

The WHO Rabies Bulletin Europe: a key source of information on rabies and a pivotal tool for surveillance and epidemiology

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Summary

Rabies is one of the most, if not the most, prominent and feared zoonotic diseases in the world and the World Health Organization (WHO) estimates that 55,000 people die of the disease every year. Most of these deaths occur in Asia and Africa and are usually the result of dog-mediated rabies. In Europe, the red fox is considered the main reservoir species for wildlife rabies caused by the rabies virus. Besides foxes, bats have also been identified as a reservoir for European bat lyssaviruses in many European countries. Here, the authors present the rabies surveillance data for Europe in recent years, as reported to the WHO Rabies Bulletin Europe. This journal has evolved into a web-based platform for rabies information (including an online accessible database) that on average receives more than 60,000 visitors each year.

Keywords

Epidemiology – Europe – Rabies – Surveillance.

Introduction

Rabies is a highly fatal, but preventable, disease that is regarded as a truly neglected zoonosis. It is caused by negative strand RNA-viruses belonging to the genus *Lyssavirus*, family *Rhabdoviridae* of the order *Mononegavirales*. The genus *Lyssavirus* is delineated into different virus species based on demarcation criteria such as genetic distance and antigenic patterns (13). Rabies virus (RABV), the prototype of lyssavirus species, is the causative agent of classical rabies and is responsible for the vast majority of all human rabies cases. The World Health Organization (WHO) estimates that 55,000 people die of rabies every year (29). Most of these deaths occur in Asia and Africa as a result of dog-mediated rabies (17). This is a tragedy, as rabies in humans is preventable, provided that the appropriate biologicals are available and treatment is given in a timely manner (23).

In Europe, Turkey is the only country where dog-mediated urban rabies is present. Elsewhere in Europe, the red fox

(*Vulpes vulpes*) is considered the main reservoir species for wildlife rabies caused by RABV. A fox rabies epizootic started in the Kaliningrad region of Russia, which borders Poland and Lithuania, in the 1940s, and had spread to most countries of Eastern, Central and Western Europe by the middle of the 1970s, regardless of natural or administrative borders (25). The front wave of this epizootic caused an enormous increase in rabies cases, leading to great concern among public and veterinary health authorities in Europe. The objective of this study is to review the rabies situation in Europe and to demonstrate how a database such as the Rabies Bulletin Europe (RBE) can help to control a disease.

Current disease situation in Europe

In large parts of Europe, fox rabies was endemic before the 1980s, with around 16,000 to 25,000 cases every year (RBE). The incidence of rabies in Europe has decreased dramatically since the late 1980s (Fig. 1), largely as a result of the oral rabies vaccination (ORV) of wildlife reservoirs (2). At present, many European countries have officially declared themselves 'rabies free' after fulfilling the

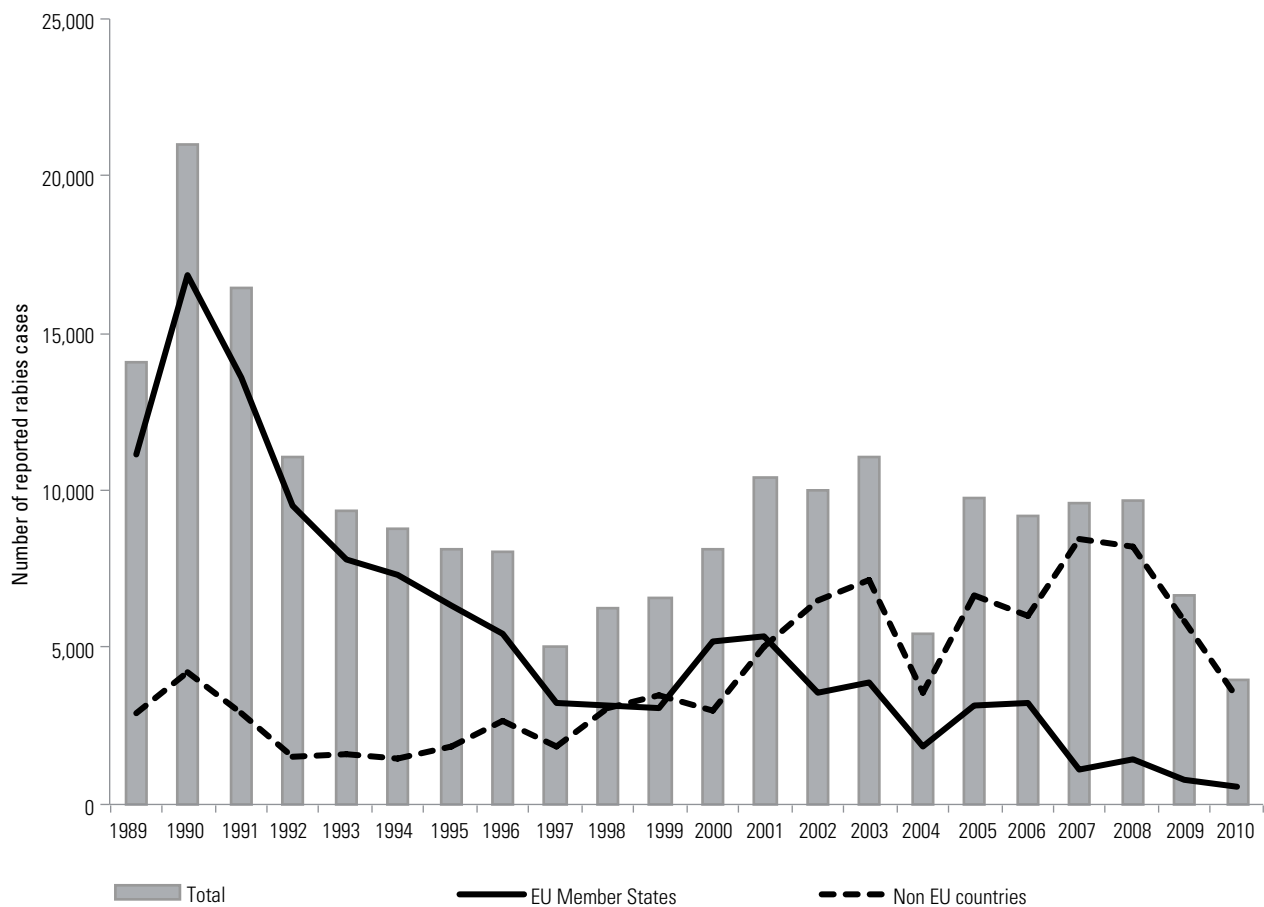


Fig. 1
Chart of reported animal rabies cases (except bats) in Europe, 1989–2010

requirements of the *Terrestrial Animal Health Code (Terrestrial Code)* of the World Organisation for Animal Health (OIE) (30). Of these, the United Kingdom, Iceland, Norway, Sweden, Ireland, Spain, Portugal, Malta, and Greece have a long history of freedom from the disease. Other countries, i.e. France, Switzerland, Belgium, Luxembourg, the Netherlands, the Czech Republic, Finland, Germany and Austria have become free by implementing ORV campaigns. The disease situation is improving, with only a few reported cases in those countries that have successfully implemented ORV, such as Estonia, Lithuania, Latvia, Poland, the Slovak Republic, Hungary and Slovenia.

To date, the rabies epidemic in foxes is restricted to areas in east and south-east Europe. Oral vaccination campaigns co-financed by the European Union (EU) have been established to control the disease and also to serve as a *cordon sanitaire* along the border(s) to prevent re-incursion (11) (Fig. 2). Except for Romania, all EU Member States that are affected by fox rabies use ORV to control the disease. Consequently, there has been a bigger decrease in the number of reported rabies cases in these countries than in non-EU countries (Fig. 1). In Europe, between 1990 and 2009, 184 human

cases were reported, of which the majority ($n = 143$) were reported from Russia. In the EU, human rabies cases are relatively rare (8). Only 31 human cases were reported from ten countries during this period (RBE) and these included a considerable number of travel-related human rabies cases. In Germany in 2004, the transplantation of organs from an infected donor caused four human rabies cases, but this was an isolated event (19).

Bat rabies was first reported in Europe in 1954, and European bat lyssavirus 1 (EBLV-1) and EBLV-2 have been isolated from rabid bats (3). The West Caucasian bat lyssavirus was also isolated from a bat in the European part of the Caucasus (18). Recently, another putative lyssavirus, Bokeloh bat lyssavirus (BBLV), was isolated from a rabid Natterer's bat (*Myotis nattererii*) from Germany (12).

Between 1977 and 2010 a total of 959 bat rabies cases were reported in Europe, with the majority characterised as EBLV-1 associated with the Serotine bat (*Eptesicus serotinus*), frequently isolated in the Netherlands, Germany, Denmark, Poland, and also in parts of France and Spain. A few cases were also reported from Romania, Hungary, Slovenia and Russia. Most EBLV-2 isolates originated from

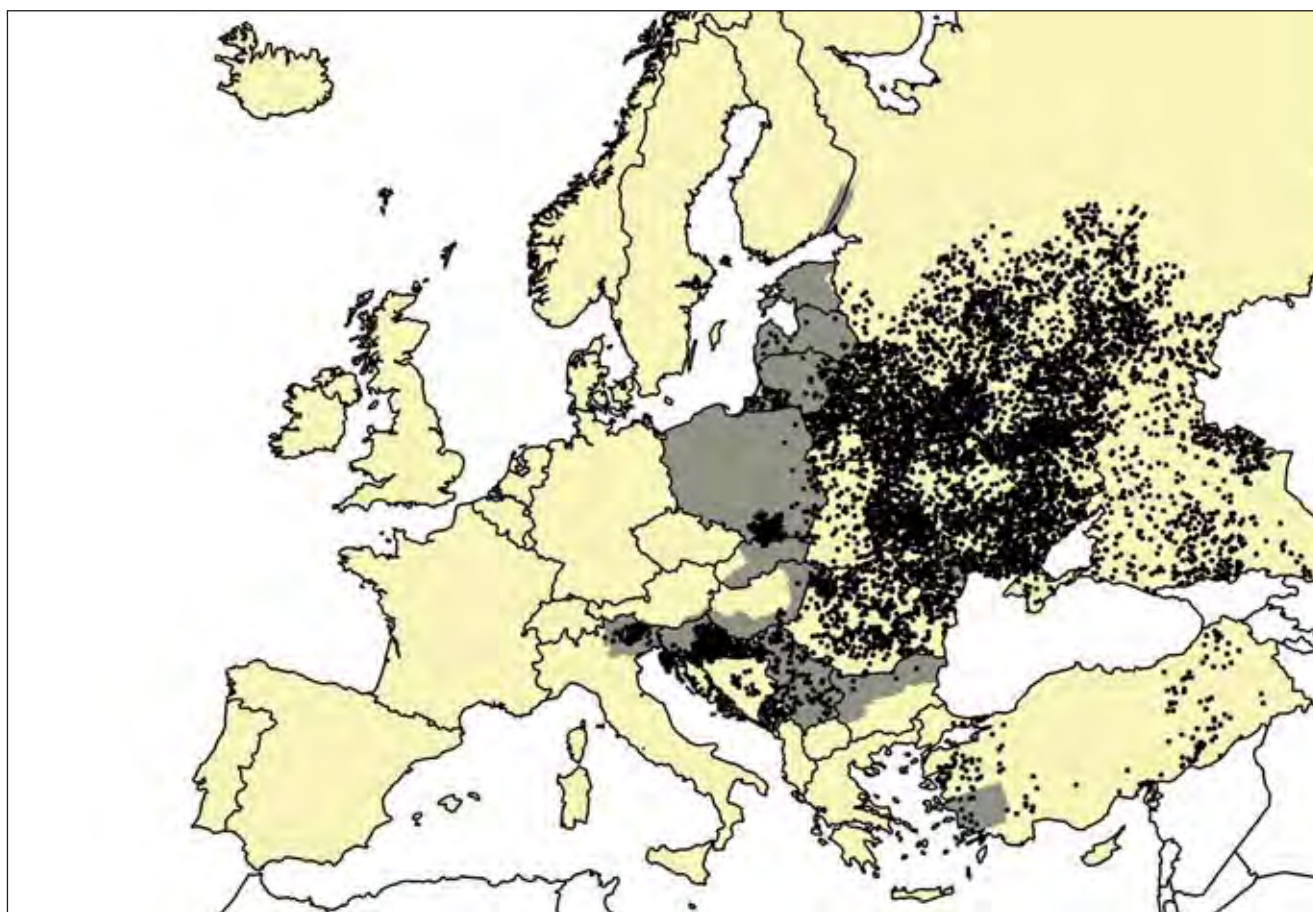


Fig. 2

Map of oral rabies vaccination areas (dark grey) and reported animal rabies cases (black dots) in Europe in 2010

Bat rabies cases and imported cases are omitted

the UK and the Netherlands, and EBLV-2 was also detected in Germany, Finland and Switzerland. Thus far, only one isolate of BBLV has been found in Germany. In Europe, the presence of rabies in bats does not change the OIE disease status of a country regarding rabies.

It should be noted that surveillance in bats is restricted due to the fact that almost all European bat species are endangered and thus protected by the regulations of Council Directive 92/43/EEC of the European Union on the conservation of natural habitats and of wild fauna and flora, by the Agreement on the Conservation of Bats in Europe (EUROBATS 1991), or by national legislation. National bat rabies surveillance networks are desirable in all European countries and should be implemented in close collaboration with bat specialists, including international bat agencies. For disease detection the focus should be on dead found bats (5, 20), with the species being determined in both positive and negative cases, while active screening of live bats can contribute to the understanding of lyssavirus epidemiology.

As seen in the data provided by the reporting countries, bat rabies surveillance is very heterogeneous across Europe

(Table I), and therefore the true distribution of bat lyssaviruses is poorly understood.

Sporadically, bats have caused human casualties in Europe (15). Confirmed infections with EBLV-2 caused the death of bat biologists in Finland and in Scotland (9), and EBLV-1 was responsible for the death of a girl in Russia (15). Also, one human rabies case in the Netherlands was caused by Duvenhage virus, an African bat lyssavirus, which had been transmitted by a bat in Kenya (27).

Spillovers of EBLV-1 to other mammal species have been observed in sheep in Denmark (22), in a stone-marten (*Martes foina*) in Germany (21) and in two cats in France (6).

Rabies as a continuous threat for animals and humans

The rabies situation in Europe is reasonably good: many countries are rabies free and many others are increasing their efforts to eliminate fox-mediated rabies. The standards and regulations that have been crucial in the

Table I
Reported rabies surveillance data 2006–2009 (animals tested negative)

Countries that did not report data were omitted

Country	2006			2007			2008			2009		
	Domestic	Wild	Bats	Domestic	Wild	Bats	Domestic	Wild	Bats	Domestic	Wild	Bats
Albania	6	25	43	5	30	26	14	26	13	4	35	29
Austria	174	8,063	2	177	9,075	45	152	9,258	68	153	8,313	360
Belgium	297	170	21	383	196	23	367	321	25	317	229	29
Bosnia-Herzegovina				10	3	0	33	19	0	28	1	0
Bulgaria	149	9	0	0	0	0	114	73	0	103	401	1
Croatia	727	2,738	0	745	3,639	0	1,118	4,217	0	1,103	4,282	0
Czech Republic	597	7,318	12	974	8,601	15	361	5,473	10	327	7,102	22
Denmark	3	7	39	0	3	19	5	2	15	5	0	9
Estonia	246	228	1	182	187	0	135	169	1	77	150	1
Finland	20	533	1	26	523	3	50	788	0	32	495	21
France	1,199	375	200	1,091	262	134	1,919	273	224	1,476	94	249
Germany	800	15,391	61	627	15,230	89	565	14,140	64	396	17,390	66
Greece	13	1	0	18	1	1	12	1	1	11	1	3
Hungary	846	6,796	10	569	5,854	4	803	8,838	4	757	8,080	11
Italy	556	3,064	2	522	2,804	9	396	2,148	2	628	3,970	7
Latvia	271	301	0	288	443	0	287	583	0	170	478	0
Lithuania	963	1,280	1	671	1,045	1	400	1,203	4	275	784	0
Luxembourg	6	22	0	4	30	0	11	28	0	2	27	0
Moldova				48	31	0	45	15	0	80	28	0
Montenegro				0	13	0	0	26	0	1	63	0
Poland	2,138	24,544	118	1,634	21,014	58	1,752	21,995	73	1,549	23,795	109
Serbia*	89	72	2	236	129	2	303	208	0	269	140	0
Montenegro*	115	86	1									
Slovak Republic	506	3,721	14	476	3,836	1	509	3,496	3	418	3,281	2
Slovenia	161	1,734	0	139	1,936	0	202	2,417	219	233	2,576	171
Switzerland+	33	55	11	23	42	16	35	50	18	30	39	41
Lichtenstein												
Netherlands	5	3	113	7	10	147	9	8	113	13	8	160
Turkey	155	21	0	236	20	0	232	36	0	62	2	0
Ukraine	2,754	5,327	7	0	8,690	0	0	8,283	0	0	8,606	0
United Kingdom	45	10	867	25	32	1,203	37	15	1,308	30	7	1,097

*Until 2007 Serbia and Montenegro were one country

prevention of rabies (re)introduction are the OIE *Terrestrial Code* (Chapter 8.10 on rabies) and, specifically for Europe, EU Regulation (EC) 998/2003 for the non-commercial movement of pets from within and outside the EU (16). The latter stipulates that any pet entering an EU country must be identifiable by a microchip or tattoo, must have been vaccinated against rabies and, depending on the status of the country of origin, must have been serologically tested. A veterinary certificate should accompany the animal during the period of travel. Failure to meet these requirements could lead to the animal being returned to its country of origin, isolation of the animal until it meets the requirements or, as a last resort if the first two options are not feasible, the destruction of the animal.

Despite current regulations, importation of rabid animals can still occur through failure of border controls, ignorance of importation rules or active subversion of these rules. This is demonstrated by the fact that none of the imported animals that have tested positive for rabies since the introduction of EU Regulation 998/2003 has fulfilled the requirements; all of them were illegally imported (14). The importation of rabid animals can have severe implications, as recently exemplified by cases of rabies in dogs in France that were traced back to an illegal import from Morocco (1).

Another possible means of disease (re)introduction is the natural movement of infected wild animals. The only way

to prevent such spread is the maintenance of a vaccination belt. While usually a zone of 30–50 km seems to be sufficient, in 2008, the Udine region in Italy was re-infected by fox-mediated rabies from rabies-endemic regions of the Balkans (7), and the disease spread further to neighbouring regions. Concerted counteractions, including oral bait distributions several times a year and baiting in areas above 1,500 m, drastically reduced the number of infected animals in the affected region (4).

In 2010 rabies re-emerged in the Małopolskie *voivodship* (province) of Poland, despite the fact that vaccination programmes had been in place for several years (24). Generally, continuous disease awareness is necessary to allow early detection and avoid further spread.

Reporting rabies surveillance data to the WHO Rabies Bulletin Europe

In March 1975, the Chief Veterinary Officers of ten European countries and representatives of WHO and OIE met with experts in rabies epidemiology and computing. They recommended that, in order to meet the demand for adequate and reliable rabies surveillance data, a computerised European database for rabies surveillance be put into place. The European rabies database, which is maintained by the WHO Collaborative Centre for Rabies Surveillance and Research at the Friedrich-Loeffler-Institute in Germany, was duly established. Veterinary authorities from 27 different European countries submit rabies data on a quarterly basis. The first issue of the WHO RBE was published in 1977 and distributed to rabies-related authorities all over the world. The RBE is now available both in printed form and electronically (www.who-rabies-bulletin.org). It provides epidemiological data and information on the disease and its control.

The veterinary authorities of participating European countries regularly submit data on officially confirmed rabies cases per species. Human rabies cases are also reported to the RBE. All data is summarised at regional level using the classification system which, for the purpose of statistical analysis, divides up the economic territory of the EU into three 'NUTS' levels (Nomenclature of Units for Territorial Statistics), which range from major socio-economic regions (level 1) to small local areas (level 3). The data is then also summarised per country. All data reported to the RBE is transferred into a database that is open to web-based data queries.

As of 2002, to increase the value of the reported rabies data, countries have also been requested to submit information on the number of animals testing negative for rabies. The number of animals tested depends on the rabies status of the country, the implementation of ORV campaigns and the country's individual approach to rabies

surveillance. Thulke *et al.* noted that, as indicator animals (i.e. animals that show abnormal behaviour suggestive of rabies) are the best target for disease surveillance, a defined sample size is inappropriate (26). A recent European Food Safety Authority (EFSA) report also concluded that fixed sample sizes are not appropriate (5).

According to the international standards contained in the OIE *Terrestrial Code*, a country can only be granted 'rabies-free' status if it implements effective rabies surveillance that includes testing clinically or epidemiologically suspect cases. In Europe, surveillance data is collected, summarised at the country level, and published annually in the RBE. As summarised in Table I, surveillance for classical rabies varies among European countries. Some countries, e.g. Poland, Germany and Austria, test thousands of wild animals (except bats), while others only test wild and domestic animals sporadically. This seems to reflect the epidemiological situation – in countries that implement ORV increased surveillance and monitoring is performed, as recommended by international organisations. However, since a precise number of suspect animals cannot be predetermined for basic routine surveillance, it remains open for scientific debate at what level adequate or effective surveillance can be guaranteed and a possible incursion swiftly detected.

Outreach of the Rabies Bulletin Europe

Since the RBE was first created, the way in which data is presented has changed a few times. Besides the information on rabies presented in tables and in maps with short comments from reporting countries, a section entitled 'Miscellaneous articles' has also been introduced. The RBE had always intended to promote trans-border cooperation in rabies surveillance and control. Before 1989 rabies experts on both sides of the 'Iron Curtain' used the 'Miscellaneous articles' section to swiftly share relevant information on this important disease and present their research findings. In total, more than 160 such articles have been published in the RBE and a quick search by the authors revealed that articles have been cited more than 200 times in scientific papers on rabies. The articles cover a wide variety of rabies-related topics, including the rabies situation in particular geographical regions, human rabies case studies, problems in rabies control, conference proceedings, trends in rabies research, and molecular biology of the rabies virus.

The printed version of the RBE is published quarterly and 250 copies are distributed, mostly to institutional subscribers. In 1994, as the internet was becoming the medium for sharing information, the RBE also began to be published online. The journal was available as HTML as well as in a PDF file (all electronically published journals are stored in a special archive for future access). This

online version was renewed in 2006 when it evolved from a static display of information to a dynamic rabies data query system (10). Online production of rabies maps as well as trend tables and summaries was made possible. To reflect the increasing demand for information, a new static section was also implemented in the web version. More recently there have been further improvements, including the switch to a GIS-server, allowing the creation of more comprehensive maps and the introduction of a members' area for secure data submission.

Publishing the journal online made it much more easily accessible and the RBE has become a pivotal tool for both the general public as well as members of the scientific community. This was clearly demonstrated by an evaluation of the web statistics of the URL www.who-rabies-bulletin.org. In 2000, the website received around 200 visits per month; by 2007 the same number was recorded per day. Between 2007 and 2011 a total of 353,964 web visits were counted (Fig. 3). About 45% of users directly visited the URL, while the majority used search engines, e.g. Google®. Search engines use mathematical algorithms to verify their results by taking the user's response into account. When requesting a result with the terms 'rabies' and 'Europe' using Google® the WHO RBE is ranked first out of 1,300,000 results, indicating its value.

Visitors to the website mainly used the database search function. The second most consulted section was the 'About rabies' section, which contains general facts about the disease and its prevention and control. The third most popular section was the 'Journal' where current and previous issues of the RBE can be downloaded as a PDF. Between 2007 and 2010, the number of hard copies distributed was 3,200. During the same period, about three times as many issues, i.e. 9,600, were downloaded from the website, highlighting the importance of the internet as a medium for spreading information.

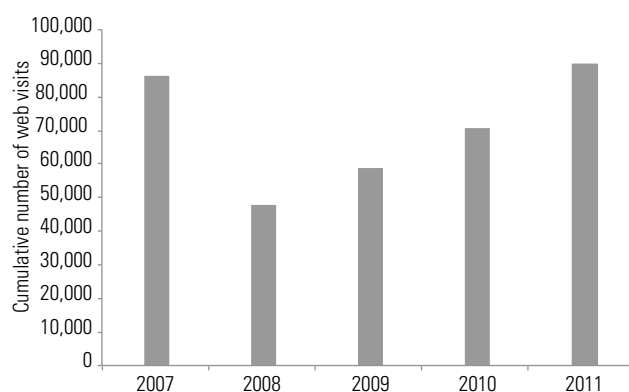


Fig. 3
Cumulative number of visits to the WHO Rabies Bulletin Europe website

Discussion

Europe is in a very favourable position in regards to the rabies situation and may serve as an example for rabies disease control in wildlife and other animals. One of the foundations of disease control is having sound knowledge about the epidemiology of the disease, based on valid surveillance data. In this respect, the WHO RBE has served as an invaluable tool for veterinary epidemiologists and decision-makers. The information in the WHO RBE is supplemented by the reports sent to the OIE by the Delegates of Member Countries. This information is included in the OIE World Animal Health Information Database, and data on disease emergence, including the emergence of rabies, is issued to Member Countries as an OIE immediate notification. To protect public health, a Network for the Surveillance and Control of Communicable Diseases has been established by the European Parliament and Council Decision 2119/98/EC. This network includes an Early Warning and Response System which helps to raise disease awareness, as it did during outbreaks of introduced canine rabies in France (1) and in Germany (28).

The availability of precise European rabies data spanning over more than two centuries, combined with the option of creating maps, makes the RBE a unique information source. As this rabies information system is in the public domain and is freely available on the internet it facilitates the work of veterinary and public health services in European countries as well as that of international organisations, and it supports trust and transparency. As it is well established and has a very high level of reporting compliance, it was suggested that it be the basis for the required reporting of rabies within the framework of zoonoses reporting to EFSA (5).

More frequent international travel has increased people's need for information about the current regulations on pet travel. Answering queries about the rules and regulations has become a time-consuming task for authorities and institutions. As the RBE homepage provides such information this can be regarded as a service to both the health and veterinary authorities and the general public.

The improvement of this web-based information platform will continue. It would be beneficial if data on negative cases were analysed in the same way as positive cases. A challenge both in technical and financial terms is the maintenance of up-to-date GIS information for all European countries. All European countries must make this information (including information on the respective NUTS level) available so that it can be displayed in online maps. While reporting and displaying data at NUTS 3 level (i.e. at the level of small local administrative units) can be more difficult and is more complicated in terms of data

storage, it results in more geographical precision. The new GIS-server allows the analysis of even more detailed GIS data, if available. However, countries are not obliged to report data but are simply asked to, so an overload of reporting duties must be avoided as it may mean that countries stop reporting altogether or only supply limited data.

As the rabies risk will persist, vigilance, awareness, diagnostic capacity and surveillance will continue to be required in the future.

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All people involved in every aspect of rabies surveillance, i.e. the shooting of suspect animals, their distribution to laboratories, testing, reporting of results to ministries and, finally, reporting to the WHO RBE, deserve great appreciation. ■

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Rabies Bulletin Europe : une source majeure d'informations sur la rage et un outil essentiel pour la surveillance et l'épidémiologie

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Résumé

La rage occupe l'une des premières places, sinon la première, parmi les maladies zoonotiques majeures les plus redoutées dans le monde, faisant chaque année, d'après l'Organisation mondiale de la santé (OMS), près de 55 000 victimes humaines. La plupart de ces décès surviennent en Asie et en Afrique et résultent généralement d'une morsure de chien enragé. En Europe, le renard roux est le principal réservoir sauvage du virus responsable de la rage sylvatique. Outre les renards, les chauves-souris sont dans bien des pays d'Europe le réservoir des lyssavirus des chauves-souris. Les auteurs de cet article présentent les données de la surveillance de la rage en Europe réunies au cours des dernières années, telles qu'elles ont été notifiées au Rabies Bulletin Europe de l'OMS. Cette publication périodique a évolué ; elle se présente désormais sous forme de plateforme Internet dédiée à l'information sur la rage, avec une base de données en ligne accessible au public et consultée chaque année par plus de 60 000 internautes.

Mots-clés

Épidémiologie – Europe – Rage – Surveillance. ■

El Rabies Bulletin Europe, fuente básica de información sobre la rabia e instrumento fundamental en materia de vigilancia y epidemiología

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Resumen

La rabia es una de las enfermedades zoonóticas más prominentes y temidas del mundo, si no la que más, y la Organización Mundial de la Salud (OMS) calcula que cada año mueren por su causa 55.000 personas. La mayoría de esas muertes tienen lugar en Asia y África, y suelen deberse a la rabia transmitida por perros. En Europa, el zorro común es considerado como el principal reservorio en la fauna salvaje de la enfermedad causada por el virus rábico. Además del zorro, también se ha observado que en muchos países de Europa los murciélagos ejercen de reservorio de "lisavirus del murciélago" europeos. Los autores presentan datos de las actividades de vigilancia de la rabia realizadas en Europa en los últimos años, tomados del Rabies Bulletin Europe de la OMS. Esta publicación ha pasado a ser un dispositivo en línea de información sobre la rabia (incluida una base de datos accesible en línea) que recibe en promedio más de 60.000 visitas al año.

Palabras clave

Epidemiología – Europa – Rabia – Vigilancia.



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