animal products, and in some cases, public health and the environment, could be very serious. Therefore, the need for rapid diagnosis and timely action in the case of an outbreak is of paramount importance to protect animal production, disease-free status and public health (Bellini et al., 2000).

In addition, SIMAN helps the veterinary services in carrying out epidemiological analysis, which are essential for surveillance and control of a wide range of animal diseases.

EpiTrace application intends to help veterinarians in epidemiological investigations in case of outbreaks of infectious disease, promptly extracting the data on animal movements from the BDN and presenting them as a network, in the best way for the consequent epidemiological analyses. In other words, EpiTrace web application allows the prompt visualization of all direct and indirect links of a specific herd in a given period of time. The application accesses in real time the data stored in the BDN and, used together the other tools in the website of the veterinary information system is able to assist the official veterinarians at central and local levels to perform outbreak investigations. It has proven its effectiveness and efficiency when used to trace the origin of infection in case of a suspected bovine brucellosis outbreak.

EpiTrace was able to reduce the brucellosis tracing work from several days to one day. In this way, it increased the performance efficiency. EpiTrace is a relatively expensive integrated IT component, but its future widespread use will largely compensate its cost through a reduction of days-wages. The increased efficiency given by EpiTrace perhaps has no effect on the disease consequences in case of a chronic disease like brucellosis, but this increased efficiency will possibly be invaluable in case of outbreaks due to faster moving diseases.

EpiTrace is still a tool difficult to use by a field veterinarian, therefore its use is now only restricted at the central level. Furthermore, since most diseases of the ex-list A are exotic to Italy, the testing of the performance of EpiTrace with these diseases had to be made by the use of simulations. Testing of EpiTrace with real world data are on-going for endemic diseases.

The next steps of implementation will be a testing of EpiTrace as full as possible, and the improvement of the integration of EpiTrace with the other information systems of the veterinary information website (www.vetinfo.sanita.it), to obtain a more efficient use of all modules for outbreaks management and epidemic emergencies and to allow the release of a user-friendly version of EpiTrace, easily accessible also by field veterinarians. Therefore, at the end of this experimental phase, all activities performed for the investigation shown in the Supplementary document S1 will be possible using a single integrated and user-friendly interface.

Moreover, it will be necessary to evaluate the reasons of the low level of use of the GIS module, which theoretically is a fundamental tool for all epidemiological activities.

In conclusion, SIMAN (which also includes EpiTrace among its functions) has been proposed to the Parliament as the sole official system for outbreak notification (Italian Veterinary Epidemiological Bulletin, 2013).

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Table 3
Frequency of accesses to the various sections of SIMAN/number of outbreaks, subdivided by year.

<table>
<thead>
<tr>
<th>Section</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uploading of notification and update of outbreaks data</td>
<td>0.71</td>
<td>1.8</td>
<td>2.78</td>
<td>2.86</td>
</tr>
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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.prevetmed.2014.01.015.

References


