

Legionnaires' disease in Europe 2007–2008

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Each spring, countries that participate in the European Surveillance Scheme for Travel Associated Legionnaires' Disease (EWGLINET) are requested to submit their annual dataset of all cases of Legionnaires' disease in residents of their country with onset of illness in the preceding year. These data have been collected annually since 1994 and are used to analyse epidemiological and microbiological trends within and between countries over time. This paper presents an overview of the data collected for 2007 and 2008. A total of 5,907 cases were reported by 33 countries in 2007 and 5,960 cases by 34 countries in 2008, a similar two-year total to that recorded in 2005 and 2006 [1]. The only countries with a major difference in case numbers between 2007 and 2008 were Russia, due to a large outbreak in 2007, and Italy where cases increased by 256 in 2008 mainly due to an increase in community-acquired infections. The 779 reported deaths give a two-year case fatality rate of 6.6%. Some 243 outbreaks or clusters were detected, 150 of which were linked to travel-associated infections. As in previous years, the overall main method of diagnosis was by urinary antigen detection and the proportion of cases diagnosed by culture remained low at 8.8%, although isolation rates by country ranged from under 1% to over 40%.

Introduction

Legionnaires' disease is a bacterial infection characterised by atypical pneumonia. It is caused by *Legionella* bacteria which live in water and other moist environments, and are ubiquitous in the natural environment. When aerosolised and inhaled they can cause infection. Aerosol-generating outlets that are commonly associated with cases of Legionnaires' disease include wet cooling systems, water systems and spa pools [2].

In 1986, collaborations across Europe were established to share knowledge about *Legionella* spp. and to monitor trends in this infection. This became known as the European Working Group for Legionella Infections (EWGLI), and it currently has 36 member countries. Every year EWGLI requests a dataset from each participating country, to record the number and characteristics of the cases of Legionnaires' disease that were diagnosed in that country's residents

during the preceding year. This allows for comparison of the disease between countries, the monitoring of trends within countries and for analysis of data at the European level.

Data from the years 1996 to 2006 have been published previously [1,3-8]. This paper presents the dataset for the years 2007 and 2008.

Methods

The datasets requested from the countries contain epidemiological and microbiological information: the number of confirmed and presumptive cases, the number of deaths, the population base covered (in some countries, the institution collaborating with EWGLI only receives data for a region of the country), the method of diagnosis and the species and serogroup of any isolates obtained, age group and sex of

TABLE 1

Reported cases of Legionnaires' disease and incidence rate per million population, 1993–2008 (n=53,494)

Year	Number of cases	Number of countries contributing data ¹	Population (millions)	Rate per million
1993	1,242	19	300	4.1
1994	1,161	20	346	3.4
1995	1,255	24	339	3.7
1996	1,563	24	350	4.5
1997	1,360	24	351	3.9
1998	1,442	28	333	4.3
1999	2,136	28	398	5.4
2000	2,156	28	400	5.4
2001	3,470	29	455	7.6
2002	4,696	32	466	10.1
2003	4,578	34	468	9.8
2004	4,588	35	550	8.3
2005	5,700	35	554	10.3
2006	6,280	35	566	11.1
2007	5,907	33	523	11.3
2008	5,960	34	506	11.8

¹ With England and Wales, Northern Ireland and Scotland counted as three distinct countries.

Source: European Working Group for Legionella Infections (EWGLI) data.

the cases, category of exposure (nosocomial, travel- or community-associated), countries of travel (where appropriate), and outbreaks by type, size and suspected source.

Cases are classified as confirmed or presumptive according to the EWGLI case definitions (a classification of 'diagnosis not known' is accepted according to national reporting criteria) [9]. In addition, each case is categorised by the activities they were engaged in during their incubation period and are recorded as 'travel', 'nosocomial' or 'community' infections. Each country defines nosocomial and community categories according to their national case definitions, whereas

a European-wide case definition is used for travel-associated cases. If there is insufficient evidence to allocate a case to one of the categories (e.g. if a case spent part of their incubation period travelling and part in hospital), the case is classified as 'other'. If no exposure information is available, the case is classified as category 'not known'.

Incidence rates per million population are based on national population size, with the exception of three countries where regional incidence rates were reported in both years (Bulgaria, Lithuania and Russia), and in Romania where regional incidence rates were reported for 2008. It should be noted that these data may not

TABLE 2

Number of cases of Legionnaires' disease and incidence rate per million population, 2007-2008

Country	2007			2008		
	Population (millions)	All reported cases	Rate per million	Population (millions)	All reported cases	Rate per million
Andorra	0.1	6	73.0	0.1	1	11.9
Austria	8.3	105	12.7	8.3	100	12.0
Belgium ¹	10.6	145	13.7	10.7	138	12.9
Bulgaria	1.2	1	0.8	1.2	1	0.8
Croatia	4.4	40	9.0	4.4	30	6.8
Cyprus	N/A	N/A	N/A	0.8	9	11.4
Czech Republic	10.3	21	2.0	10.4	20	1.9
Denmark ¹	5.4	133	24.4	5.5	128	23.3
Estonia	1.3	3	2.2	1.3	7	5.2
Finland	5.3	16	3.0	5.3	15	2.8
France ¹	62.6	1,428	22.8	62.6	1,244	19.9
Germany ¹	82.3	529	6.4	82.2	522	6.3
Greece	11.0	23	2.1	11.0	27	2.5
Hungary	10.1	18	1.8	10.0	25	2.5
Ireland	4.2	16	3.8	4.2	11	2.6
Italy ¹	59.1	851	14.4	59.6	1,107	18.6
Latvia	2.3	2	0.9	2.3	5	2.2
Lithuania	3.4	2	0.6	3.4	2	0.6
Luxembourg	0.5	4	8.4	0.5	5	10.1
Malta	0.4	14	34.3	0.4	3	7.6
Netherlands ¹	16.4	321	19.6	16.4	337	20.5
Norway	4.7	35	7.5	4.8	38	7.9
Poland	38.1	13	0.3	38.1	20	0.5
Portugal	10.6	86	8.1	10.6	102	9.6
Romania	21.6	1	0.0	1.9	4	2.1
Russia	20.0	140	7.0	20.0	18	0.9
Slovakia	5.4	2	0.4	5.3	9	1.7
Slovenia	2.0	24	11.9	2.0	48	23.7
Spain ¹	44.2	1,098	24.8	44.7	1,219	27.3
Sweden	9.2	130	14.2	9.3	155	16.7
Switzerland ¹	7.6	205	26.9	7.7	220	28.6
UK - England & Wales ¹	53.7	441	8.2	54.1	358	6.6
UK - Northern Ireland	1.7	11	6.3	1.8	6	3.4
UK - Scotland	5.1	43	8.4	5.1	26	5.1

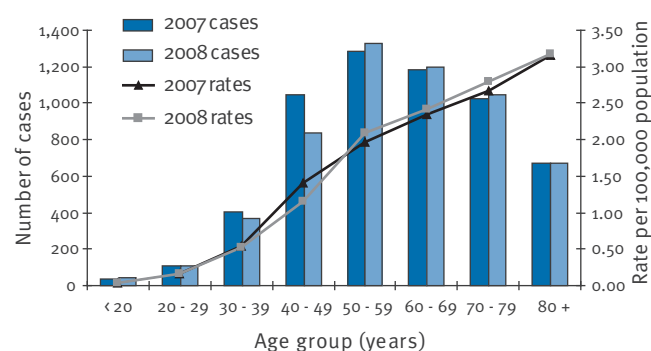
N/A: not applicable. UK: United Kingdom.

¹ Countries where data has been presented in previous years' papers.

Source: European Working Group for Legionella Infections (EWGLI) data.

be representative of the entire country if, for example, reporting is stronger in the region of the country which reports to this international scheme. Age-standardised rates are calculated from the number of cases in each age stratum and the underlying population denominator for the strata in each participant country.

FIGURE 1
Cases of Legionnaires' disease and age standardised rates per 100,000 population by age group, 2007-2008



Source: European Working Group for Legionella Infections (EWGLI) data.

The term 'outbreak' is mainly used to describe outbreaks in hospitals or community settings, and the term 'cluster' is mainly used for travel-associated cases to describe the association of more than one case with a hotel or other tourist accommodation site. Travel-associated clusters are defined as 'two or more cases associated with the same accommodation site within two years', based upon the definitions established by EWGLI's travel-associated surveillance scheme, EWGLINET [9]. All other clusters and outbreaks are defined independently by the country where the infection was acquired.

Results

In 2007, 5,907 cases were reported by 33 countries, and in 2008, 5,960 cases were reported by 34 countries (including Cyprus, who contributed data for the first time). In the 16 years for which this dataset has been collected, a total of 53,494 cases have been reported (Table 1).

Incidence rates

The overall incidence per million population was 11.3 in 2007 (based on a population of 523.3 million) and 11.8 in 2008 (based on a population of 506.2 million). The fall in total population in 2008 is accounted for by

TABLE 3
Cases of Legionnaires' disease by main method of diagnosis, 2007-2008 (n=11,867)

Main method of diagnosis	<i>Legionella pneumophila</i> sg1		<i>L. pneumophila</i> other serogroup, or serogroup not determined		Other <i>Legionella</i> species or species not known		All <i>Legionella</i> cases	
	Cases	%	Cases	%	Cases	%	Cases	%
Isolation/culture	896	9.5	113	6.3	33	5.1	1,042	8.8
Urinary antigen detection	8,252	87.5	1,108	62.1	247	38.2	9,607	81.0
Serology: four-fold rise	66	0.7	92	5.2	42	6.5	200	1.7
Serology: single high titre	167	1.8	280	15.7	137	21.2	584	4.9
Respiratory antigen detection	1	0.0	1	0.1	4	0.6	6	0.1
PCR	37	0.4	149	8.3	55	8.5	241	2.0
Unknown	17	0.2	42	2.4	128	19.8	187	1.6
Total	9,436	100	1,785	100	646	100	11,867	100

Source: European Working Group for Legionella Infections (EWGLI) data.

TABLE 4
Number of cases of Legionnaires' disease and proportion by category of infection, 2007-2008 (n=11,867)

Category	2007		2008		Total cases	%
	Cases	%	Cases	%		
Nosocomial	329	5.6	419	7.0	748	6.3
Community	3,671	62.1	3,657	61.4	7,328	61.8
Travel abroad	791	13.4	689	11.6	1,480	12.5
Travel home	492	8.3	538	9.0	1,030	8.7
Other	54	0.9	32	0.5	86	0.7
Not known	570	9.6	625	10.5	1,195	10.1
Total	5,907	100.0	5,960	100.0	11,867	100.0

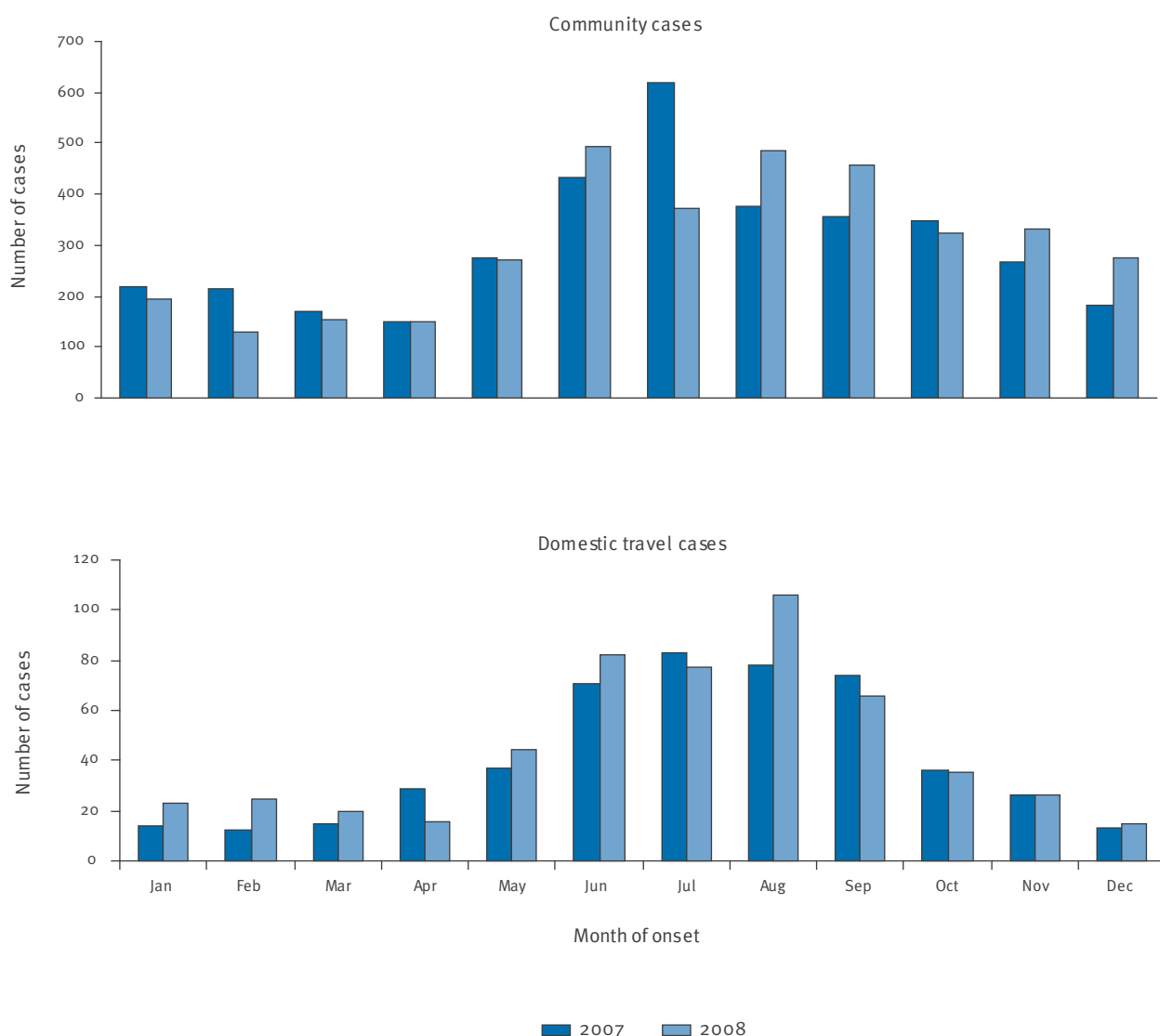
Source: European Working Group for Legionella Infections (EWGLI) data.

Romania reporting only data from one region in that year. In all other countries, the area of each country covered by their datasets remained consistent across both years. The number of reported cases for both years was highest in France, Italy and Spain, although

rates per million population were higher in some countries that had reported fewer cases (in 2007: Andorra, Denmark, Malta, the Netherlands and Switzerland; in 2008: Denmark, the Netherlands, Slovenia and Switzerland).

FIGURE 2

Cases of Legionnaires' disease acquired within country of residence by month of onset, 2007-2008



Source: European Working Group for Legionella Infections (EWGLI) data.

TABLE 5

Outbreaks of Legionnaires' disease and associated cases by category of infection, 2007-2008

Category	2007		2008		Total	
	Outbreaks	Cases	Outbreaks	Cases	Outbreaks	Cases
Nosocomial	13	48	15	50	28	98
Travel (abroad)	44	111	49	113	93	224
Travel (home)	27	77	30	69	57	146
Community	26	260	37	157	63	417
Other	1	3	1	2	2	5
Total	111	499	132	391	243	890

Source: European Working Group for Legionella Infections (EWGLI) data.

In 2007, rates were highest in Andorra (six cases, rate 73.0), followed by Malta (14 cases, rate 34.3) and Switzerland (cases 205, rate 26.9), whilst in 2008, Switzerland had the highest rate (220 cases, rate 28.6), followed by Spain (1,219 cases, rate 27.3) and Slovenia (48 cases, rate 23.7). Six countries reported incidence rates of less than one case per million population in 2007 (Bulgaria, Latvia, Lithuania, Poland, Romania and Slovakia), compared with four countries in 2008 (Bulgaria, Lithuania, Poland and Russia). Table 2 shows the rates of Legionnaires' disease per million population for all countries, with 10 of them selected for their consistent rates and in order to allow comparison with previous papers.

Case characteristics

Of the 11,867 cases reported in 2007-2008, 8,376 cases were male (70.6%), 3,176 were female (26.8%) and for 315 sex was unknown (2.7%). In both years the highest number of cases fell within the age group of 50-59-year-olds (1,288 cases in 2007, 21.8%; 1,328 cases in 2008, 22.3%). However, when age-standardised rates were calculated, the rate of infection per 100,000 population increased with increasing age with people aged 80 years or more having the highest rate at 3.16 and 3.17 per 100,000 in 2007 and 2008, respectively. This pattern was observed in both years (Figure 1).

The case fatality ratio (CFR) remained stable across the two years: 391 deaths were reported in 2007 (CFR 6.6%) and 388 were reported in 2008 (CFR 6.5%).

Microbiology

EWGLI collaborators allocate a main method of diagnosis to each reported case, taking culture as the 'gold-standard' test. Over the two years, a total of 1,042 cases were diagnosed by isolation/culture (8.8%). The primary method of diagnosis used was urinary antigen detection (81.0%), and the method of diagnosis was unknown for 187 cases (1.6%) (Table 3). This method of classifying the cases cannot take into account the fact that some will have had more than one method of diagnosis carried out, e.g. culture and urinary antigen detection or PCR and serology. In such cases the primary method is defined in the following order of preference for this analysis: culture, urinary antigen, serology, other.

A total of 10,715 of the cases reported to the dataset were classified as confirmed cases, and 965 were classified as presumptive. For 187 cases, the status was unknown.

The proportion of cases diagnosed by culture was similar in both years: 515 cases (8.7%) in 2007 and 527 cases (8.8%) in 2008. A similar trend was observed for the cases diagnosed by urinary antigen detection; they rose from 4,759 (80.6%) in 2007 to 4,848 (81.3%) in 2008. The proportion of cases diagnosed serologically

(including both four-fold rises and single high titres) fell from 417 (7.1%) in 2007 to 367 (6.2%) in 2008.

The overall very low proportion of cases diagnosed by culture (approximately 9%) masks the fact that the range stretched from under 1% to over 40% in individual countries. Denmark consistently has the highest proportion of cases diagnosed by culture at 40% for 2007-2008, followed by Austria, France, the Netherlands, England and Wales and Sweden at around 15-20%. In Spain, where 2,317 cases were reported for 2007-2008, diagnosis by culture was reported for only 10 of these cases (0.45%) and in Italy for only 33 of 1,958 cases (1.7%).

9,436 (79.5%) of the cases across the two-year period were caused by *Legionella pneumophila* serogroup 1. 'L. pneumophila other serogroup or serogroup not determined' accounted for 1,785 cases (15.0%), and the remaining 646 cases (5.4%) were reported as 'other *Legionella* species' or 'species not known'.

Of the 1,042 isolates obtained, 896 (86.0%) were *L. pneumophila* serogroup 1, 78 (7.5%) were *L. pneumophila* serogroups 2-16 (predominantly serogroup 3 (33 isolates; 3.2%) and serogroup 6 (13 isolates; 1.2%) and 35 (3.6%) were *L. pneumophila* serogroup unknown. Nineteen of the isolates were identified as non-pneumophila species of *Legionella*: *L. anisa* (n=2), *L. bozemanii* (n=4), *L. dumoffii* (n=1), *L. gormanii* (n=1), *L. longbeachae* (n=9), *L. maceachernii* (n=1), *L. wadsworthii* (n=1). For 14 isolates, the species of *Legionella* was not known.

Category of case

Over the two year period, 748 cases were categorised as nosocomial, 7,328 as community-acquired cases, 1,480 as being associated with travel abroad, 1,030 as associated with travel within the country of residence, 86 as 'other' and 1,195 as 'not known' (Table 4). In 2008, nosocomial cases were reported in two categories: cases associated with hospitals (n=307) and cases associated with other healthcare premises (n=112). Within countries, the proportion of cases reported to be community-acquired or travel-associated varied to the extent that a north-south divide is apparent, with northern countries having higher rates of travel-associated infections and southern countries higher rates of community-acquired infections. In Denmark, England and Wales and the Netherlands around 40% of cases are acquired as a result of travel abroad, compared with less than 10% for the southern countries France, Italy and Spain where the proportion of travel-associated cases is lower and the majority of these are related to travel within their own country of residence. In contrast, home-acquired community infection is more common in the southern countries where between 65% and 80% of cases fall into this category compared with around 50% for the northern countries specified above.

Travel within Europe accounted for 2,146 (85.5%) of the travel-associated cases over the two years. Italy was associated with the most cases (513 cases), followed by France (433 cases) and Spain (400 cases). Travel on cruise ships was associated with 11 cases in 2007 and four in 2008. Outside Europe, cases were associated with travel to the Far and Middle East (74 cases), Africa (64 cases), North and South America (57 cases), Asia (54 cases), the Caribbean (19 cases) and Oceania (two cases). The remaining cases that travelled outside Europe visited more than one country or had an unknown travel history.

A more detailed analysis of travel-associated cases of Legionnaires' disease is published each year from EWGLI's surveillance scheme EWGLINET [10]. EWGLINET operates a strict case definition for travel-associated infections (for example excluding patients for whom travel information was incomplete or those for whom travel was outside the 2-10-day incubation period), and so not all cases reported as associated with travel in this dataset can be reported to EWGLINET. Between 2007 and 2008, 2,510 travel cases were reported in the annual dataset, but only 1,795 (71.5%) were reported to EWGLINET (excluding an additional 17 cases that were reported to EWGLINET by countries outside EWGLI).

The month of onset was analysed for those cases that were acquired within the country of residence and reported as community-acquired or associated with travel in their own country. The domestic travel cases followed a similar monthly pattern of onset in both years, although the 2008 cases peaked later (the 2007 peak occurred in July (83 cases), whilst the 2008 peak occurred in August (106 cases)). In contrast, a different pattern was observed across the two years for the community-acquired cases: in 2007 there was a single peak in July (619 cases) mainly accounted for by a large outbreak in Russia (see below), whilst in 2008 there was a double peak, in June (492 cases) and August (486 cases).

Outbreaks/clusters

In 2007, EWGLI countries detected 111 outbreaks or clusters involving 499 cases (8.4% of cases in 2007); in 2008, 132 outbreaks or clusters were detected, involving 391 cases (6.6% of cases in 2008) (Table 5). The outbreaks ranged in size from two to 130 cases. The largest outbreak in 2007 occurred in Verhnaya Pyshma, Russia (130 cases, five deaths) and was attributed to an interruption of the town's hot water supply [11-12]. In 2008, the largest outbreak occurred in eastern Spain (21 cases, one death); the source was identified as a cooling tower.

Over the two year period, 28 outbreaks (11.5%) involving 98 cases were linked to hospitals or healthcare facilities in Austria, Belgium, Cyprus, Denmark, England and Wales, France, Germany, Ireland, Italy, the Netherlands, Poland and Spain. Twenty-two of these were attributed to hot or cold water systems, one to a

wet cooling system and the remaining five could not be attributed to a source. These sources are as reported by our collaborators, and the standard of investigation may vary between countries.

Sixty-three community outbreaks/clusters (25.9%) were identified across the two-year period, involving 417 cases. They occurred in Denmark, England and Wales, France, Ireland, Italy, the Netherlands, Norway, Russia, Spain and Sweden. Sources were identified for 30 (47.6%) of the community outbreaks: wet cooling systems in ten outbreaks, hot or cold water systems in 13, spas in four, a biological treatment plant in one, a footbath in one, and a condensation pipe in one. The source for the remaining 33 could not be identified.

Some 150 clusters (61.7%) were associated with travel, involving 370 cases: 93 with travel outside the country of residence, and 57 with travel within the country of residence. Hot or cold water systems were responsible for 52 of these clusters, a wet cooling system was responsible for one cluster, spa pools for two, and for the remaining 95 the source was unknown. The dataset described here contains only clusters that were detected by individual countries, it does not include clusters that were detected by pooling data across countries (i.e. clusters that comprised single cases from different countries); such clusters are detected by EWGLINET and are reported elsewhere [10].

In addition, there were two outbreaks associated with private buildings: one in 2007 which was found to be associated with a spa (three cases), and one in 2008 (two cases) for which no source could be identified.

Discussion

The overall number of cases of Legionnaires' disease for 2007-2008 (n=11,867) has remained similar to that of 2005-2006 (n=11,980). In some countries the number of reported cases remains consistently low, in others it fluctuates due to the unpredictability of large community outbreaks or the seasonal impact of meteorological factors, as has been shown previously in some northern European countries [13-14]. These fluctuations will also impact on national differences regarding peak months of onset for cases acquired in the community or during domestic travel. Data on month of onset has only been collected in this dataset for two years and, as such, trends cannot yet be determined.

However, the differences in overall trends between countries are usefully highlighted through analyses of these annual datasets and can help to emphasise where improvements in case ascertainment or control and preventive measures can be targeted. The reasons why countries such as Bulgaria, Estonia, Latvia, Lithuania and Romania report fewer than ten cases per year should be urgently reviewed by health officials to assess whether they might benefit from additional laboratory support for diagnosing legionella infections

alongside schemes to raise awareness of the disease among their hospital physicians.

It is not possible to draw firm conclusions about the number of deaths caused by Legionnaires' disease from this dataset. In some countries it is not compulsory to report deaths, and of those that are reported we do not know which were attributable to their legionellosis and which may have been associated with underlying conditions or other causes.

This two-year dataset has also shown that some countries are much more successful than others in obtaining respiratory samples for culture. A lack of isolates in many countries is problematic for public health officials when investigating outbreaks or clusters because without them, no source of infection can be microbiologically confirmed. A high proportion of isolates not only facilitate the identification of sources of infection when environmental isolates are also available for strain matching, but also make possible the identification of *L. pneumophila* non-serogroup 1 infections or other *Legionella* species. These are not normally detected by the most commonly used diagnostic method of urinary antigen detection which almost exclusively detects *L. pneumophila* serogroup 1 infections. Thus if more countries were able to obtain a greater proportion of samples for culture, it is likely that an increase in the less common strains of *L. pneumophila* would be detected such as *L. pneumophila* serogroup 3 and serogroup 6. In addition, an increasing use of PCR as a method of diagnosis in some countries should also enable more cases to be characterised at the molecular level. The dominance of *L. longbeachae* in the 'other' species of isolates is a new finding in Europe and has been linked to exposure to potting soil compost in one or two of the cases, in line with similar findings in Australia [15].

It is encouraging that a smaller proportion of cases (7.5%) was linked to outbreaks or clusters in 2007-2008 compared with 8.6% in 2005-2006. Only one very large outbreak occurred in the 2007-2008 period. It was the first of its kind in a EWGLI participant country and involved a communal hot water supply to several blocks of residential apartments in one town in Russia [11]. Lessons have been learnt from this outbreak and new legislation introduced in Russia to prevent this in the future [12]. Very large community outbreaks such as this are normally associated with cooling towers which have the capacity to spread contaminated aerosol over many square meters and expose large populations to the source of infection. A EWGLI survey into legislation associated with cooling towers (wet cooling systems) found that in 2007 and 2008, only 12 countries or regions had legislation for the registration of cooling towers and for microbiological monitoring of *Legionella* organisms [16]. Several collaborating countries have stated that European Union-wide regulations regarding wet cooling systems are required to prevent a high proportion of cases linked to community-acquired

infection, and EWGLI has recommended that the European Centre for Disease Prevention and Control (ECDC) should take the initiative to propose such regulations. The differences in the proportion of cases acquired at home or abroad between north and south European countries behoves all countries to ensure their detection and reporting mechanisms are operated at levels that minimise the risk of legionella infection as far as is possible for all citizens.

From 1 April 2010, EWGLI's surveillance network for travel-associated Legionnaires' disease, EWGLINET, will be coordinated and managed by the ECDC, as will the collection of this annual dataset from each participant country. It is expected that EWGLI's active and enhanced surveillance activities will continue under the ECDC and will be developed further in line with the specific needs or requirements of individual countries, in order, for example, to improve ascertainment of cases in low incidence countries or to support efforts for the control and prevention of Legionnaires' disease in different countries and exposure settings.

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