Sylvatic rabies epidemic in Italy: implementation of a data management system to assess the level of application of preventive dog vaccination

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After 20 years of absence, rabies re-emerged in wild animals in north-eastern Italy in October 2008. Besides measures undertaken to fight the spread of infection in wildlife, vaccination against rabies was made compulsory for dogs living in the risk area. In the last 15 years, the veterinary authorities have focused on implementing computerized data collection systems in animal health, to serve as working tools for epidemiological surveillance activities and emergencies management. The prerequisite for implementing any data collection system is knowledge of the animal population. This also applies to the Canine Registry Data Bank, in which data on dogs and their movements, together with personal data on each owner and keeper, have been stored since 2003. The management information system has been updated and specific functions have been integrated in order to support the activity of both the veterinary services and the veterinary practitioners involved in the dog vaccination program. Vaccination became voluntary in February 2013. This paper describes implementation of the software and organization of data gathering, highlighting the benefits of computerized data compared to previously used paper-based data collection systems. The new functions, designed to centralize collection of uniform, updated vaccination data, have led to more efficient organization and better control of the vaccination plan. Automated information processing allowed vaccination operations to be supervised, incurred costs to be calculated, and vaccination coverage of the dog population to be monitored during the 3 years of compulsory vaccination.

Keywords: Rabies, Vaccination, Dog, Information system, Italy

Introduction

Canine rabies has been eradicated from industrialized countries over the last 60 years¹ by a process of dog control. Since 1973, the WHO Expert Committee on rabies has recommended compulsory dog vaccination in combination with rigorous stray-dog control.² In Italy, too, the systematic vaccination of dogs and livestock kept in free pastures, and the determined fight against stray dogs and cats contributed to the eradication of canine rabies in 1973. However, between 1977 and 1986, cases of rabies in wildlife were registered in the Italian alpine regions, linked to the presence of the disease in France, Switzerland, Austria, and Yugoslavia. A second epidemic in 1988–1989 and a third in 1991–1995 affected the Friuli

Venezia Giulia Region, spreading in 1993 and 1994 to the province of Bolzano, again related to the presence of sylvatic rabies in neighboring countries.³ After being totally rabies-free from 1997, fox-mediated rabies re-emerged in north-eastern Italy in October 2008⁴ and circulated until early 2011. The Italian cases were linked to the epidemiological situation of rabies-endemic regions in the Balkans.⁵ From January 2009, three oral vaccination campaigns against rabies were carried out in fox populations by manual distribution of vaccine baits in Friuli Venezia Giulia. In autumn 2009, the first case of wildlife rabies in the province of Belluno (Veneto Region)⁶ prompted the implementation of a series of emergency measures, to curb the spread of the disease and to limit the risk of human infection. Between December 2009 and December 2012, eight vaccination campaigns were conducted in a larger area in

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Figure 1 2009–2010 rabies cases in wild and domestic animals in the Veneto Region and the compulsory dog vaccination area.

which the vaccine baits were distributed by helicopter, using a satellite-navigated, computer-supported automatic bait-dropping system.⁷

Wildlife outbreaks pose a risk of reintroducing rabies into domestic animals, considered spill-over infections.⁸ Wildlife rabies has proven to be a health problem to small domestic animals, which in turn pose a higher risk of transmission to human beings because of their close contact with people.⁹ Vaccination of the dog population residing in the areas at higher risk was thus enforced¹⁰ as the key to preventing rabies in small animals and its transmission to humans.

The aim of this work is to illustrate how the vaccination activities were organized and how the information system, specifically designed to allow more efficient, more effective management of the vaccination campaign, evolved to meet the different operational and informational needs emerging in the 3 years when compulsory vaccination of dogs was in force.

The paper also aims to demonstrate that by using information technology tools, veterinary authorities were able to directly collect uniform, updated, validated data on the dog population and on the vaccination activities, which could not have been obtained with previously used reporting systems, based primarily on self-reporting of activities.

Materials and Methods

Study area

The dog vaccination data management system was implemented to support the vaccination activities carried out in the area at higher risk: provinces of Belluno, Treviso, 20 municipalities of the province of Venice, and 60 of the province of Vicenza of the Veneto Region (Fig. 1). In this area, the veterinary services (VSs) were organized in eight Local Health Units (LHUs). According to the BAC (Data Bank of the Regional Canine Registry), the estimated canine population living in these areas and requiring vaccination was approximately 250 000 units.

Organization of vaccination activities

The vaccination plan, which began at the end of November 2009 and had to be completed by 31 March 2010, involved all dogs living and introduced or transiting through the study area. Dogs in transit had to be vaccinated at least 21 days in advance.

The initial vaccination plan was mainly based on the provision of many different logistic solutions, provided at a fixed vaccination price, which was much lower than the ordinary fee, making it easy and cheap for dog owners to have their animals vaccinated.

The rabies vaccinations were performed by:

- VSs of eight LHUs entrusted with making pet vaccinations available at public surgeries or provisional

vaccination centers, set up in different municipalities to ease citizen access;

- veterinary practitioners (VPs) authorized by the VS to perform the immunizations at their own private practices for which they were reimbursed on a per-vaccination basis.

The veterinarian was free to choose which vaccine to administer from among the products registered in Italy, but the VSs were advised to give preference to longer lasting vaccines. However, during the mass vaccination campaign, it was almost impossible to find the 3-year vaccines on the market, so many VSs were forced to use 1-year ones.

Proof of vaccination was provided by a vaccination document (Form 12) drawn up and signed by the veterinarian, which the dog owner had to show to the control authorities, on request. Besides Form 12 for the dog owner, VPs had to fill in and send a copy of the form to their reference VS after performing a vaccination.

An extensive information campaign was conducted through local newspaper articles, television, and radio announcements, information boards posted in public places, and notices distributed at schools. A fine of €3000 was also fixed for the owners of unvaccinated dogs.

When the vaccination plan ended, at the end of March 2010, the compulsory vaccination no longer included the initial facilitations and from then on, dogs had to be vaccinated at the ordinary fees. Despite the decreased prevalence of the infection in wild animals,¹¹ due mainly to campaigns to orally vaccinate foxes,¹² it was still compulsory during 2011 to vaccinate dogs in the designated vaccination area. However, from February 2012, immunization remained compulsory only in the provinces of Belluno and Treviso and in the 60 municipalities of Vicenza,¹³ due to favorable epidemiological conditions. The vaccination became voluntary in February 2013, 2 years after the last reported case of rabies, since Italy regained the rabies-free status.

Vaccination information system

The information system implemented to collect the vaccination data was based on the BAC, which stores data on the dogs living in the Veneto Region (e.g. sex,

age, breed, address, etc.) and personal data of their owners and keepers (e.g. name, social security number, address, etc.). The canine registry is based on mandatory identification of each dog by a microchip injected before 2 months of age, in accordance with national and regional legislation.^{14,15}

The dataset recorded in the BAC on the dog, its movements, and related people (owner and keeper) is summarized in Table 1.

The BAC management software, ANACANI, is a client-server program based on web services technology. It is developed in Delphi7, designed according to HTTP/SOAP/XML standards, and is resident on Web server Apache 2.2.8 and Windows 2008.

The database is a relational database built on the Oracle platform (ORACLE 11.g) with two kinds of table: basic (dictionary), read-only tables updated by the maintainer, and data tables containing the data entered by the users.

A table holding vaccine data (brand, product name, duration of immunization coverage) and a table containing key data on the veterinarian (name, surname, identification code, address, phone number) were added to the basic tables. A data table was created to collect information on the vaccination, i.e. date and place of vaccination, attending veterinarian, type of vaccination — privately or within the public veterinary service — and end of the vaccine protection.

In order to register the vaccination, the dog must already exist in the BAC. The vaccination is then automatically associated with the owner and keeper of the animal registered there.

This ensures the historical depth of available data on dog residence and ownership at the time of each individual vaccination. The animal retains the status of 'vaccinated' with every move/change of ownership, regardless of place of vaccination and person entering the data. All system users have access to the dog's immunization status including those who access the BAC via smart phone.

The software performs both formal (i.e. date validity) and logical (i.e. identification date ≤ vaccination date) data integrity checks.

Table 1 Data recorded in BAC

Dog data	Movement data	Owner-keeper personal data
Identification number	Date of movement	Last name, first name
Chip location and inoculation date	Date of notification to the system	Fiscal code and VAT
Previous tattoo and tattooing date	Type of movement: birth, registration of dog ownership, transfer, change of ownership, chip replacement, death, theft, import/export, loss, recovery	Date and place of birth
Name of the animal		Sex
Date of birth, date of death		Residence address (street, town, postal code, province)
Sex, coat, hair, size, breed		Telephone number, cellular phone
Residence address (street, town, postal code, province)		E-mail, fax
Passport number and date		
Episodes of bite/attack and degree of dangerousness assessed		

Automatically derived data appear in the data entry window: the manufacturer's name is linked to the product name and the duration of immunization is inferred from the date of vaccination and vaccine name (end of immunization = vaccination date + 11 or 35 months). This information can be modified by the user if special circumstances so demand.

Analysis of the software requirements highlighted that LHUs had different operational needs depending on how the VS organized its immunization activities, calling for the optimization of available resources. The forms were designed to suit different needs and to fulfill the following tasks:

- to make appointments with the owners to have their dogs vaccinated. Using the data stored in the BAC, the software processes call letters for owners/keepers indicating the date, time, and location of the appointment;
- to automatize data entry at the time of vaccine administration;
- to fill out and print documents such as the receipt for the fee paid and Form 12;
- to calculate the fixed-rate reimbursement for each VP performing the vaccination;
- to extract data on individual dogs and their owners (e.g. whose vaccination booster is due at a given time or is unvaccinated).

During the vaccination campaign and up to the end of 2010, all vaccination data were computerized solely by VS users. Since 2011, VPs have been instructed to directly record the vaccinations they perform in the BAC, using the same software as the VSs. The information system was centralized on a regional basis, so rabies vaccinations of dogs living in not-at-risk areas, but expected to be taken to at-risk areas or to travel abroad, were entered in the BAC too, using the same software.

Specific tools made available to the local and regional authorities via the web, were designed to assess the state of progress of the vaccination plan based on the computerized vaccination data and canine population data recorded in the BAC.

Indicators were deduced and specific data extrapolation was stratified at both the LHU (the distribution of the dog population differed among the catchment areas of the eight LHUs) and municipality levels, with the option of being specifically structured by the applicant.

The first software upgrade release was ready by the first week of December 2009 and was financed by public funds. The costs and the advantages of developing and implementing the computerized system have been evaluated.

Vaccination data analysis

Specific reports were designed to enable the regional health authorities to retrospectively analyse the evolution of the canine population and the trend in vaccination coverage in the at-risk area. Vaccination and dog data were processed by an automated data analysis tool to periodically investigate the population during the 3-year period to assess immunization coverage. This was done by calculating the number of dogs with valid vaccination coverage on the first day of each month compared to the dog population present in the BAC.

Results

As regards software utilization, the number of VS users connected to the information system in the eight LHUs involved stood at 74 in 2010, 106 in 2011, and 99 in 2012. In addition, the VP users numbered 162 in 2011 and 250 in 2012.

Table 2 summarizes all vaccinations recorded in the BAC by these users over the 3-year period, thereby increasing the informative content of the BAC.

During the vaccination campaign, the VSs' administrative offices utilized the software to cost-effectively organize the vaccination activities. Thousands of appointment letters providing simple but exhaustive information were printed using the software and sent to the dog owners. LHUs numbers 2, 4, and 10 used the software directly during the vaccination operations at the provisional vaccination points. These were staffed by veterinarians and administrative workers, and a simple internet connection via a mobile device enabled sufficient network coverage and full use of the software features.

One immediate result of software tool utilization was that users no longer had to manually fill out documents (Form 12, payment receipt) and VPs no longer had to send a copy of Form 12 to the VS, since the vaccination data were already available in the

Table 2 2010–2012 vaccinations recorded in BAC per year

Year	Place of vaccination	No. vaccinations recorded in BAC	% vaccinations recorded		% vaccinations with	
			by vet services	by vet practitioners	One-year duration of immunity	Three-year duration of immunity
2010	At risk area	193 468	100	0	87	13
	Not at risk area*	17 823	100	0	88	12
2011	At risk area	112 707	91	9	45	55
	Not at risk area*	20 273	65	35	77	23
2012	At risk area	37 810	62	38	53	47
	Not at risk area*	27 026	43	57	79	21

Note: *Dogs expected to be taken to at-risk area (study area) or abroad.

Table 3 Costs and advantages of the computerized information system

Computerized data management system	
Costs	Advantages
Software implementation approx. €12 000, taking into account that:	Considerable reduction in administrative workload for organizing vaccination appointments with dog owners
• the central mainframe was already operating;	Time saved by using printed rather than manually filled in documents
• the dog identification system was in place;	More completeness (all compulsory fields filled in), better readability of printed documents
• a computerized dog register was operational;	Money and time saved by no longer sending the copy of Form 12 from VPs to VSs
• staff to manage and maintain the system was already available	No need for VS to store hard documents
Time required for data entry — from 30 to 50 seconds for each vaccination	Automated data processing and reporting
Hardware (personal computers, laptops, printers) — already available for VSs and VPs	Direct, correct calculation of the reimbursement for each VP
Internet access already available for VSs and VPs	

BAC. The costs and the advantages of developing the data management system are illustrated in Table 3.

Since the timely availability of data is pivotal to the supervision of any plan, Table 4 investigates the time elapsing between vaccination and its entry in the BAC between 2009 and 2012. Vaccinations recorded in the BAC are grouped into three categories: entry made at < 7, 7–30, and > 30 days from the actual vaccination date. In 2010, LHUs numbers 2, 4, and 10 recorded 25.1%, 30.7%, and 19.6% of the vaccination events, respectively, in less than 7 days. In the other LHUs, this percentage ranged from a minimum of 1.1% to a maximum of 9.9%. The VPs recorded 73.4% of their vaccinations in real time in 2011 and 81.1% in 2012.

At the end of the vaccination campaign (31 March 2010), 69% of the canine population in the at-risk area had been vaccinated: 185 033 out of the 268 336 dogs present in the BAC, 8497 of which had been vaccinated in December 2009, and the others in the first 3 months of 2010. According to the data registered in the BAC, the VPs participating in the campaign performed and were reimbursed for 28 859 vaccinations, using the specific software tool.

Figure 2 shows the number of dogs with a valid vaccination and the immunization status of the canine population in the vaccination area from 2010 to 2012.

The immunization coverage of the canine population varied greatly among the catchment areas of the different LHUs. In some cases, such as LHUs numbers 10 and 2, immunization coverage reached 82% and 83%, respectively, in November 2010, but the highest number of vaccinated dogs was in LHU number 9, followed by numbers 8 and 7. Rates were consistently higher in LHU number 2 than in the other LHUs, rising to 89–90% in 2012. In LHU number 7, the percentage of immunized dogs decreased abruptly to 32–33% in 2011 and never rose again. From 2010 onwards, the rate continued to drop slightly in LHU number 4, falling to 32% in December 2012.

The automated data analysis tools revealed that at the end of the compulsory vaccination period, 88 585 dogs living in the at-risk area had never been vaccinated against rabies. In order to study this sub-population, the dogs were grouped by the following age categories: under 12 years, between 12 and 18 years, and over 18 years old. The results are summarized in Table 5, in which the dogs' age and the size of the population refer to the end of the mandatory vaccination period.

Discussion

Emergency management calls for prompt action. Accordingly, the described software was very rapidly

Table 4 2009–2012 vaccinations divided according to the recording time

LHU	No. vaccinations recorded in < 7 days			No. vaccinations recorded in 7–30 days			No. vaccinations recorded in > 30 days		
	2010	2011	2012	2010	2011	2012	2010	2011	2012
No. 1	476	1412	1812	642	1543	1309	5783	3539	2307
No. 2	2357	2978	981	3164	2083	597	3876	2835	1553
No. 3	2121	1766	2720	907	3945	1508	18 347	7092	3182
No. 4	5965	479	830	2723	147	220	10 748	9348	369
No. 7	307	2027	1750	349	411	499	27 435	10 493	1543
No. 8	606	1295	1951	169	525	367	32 379	13 058	614
No. 9	1064	5599	5122	1987	3793	2159	44 623	19 571	6417
No. 10	5373	2824	...*	1108	5484	...*	20 959	10 460	...*
Total	18 269	18 380	15 166	11 049	17 931	6659	164 150	76 396	15 985

Note: *In 2012, LHU number 10 was no longer part of the vaccination mandatory area.

Figure 2 2010–2012 % immunization coverage of the dog population in the vaccination zone. Please note: LHU number 10 was excluded from the vaccination area at the beginning of 2012.

developed and adapted, enabling it to be used to plan activities from the very start of the vaccination campaign. The aim of the campaign was to vaccinate the dog population living in the at-risk area in a very short space of time, with a rather complex form of organization based on a public–private healthcare partnership. The presence of a consolidated databank ensured good knowledge of the local canine population, allowing quick access to dog population data, and the vaccination plan was a great opportunity to update the BAC and to improve the quality of the data thanks to the new flow of information.¹⁶

Implementation of the computer system, centralization of data collection, and the availability of tools to extrapolate and process the information achieved the following goals:

- to provide the VSs and VPs with novel technical tools to automate administrative work and simplify the document workflow;
- to standardize VS operating procedures through use of the same software;
- to calculate the reimbursements billed by VPs;
- to produce real-time detailed reports to be used by VSs for organizing and performing the vaccinations (e.g. list of never-vaccinated dogs, list of dogs due for a booster vaccination);
- to provide a system for monitoring the activities performed during the initial vaccination campaign.

The veterinary authorities could verify the outcome of the vaccination campaign on an LHU basis. Controls could be done independently, without the need to request information from VSs, as in the past. Accordingly, the veterinary authorities were able to promptly intervene with supportive measures directly in the LHUs where the problems had arisen. Owing to the time taken to computerize the vaccination data, the central veterinary authorities were unable to monitor the progress of immunization in real time and were only able to verify its effectiveness at a later stage;

- to check that population vaccination coverage was being maintained. Analysis of the data recorded in the BAC demonstrated that 73% of the total canine population in the at-risk area had been immunized against rabies in the final quarter of 2010. Since 70% vaccination coverage of the canine population in areas with endemic canine rabies has been considered sufficient to control the disease in several settings,² the veterinary authorities were able to conclude that there was a very low risk of dogs contaminating human beings. The percentage of vaccinated dogs fell significantly in 2011, remaining stable in 2012 with respect to 2011. The provision of various logistic solutions, the application of fixed low-cost fees, and fear of the disease undoubtedly encouraged owners to get their dogs vaccinated during the campaign. In 2011, the decline in cases of infection among wildlife most likely led to owners paying less attention to booster vaccination. In 2010, the massive use of a 1-

Table 5 Number of never vaccinated dogs divided into age groups at the end of the mandatory vaccination period

LHU	No. total dogs present	No. total dogs never vaccinated	< 12 years	12–18 years	> 18 years
No. 1	16 627	5945	37%	40%	23%
No. 2	13 902	2443	59%	29%	12%
No. 3	30 354	8654	53%	28%	19%
No. 4	33 436	15 454	44%	24%	32%
No. 7	43 653	16 481	42%	27%	31%
No. 8	47 076	14 544	75%	19%	6%
No. 9	68 363	20 796	49%	32%	19%
No. 10	34 312*	9961	76%	19%	5%
Entire vaccination zone	287 723	94 278	54%	26%	20%

Note: *LHU number 10 was excluded from the risk area (study area) at the beginning of 2012.

year rather than a 3-year vaccine had a very negative influence on the maintenance of vaccine coverage in the population. Conversely, the more extensive use of 3-year vaccines in 2011 contributed to maintaining population vaccination coverage in 2012. Different levels of BAC updating can partly explain the differences in population immunity levels among LHUs. Presumably, many of the oldest unvaccinated dogs (≥ 18 years) had already died, but their files had not been updated in the BAC. Hence, the rate of unvaccinated dogs may be overestimated, compared to the actual population;

- to have validated information available that can be quickly extracted and processed to meet the health authorities' data requirements at regional, national, and EU level. This afforded significant uniformity and ensured the accuracy of the reported data, confirming that data computerization is the best way to effectively monitor and report healthcare data.¹⁷

In addition, detailed vaccination data recorded in the BAC have a practical advantage in terms of routine activities: e.g. during stray dog recovery operations, users who usually consult the BAC are immediately informed about the dogs' immune status, which is useful for their own safety. In addition, access to all vaccination data enabled VSs and VPs to directly control immunization of dogs treated at their practice and remind owners when their dogs were due for a booster.

All data presented in this article were taken from the BAC and were entered by hundreds of users using the same software. The extensive use of the software by the VSs and VPs, exceeding all expectations, confirms that the application was practical and useful and of direct benefit to users. These are the two main goals of software implementation,¹⁸ since the adoption of new tools and the replacement of previously used paper-based information flows requires effort on the part of users and the will to overcome the initial difficulties. This experience confirms that users benefited from the software, encouraging them to use it proportionately, and that opening the data collection system to VPs brought long-lasting benefits. Their direct involvement in the data collection system not only reduced the administrative work of the VSs, but also made it available in less time than when all activities were carried out by the VSs.

This information system was created within an existing hardware and software infrastructure enabling a reduction in costs. Applying a similar system of computerized data management in developing countries would be feasible, provided that there was real knowledge of canine population dynamics, careful analysis of available resources, and an accurate choice of the technology to be implemented. In any event, applying a durable identification system (e.g. tattoo or microchip) and dog registration are crucial to any data collection system on individual dogs.

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References

- 1 Hanlon CA. Rabies in terrestrial animals. In: Jackson AC, editor. Rabies — scientific basis of the disease and its management. Boston (MA): Academic Press; 2013. p. 179–213.
- 2 WHO Expert Consultation on Rabies. WHO Technical Report Series No. 98. Geneva: WHO Press; 2013. p. 63–74.
- 3 Irsara A, Bressan G, Mutinelli F. Sylvatic rabies in Italy: epidemiology. J Vet Med B Infect Dis Vet Public Health. 1990;37:53–63.
- 4 De Benedictis P, Gallo T, Iob A, Coassin R, Squecco G, Ferri G, *et al.* Emergence of fox rabies in north-eastern Italy. Eurosurveillance [serial online]. 2008;13:19033. Available from: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19033> (accessed 31 July 2013).
- 5 Fusaro A, Monne I, Salomoni A, Angot A, Trolese M, Ferrè N, *et al.* The introduction of fox rabies into Italy (2008–2011) was due to two viral genetic groups with distinct phylogeographic patterns. Infect Genet Evol. 2013;17:202–9.
- 6 Capello K, Mulatti P, Comin A, Gagliazzo L, Guberti V, Citterio C, *et al.* Impact of emergency oral rabies vaccination of foxes in northeastern Italy, 28 December 2009–20 January 2010: preliminary evaluation. Eurosurveillance [serial online]. 2010;15:19617. Available from: <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19617> (accessed 1 Aug 2013).
- 7 Mulatti P, Muller T, Bonfanti L, Marangon S. Emergency oral rabies vaccination of foxes in Italy in 2009–2010: identification of residual rabies foci at higher altitudes in the Alps. Epidemiol Infect. 2012;140:591–8.
- 8 Cliquet F, Freuling C, Smreczak M, van der Poel WH, Horton D, Fooks AR, *et al.* Development of harmonised schemes for monitoring and reporting of rabies in animals in the European Union. Parma: EFSA; 2010 [document on the Internet]. Available from: <http://www.efsa.europa.eu/fr/scdocs/doc/67epdf> (accessed 1 Aug 2013).
- 9 Lackay NS, Kuang Yi, Fu Zhen F. Rabies in small animals. Vet Clin Small Anim. 2008;38:851–61.
- 10 Ministerial Order of 26 November 2009. Ordinanza ministeriale contingibile e urgente recante misure per prevenire la diffusione della rabbia nelle regioni del nord est italiano. Gazz Uffic Repubb Ital. 2009;285:30–2.
- 11 Rabies Information System of the WHO Collaboration Centre for Rabies Surveillance and Research. Geneva: WHO; 2013 [cite 2013 Aug 31]. Available from: <http://www.who-rabies-bulletin.org/Queries/Surveillance.aspx>
- 12 Mulatti P, Ferrè N, Patregnani T, Bonfanti L, Marangon S. Geographical information systems in the management of the 2009–2010 emergency oral anti rabies vaccination of foxes in north-eastern Italy. Geospat Health. 2011;5:217–26.
- 13 Ministerial Order of 10 February 2012. Ordinanza ministeriale contingibile e urgente recante misure per prevenire la diffusione della rabbia nelle regioni del nord est italiano. Gazz Uffic Repubb Ital. 2012;60:55–6.
- 14 Ministerial Order of 8 August 2008. Ordinanza ministeriale contingibile e urgente concernente misure per l'identificazione e la registrazione della popolazione canina. Gazz Uffic Repubb Ital. 2008;194:9–11.
- 15 Regional Order no 887 of 6 April 2004. Tutela degli animali d'affezione e prevenzione del randagismo. Identificazione dei cani mediante microchip. Boll Uffic Regione Veneto. 2004;45: 237–42.
- 16 Bortolotti L, Lanari M, Bricchese M, Cobianchi M, Cazzola L, Zampieri A, *et al.* Rabies re-emergence in Northern Italy: development of a regional system for centralized data management. Epidemiol Santé Anim. 2011;59:35–7.
- 17 Sinnecker H, Apitzsch L, Demski G, Rasch G, Sinnecker R, Voigt U. The rabies information system — a model for a common information system in human and veterinary medicine. Comput Programs Biomed. 1977;7:211–7.
- 18 Morris RS. Information systems for animal health: objectives and components. Rev Sci Tech. 1991;10:13–23.