Public Health England

Protecting and improving the nation's health

Legionnaires' disease in residents of England and Wales – 2016

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Executive summary

In 2016, 359 cases of Legionellosis (confirmed and presumptive) were reported to the National Surveillance Scheme for Legionnaires' disease in residents of England and Wales.

Of the 355 confirmed cases of Legionnaires' disease reported with onset of symptoms in 2016, 250 (70.4%) were male and 105 (29.6%) were female, giving a male to female ratio of 2.4 to 1.0.

Just over 60% of the 355 confirmed cases of Legionnaires' disease, (216 cases), were reported in individuals aged 60 years and over.

Over the three-year period 2014 to 2016, the incidence rate in England and Wales reached a mean of 6.1 cases per million population (pmp). As in 2015; peak incidence was reported by the East Midlands (9.1 pmp) followed by West Midlands (7.5 pmp) PHE centres.

Of the 355 confirmed cases of Legionnaires' disease, more than half of the cases, 202 (56.9%), were considered to have been exposed to the infecting organism in the community, 147 (41.4%) cases were associated with travel abroad and 6 (1.7%) were considered to have links to a healthcare facility (nosocomial) which is half that observed in 2015.

Almost three quarters of cases, 265 (74.6%), reported at least one underlying condition/risk factor; with heart conditions and smoking being the most frequently reported risk factors.

The crude case fatality rate in cases with onset of symptoms in 2016 was 7.0%, and for the first time showing evidence of a linear decrease in trend between the year of onset and case fatality.

The proportion of cases microbiologically confirmed by polymerase chain reaction (PCR) was 29.3%, which is in line with figures observed in 2015. The North West and East Midlands regions submitted lower respiratory samples to the reference laboratory for culture and PCR testing for more than or equal to half of all their cases

Of the clinical samples where complete sequence-based typing was obtained the most common strains identified were *L. pneumophila* serogroup 1 ST47 and ST42.

There has been a decrease in the total number of clusters/outbreaks identified in 2016 from 37 observed in 2015 to 25 in 2016. The greatest difference between the 2 years

was in the number of incidents associated with travel abroad which almost halved from 19 clusters/outbreaks in 2015 to 10 identified in 2016.

The proportion of travel associated cases of Legionnaires' disease decreased to levels below those reported in 2015 where 46.1% of cases were associated with travel abroad and 12.0% were associated with travel within the UK compared to 41.4% and 9.0% in travel abroad and travel UK cases respectively, in 2016.

Spain remains the destination most frequently travelled to by cases of Legionnaires' disease during 2016 with 28 cases having travelled to Spain during their 2 to 10 day incubation period with an incidence rate of 1.9 cases per million visits. This was followed by travel to the United Arab Emirates (UAE) where 24 cases had travelled however the incidence rate of cases per visit to UAE was in excess of tenfold of the rate in Spain at 26.0 cases per million visits.

Background

Legionnaires' disease is a severe atypical pneumonia that can potentially be fatal. It is caused by exposure to bacteria of the genus Legionella which are ubiquitous and inhabit natural water systems such as streams, rivers and lakes. Legionella bacteria are also able to survive in artificial water systems, for example cooling towers, evaporative condensers, spa pools and hot/cold water systems. Such man-made water systems mimic the organism's natural habitat thereby providing an ideal environment for growth (1).

The principal route of infection is through direct exposure to aerosols generated and dispersed from colonised man-made sources. Inhalation of these aerosols in high enough concentrations particularly by individuals with risk factors, such as age, male gender, tobacco smoking and immunosuppression, can result in Legionnaires' disease (2). Two further recognised syndromes caused by the same organism are Pontiac fever (3) a self-limiting, non-fatal, mild influenza-like illness and an atypical form of the disease, known as non-pneumonic Legionellosis characterised by symptoms similar to those of Legionnaires' disease but with the absence of pneumonia.

A poorly designed and/or badly maintained water system has the potential to be a source of major outbreaks. Therefore prevention of Legionnaires' disease is principally through the implementation of stringent legislation for the control and management of man-made water systems (4-6).

The primary purpose of the National Enhanced Legionnaires' disease Surveillance Scheme (NELSS) is to identify clusters and prevent or minimise the impact of potential outbreaks; historically several have been attributed to lapses in the control and management of man-made water systems within the community.

Case definitions

Confirmed case of Legionnaires' disease

A clinical or radiological diagnosis of pneumonia with laboratory evidence of one or more of the following:

- isolation (culture) of legionella species from clinical specimens
- the presence of *L.pneumophila* urinary antigen determined using validated reagents or kits
- seroconversion (a 4-fold or greater increase in titre) determined using a validated indirect immunofluorescent antibody test (IFAT) incorporating a monovalent *L. pneumophila* serogroup 1 antigen. (When submitted to the reference laboratory at

Colindale, all positive serum specimens are examined by the IFAT test in the presence of campylobacter blocking fluid, to eliminate cross reactions)

Presumptive case of Legionnaires' disease

A clinical or radiological diagnosis of pneumonia with laboratory evidence of one or more of the following:

- detection of *Legionella spp.* nucleic acid (eg by PCR) in a clinical specimen.
- a positive direct fluorescence (DFA) on a clinical specimen using validated *L. pneumophila* monoclonal antibodies (also referred to as a positive result by Direct Immunofluorescence (DIF)).
- a single high titre of 128 using IFAT or over (or a single titre of 64 in an outbreak) using IFAT incorporating a monovalent *L. pneumophila* serogroup 1 antigen. (When submitted to the reference laboratory at Colindale, all positive serum specimens are examined by the IFAT test in the presence of campylobacter blocking fluid, to eliminate cross reactions)
- a 4-fold rise increase in antibodies against other *Legionella spp.* or *L. pneumophila* non-serogroup 1 infections.

Cluster/Outbreak definitions

Cluster

Two or more cases that initially appear to be linked by area of residence or work, including a healthcare or other type of community setting and which have sufficient proximity in dates of onset of illness (eg 6 months) to warrant further investigation (this is a working definition: the decision to follow up cases is made locally). The area of residence should take account of population size and density when investigations are planned. If after investigation no common exposures to a potential source of infection are identified for the cases, other than the links mentioned above, then they should be classified as sporadic community acquired cases. Consideration should be given to convening an incident control team if a cluster is identified.

Outbreak

Two or more cases where the onset of illness is closely linked in time (weeks rather than months) and where there is epidemiological evidence of a common source of infection, with or without microbiological evidence. An incident control team should always be convened to investigate outbreaks.

Travel associated cluster

Two or more cases who stayed overnight at the same accommodation site in the 2 to 10 days before onset of illness and whose illness is within the same 2 year period. (*This definition is used throughout Europe for managing the follow up of travel associated cases reported to ELDSNet*).

National Enhanced Legionnaires' disease Surveillance Scheme

The national enhanced Legionnaires' disease surveillance scheme (NELSS) in residents of England and Wales was established in 1980 in order to collect enhanced surveillance data on all cases of Legionnaires' disease. The scheme is managed by the Respiratory Diseases Department, National Infection Service, Public Health England. The primary objectives of NELSS is to identify clusters and outbreak, collaborate with the European Legionnaires' disease Surveillance Network (ELDSNet) and support the management and control of outbreaks and incidents nationally and internationally.

Methodology

The data presented in this report is extracted from the NELSS database, which holds data on all reported cases of Legionellosis in residents of England and Wales. Cases are reported through the submission of a national surveillance form which requests detailed information on each case's activities in the 10 days prior to onset of symptoms along with information on potential exposures. The reported data is assessed and verified; once the case definition has been met the case is analysed against the national dataset for risk factors and potential associations with previously reported cases.

All Legionella data are organised by date of onset of symptoms across a calendar year, January to December. The data presented in this report is for cases with onset of symptoms from 01 January 2016 to 31 December 2016 in residents of England and Wales. Data from previous years (2007 to 2015) are presented for comparative purposes; please note that some data may differ from previous publications as further information comes to light and data is updated accordingly.

All population data has been obtained from the Office of National Statistics (ONS);

- Incidence rates – use ONS mid 2016 population estimates for England and Wales
- Travel rates – use ONS travel trends for 2016

All statistical analysis was carried out using the statistical computer program, STATA, version 13.

Descriptive epidemiology

Legionellosis

The number of potential cases of Legionellosis with onset of symptoms during 2016 reported to NELSS was 510; of these 126 were proven to be negative, four cases were lost to follow-up and 20 cases were associated with residents outside of England and Wales. The remaining 357 cases were confirmed or probable cases of Legionellosis. Based on the nation case definitions (7) 355 cases fulfilled the case definition for a confirmed case of Legionnaires' disease, 2 further cases met the definition for a probable case (ie those diagnosed by PCR alone or by serological testing). There were a further 2 cases reported with non-pneumonic legionellosis; these cases had microbiological results indicating confirmed legionella infection but no clinical or radiological evidence of pneumonia, (Table 1).

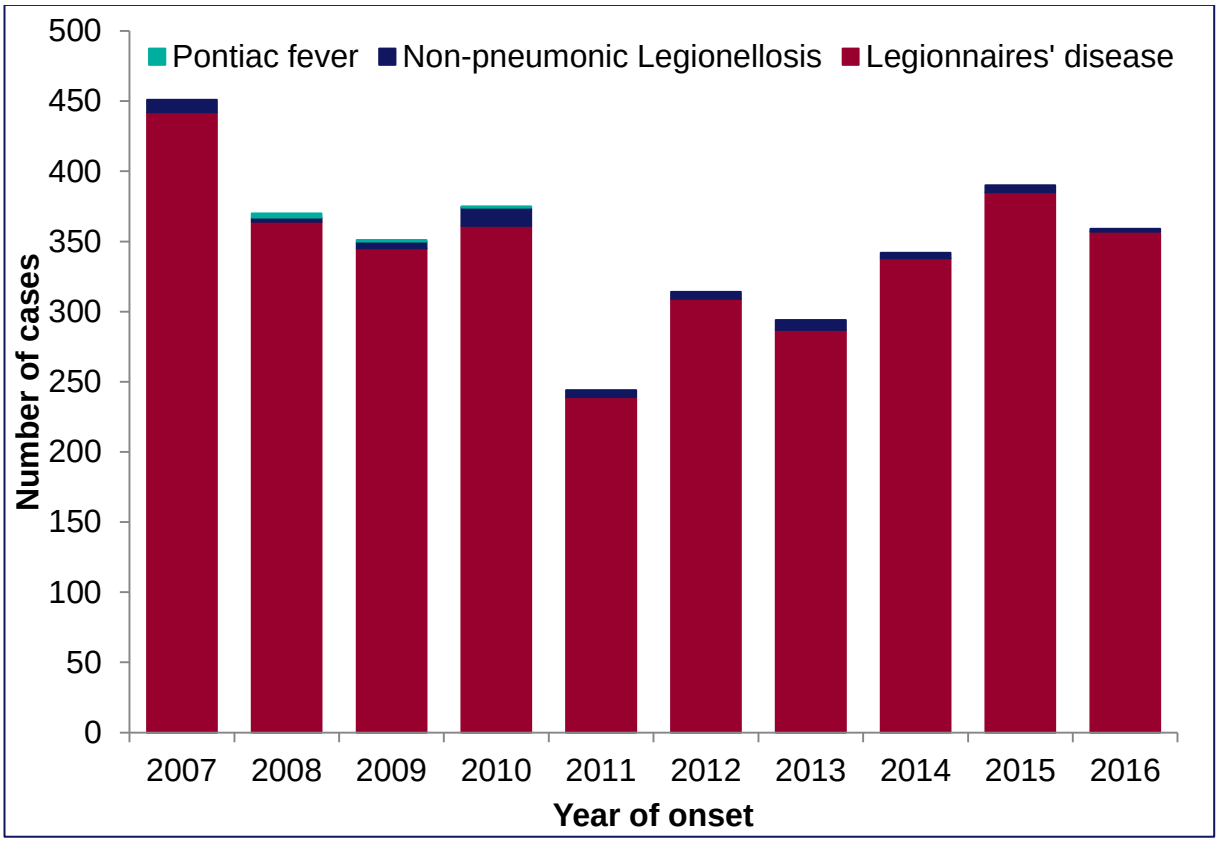
Table 1: Number of cases of Legionellosis (including presumptive) by disease type and year of symptoms onset, 2014 to 2016

	Number of confirmed (presumptive*) cases		
	2014	**2015**	**2016**
Legionnaires' disease	331 (7)	384 (1)	355 (2)
Non-pneumonic Legionellosis	4	5	2
Pontiac Fever	-	-	-
Total	**342** (335 confirmed, 7 presumptive)	**390** (389 confirmed, 5 presumptive)	**359** (357 confirmed, 2 presumptive)

( ) additional presumptive cases (ie cases with a serological diagnosis (a single high titre) or PCR result)

As shown in Figure 1, the annual number of legionellosis cases was lower in 2016 than in 2015. However, the 2016 total remain higher than the annual case numbers observed previously between 2011 and 2014 and is above the 349 mean annual number of cases observed since 2006.

Figure 1: Number of cases of Legionellosis (including presumptive) by year of onset of symptoms, 2007 to 2016



The remainder of this report will focus on the description, analysis and interpretation of only the 355 cases that meet the clinical and microbiological criteria for a confirmed case of Legionnaires' disease.

Age and gender distribution

In 2016, there were 250 (70.4%) cases reported in males and 105 (29.6%) cases reported in females, providing a male to female ratio of 2.4:1 which falls between the 2014 and 2015 ratios and continues to demonstrate the higher proportion of cases in males which has been observed internationally.

Table 2: Number and proportion (%) of confirmed cases of Legionnaires' disease by gender and age group, 2014 to 2016

	2014		2015		2016		Total	
	Females	**Males**	**Females**	**Males**	**Females**	**Males**	**Females**	**Males**
< 50 years	11 (22.0)	39 (78.0)	13 (18.8)	56 (81.2)	12 (24.5)	37 (75.5)	36 (21.4)	132 (78.6)
50-59 years	27 (32.5)	56 (67.5)	25 (25.5)	73 (74.5)	23 (25.6)	67 (74.4)	75 (27.7)	196 (72.3)
60-69 years	31 (31.3)	68 (68.7)	32 (29.1)	78 (70.9)	29 (25.4)	85 (74.6)	92 (28.5)	231 (71.5)
70+ years	32 (32.3)	67 (67.7)	25 (23.4)	82 (76.6)	41 (40.2)	61 (59.8)	98 (31.8)	210 (68.2)
All Ages	**101 (30.5)**	**230 (69.5)**	**95 (24.7)**	**289 (75.3)**	**105 (29.6)**	**250 (70.4)**	**301 (28.1)**	**769 (71.9)**

The age distribution of Legionnaires' disease cases, Table 3, has shown little change in 2016 compared to the previous 2 years, with the majority of cases observed in those aged 50 years and over. The most obvious distinction in 2016 is in the proportion of cases among those aged less than 50 years, marginally lower compared to previous years.

Table 3: Number and proportion (%) of confirmed cases of Legionnaires' disease by year of symptom onset and age group, 2014 to 2016

	2014 (%)	**2015** (%)	**2016** (%)	**Total** (%)
< 50 years	50 (15.1)	69 (18.0)	49 (13.8)	168 (15.7)
50-59 years	83 (25.1)	98 (25.5)	90 (25.4)	271 (25.3)
60-69 years	99 (29.9)	110 (28.6)	114 (32.1)	323 (30.2)
70+ years	99 (29.9)	107 (27.9)	102 (28.7)	308 (28.8)

Seasonality

Legionnaires' disease cases in 2016 followed the established seasonal pattern with a peak number of cases experiencing onset of symptoms between June and October 2016, Figure 2; this represents 60.3% of all cases in 2016 and is in line with 2014 and 2015. Additionally, the smaller peak seen in January over recent years was also observed in 2016.

Figure 2: Number of confirmed cases of Legionnaires' disease by month and year of onset of symptoms; 2014 to 2016

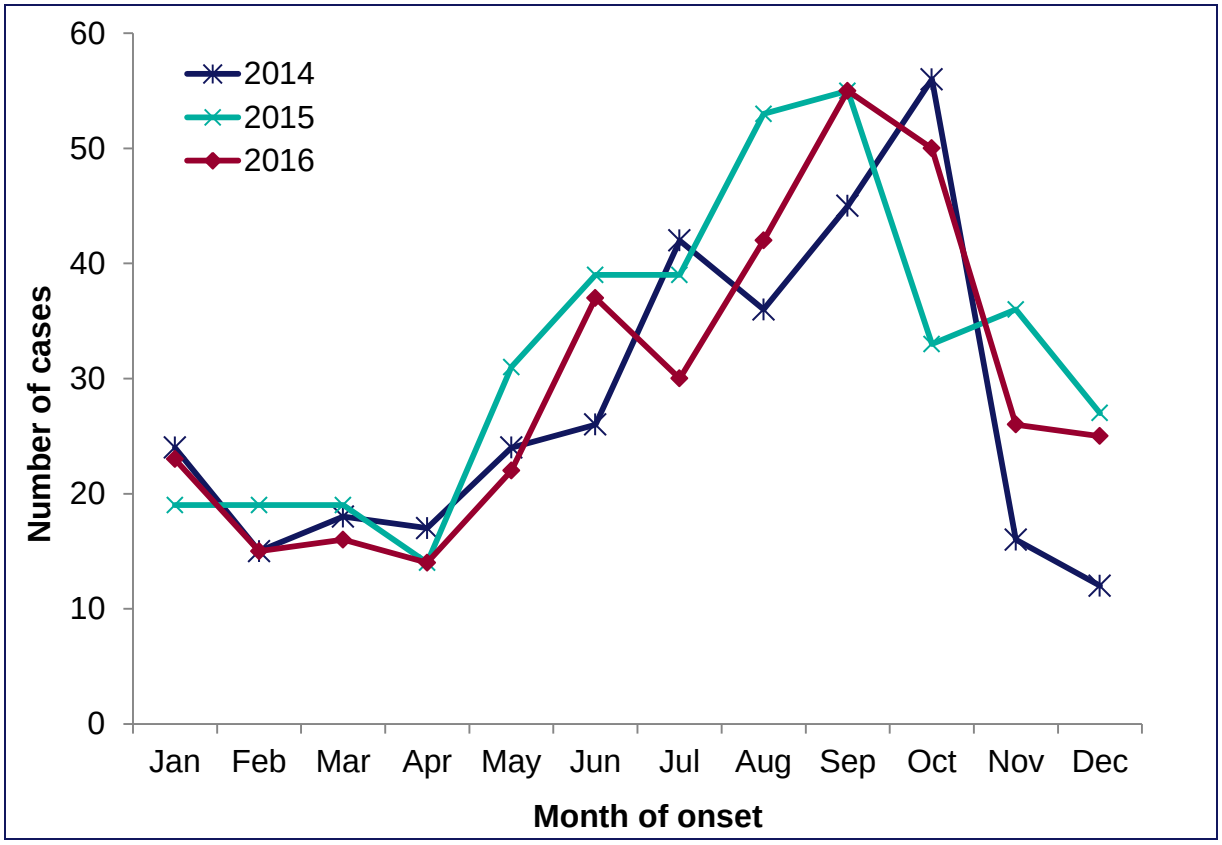
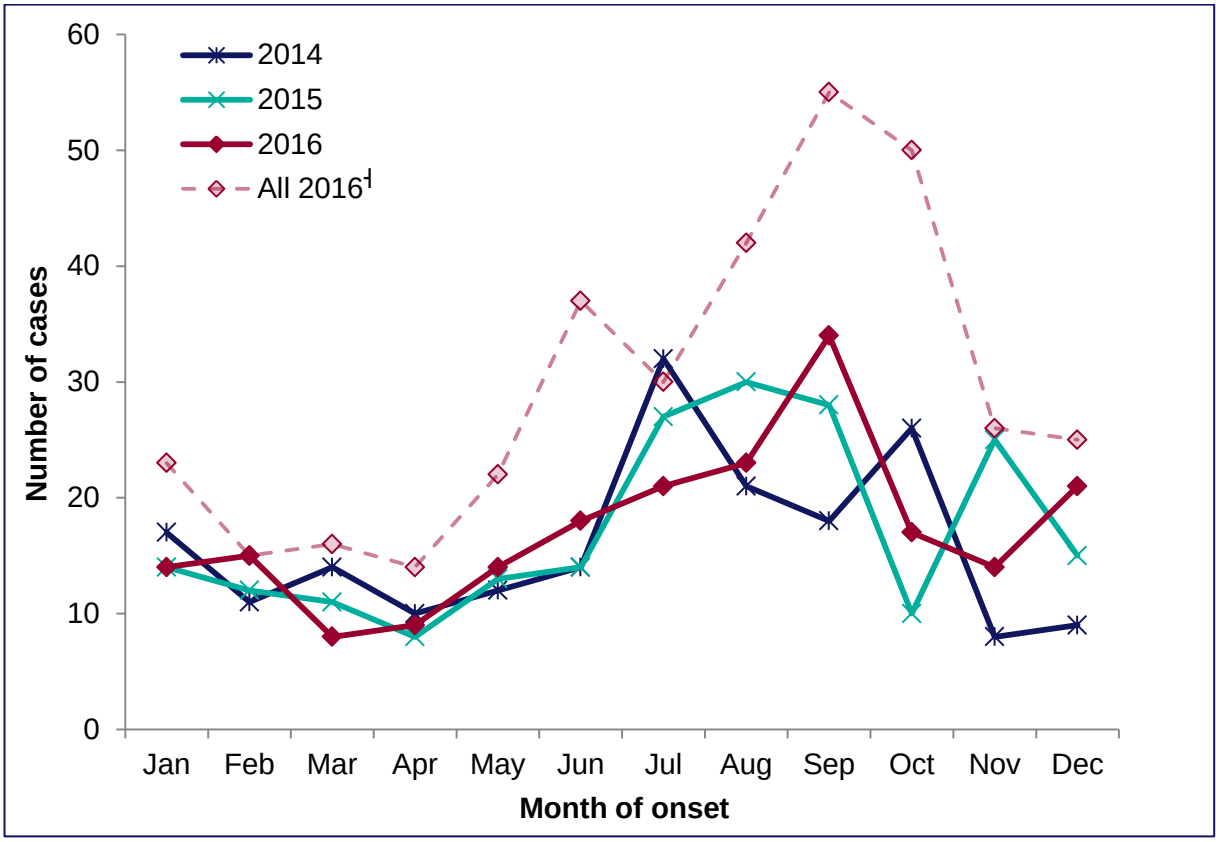


Figure 2 shows all cases of Legionnaires' disease reported to the NELSS with onset of symptoms during 2016 whilst Figure 3 shows the distribution of cases thought to have been infected in England and Wales, ie excludes cases associated with travel abroad. A comparison of the 2 graphs shows that seasonal peaks are still present when cases associated with travel abroad have been removed, thereby indicating the seasonal impact on cases acquired in England and Wales.

Figure 3: Number of confirmed cases of Legionnaires' disease excluding all travel abroad cases, by month and year of onset of symptoms; 2014 to 2016



ǂ includes travel abroad cases

Geographic distribution

The number of cases of Legionnaires' disease reported across the 9 PHE Centres in England plus Wales with onset of symptoms in 2016 ranged from 14 to 53 cases, Table 4. The PHE centres that reported the highest number of cases with onset in 2016 was the South East followed by East Midlands, then West Midlands, leaving London in fourth position whilst in the previous 2 years London reported the highest number of cases.

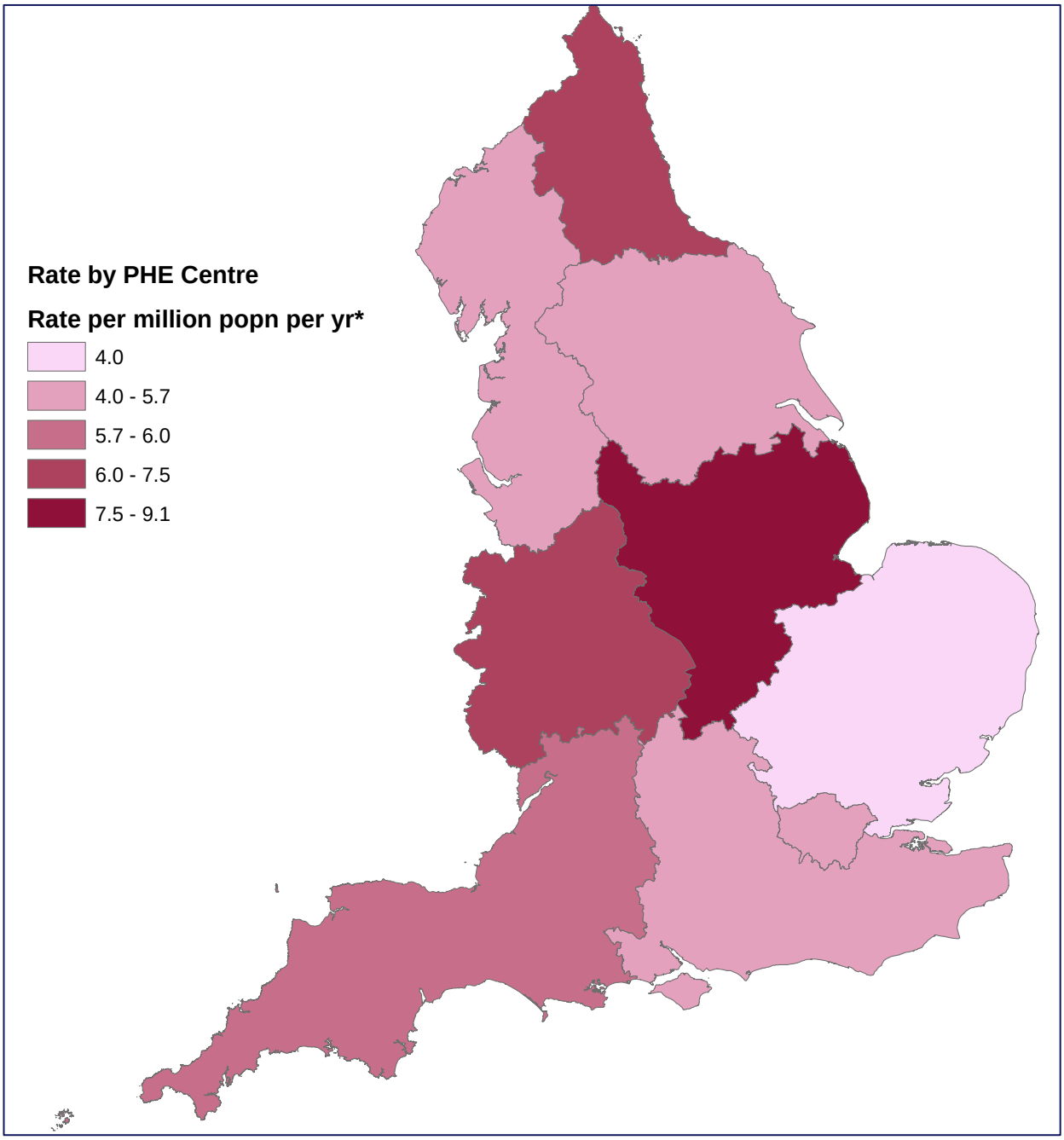
Table 4: Mean rate (million population†) of confirmed cases of Legionnaires' disease by PHE centre (and Wales) and year of symptom onset, 2014 to 2016

Public Health England centres and Wales	2014	2015	2016	Total	Rate per million popn per yr.†
East Midlands	46	33	50	129	**9.1**
East of England	14	26	34	74	**4.0**
London	48	57	45	150	**5.7**
North East	15	27	14	56	**7.1**
North West	41	45	34	120	**5.5**
South East	46	54	53	153	**5.7**
South West	34	38	27	99	**6.0**
Wales	26	19	18	63	**6.8**
West Midlands	38	43	49	130	**7.5**
Yorkshire and Humber	22	40	31	93	**5.7**
Other	1	2	0	3	**-**
Total	**331**	**384**	**355**	**1070**	**6.1**

† Population denominators based on mid-2016 population estimates from office of national statistics.

The overall Legionnaires' disease incidence rate for England and Wales was 6.1 cases per million population and as such East and West Midlands, the North East and Wales all experienced a higher incidence rate compared to the overall rate for England and Wales. Meanwhile the East of England reported the lowest mean incidence rate at 4.0 cases per million population.

Figure 4: Incidence rate per million population* of confirmed Legionnaires' disease cases by PHE centre of residence (and Wales) and year of onset, 2014 to 2016



* Population denominators based on mid-2016 population estimates from office of national statistics.

Category of exposure

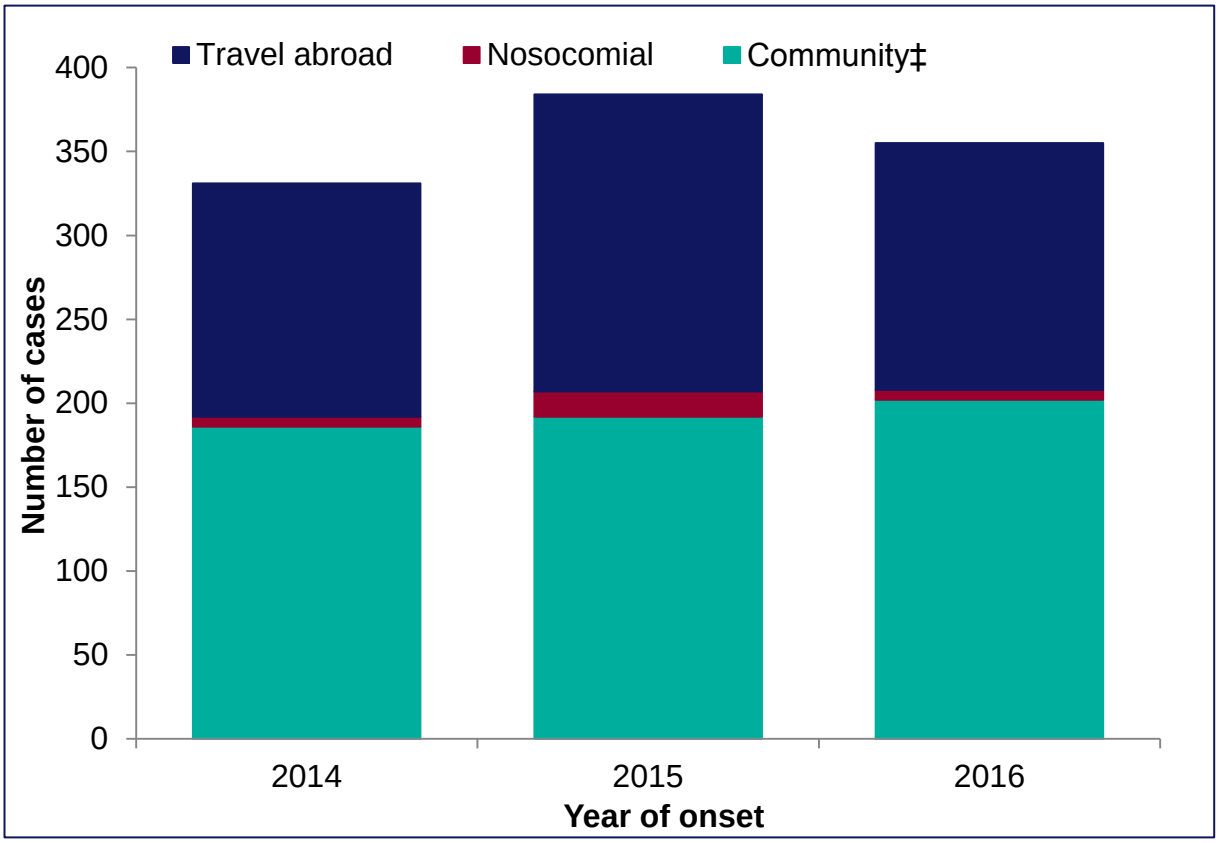
The distribution of cases between principal categories of exposure remained relatively stable between 2014 and 2016, Table 5. Small fluctuations are observed in the proportion of cases for each of the 3 categories and particularly so in the community and travel abroad categories. Such small changes in each of the categories are not uncommon and have been observed in previous years.

Table 5: Number of confirmed cases of Legionnaires' disease by principal exposure category and year of onset, 2014 to 2016

Category	**Community**‡ (%)	**Nosocomial** (%)	**Travel abroad** (%)
2014	186 (56.2)	6 (1.8)	139 (42.0)
2015	192 (50.0)	15 (3.9)	177 (46.1)
2016	202 (56.9)	6 (1.7)	147 (41.4)

‡ includes travel UK cases

Figure 5: Number of confirmed Legionnaires' disease cases by year of onset and principal category of exposure, 2014 to 2016



‡ includes travel UK cases

Risk factors

One of the main risk factors for Legionnaires' disease in individuals are underlying medical conditions including immunosuppression, long term respiratory diseases, liver and kidney diseases as well as tobacco smoking. These conditions along with others are well known to be associated with Legionella infection (8).

The proportions of cases with these individual risk factors are shown in Table 6, which indicates little change in the overall proportion of cases with one or more underlying medical condition or risk factor for Legionnaires' disease; between 2014 and 2016 the proportions range from 73.1% in 2014 to 74.6% in 2016.

As seen in 2014 and 2015 the most prevalent risk factor is smoking whilst the most prevalent underlying health conditions are heart/circulatory conditions followed by diabetes.

Table 6: Underlying medical conditions and risk factors reported in confirmed cases of Legionnaires' disease, 2014 to 2016

	2014 (%)	**2015** (%)	**2016** (%)
Any underlying condition	**242 (73.1)**	**286 (74.5)**	**265 (74.6)**
Diabetes	50 (15.1)	67 (17.4)	46 (13.0)
Heart conditions	96 (29.0)	122 (31.8)	101 (28.5)
Immunosuppression^	40 (12.1)	45 (11.7)	46 (13.0)
Liver conditions	12 (3.6)	15 (3.9)	16 (4.5)
Neoplasms	26 (7.9)	28 (7.3)	25 (7.0)
Renal disorders	12 (3.6)	19 (4.9)	13 (3.7)
Respiratory conditions	26 (7.9)	52 (13.5)	43 (12.1)
Smoking	109 (32.9)	110 (28.6)	115 (32.4)

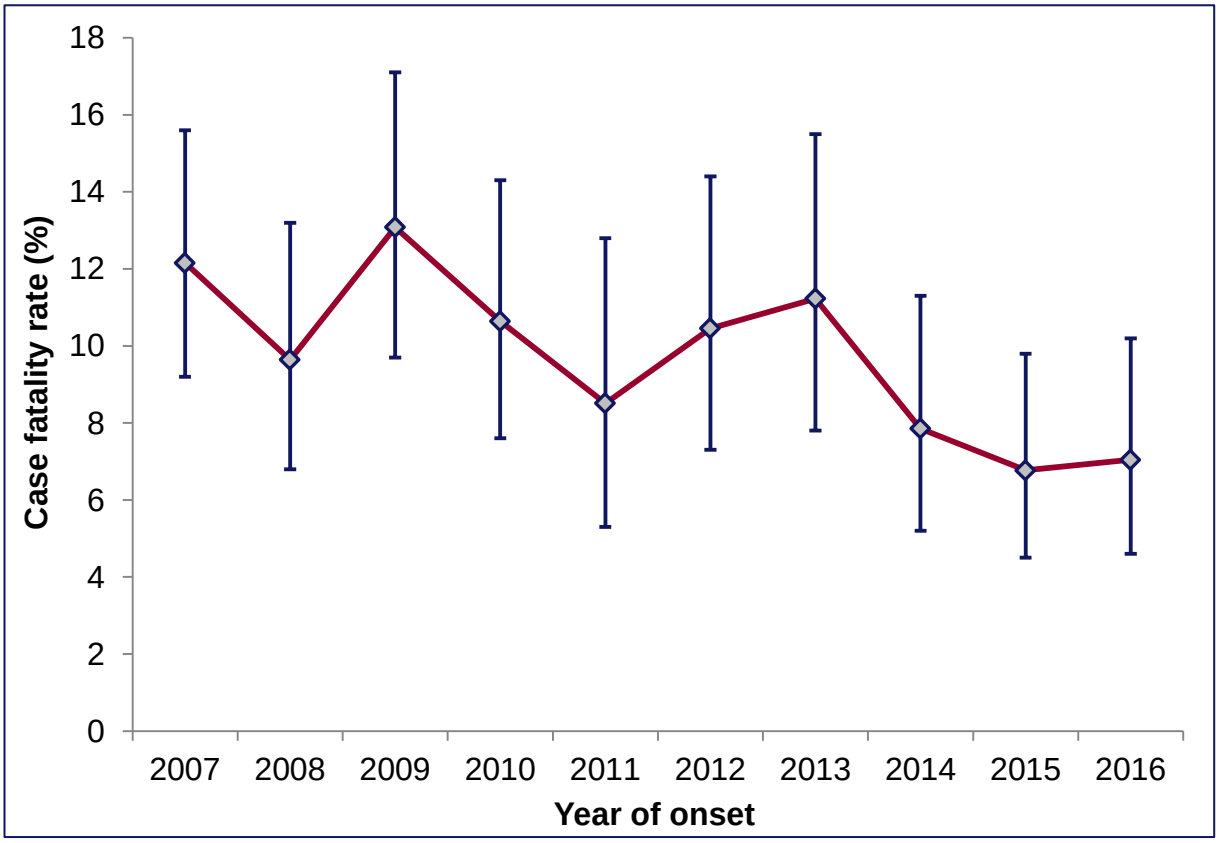
^ immunosuppression due to other conditions or clinical treatments

NB: Individual cases may have reported more than one underlying condition/risk factor

Mortality

Since 2007 the annual number of deaths reported among Legionnaires' disease cases (via either local PHE Centre Health Protection Teams or death certification data) ranged from 53 in 2007 to 20 in 2011 with a median of 32 deaths between 2007 and 2016. The number of deaths reported in 2016 was well below the median at 25 deaths, one less than in 2015.

Figure 6: Case fatality rates for Legionnaires' disease by year of symptoms onset, 2007 to 2016



The case fatality rate (CFR) for 2016 is 7.0, in line with the general trend for decreasing CFR since 2007, Figure 6. Statistically at the 0.05 level of significance there is some evidence of a linear trend between year of onset and a fatal outcome, (p-value; 0.0012, significant). This would suggest that since 2007 in England and Wales there has been an improvement in the outcome of patients diagnosed with Legionnaires' disease.

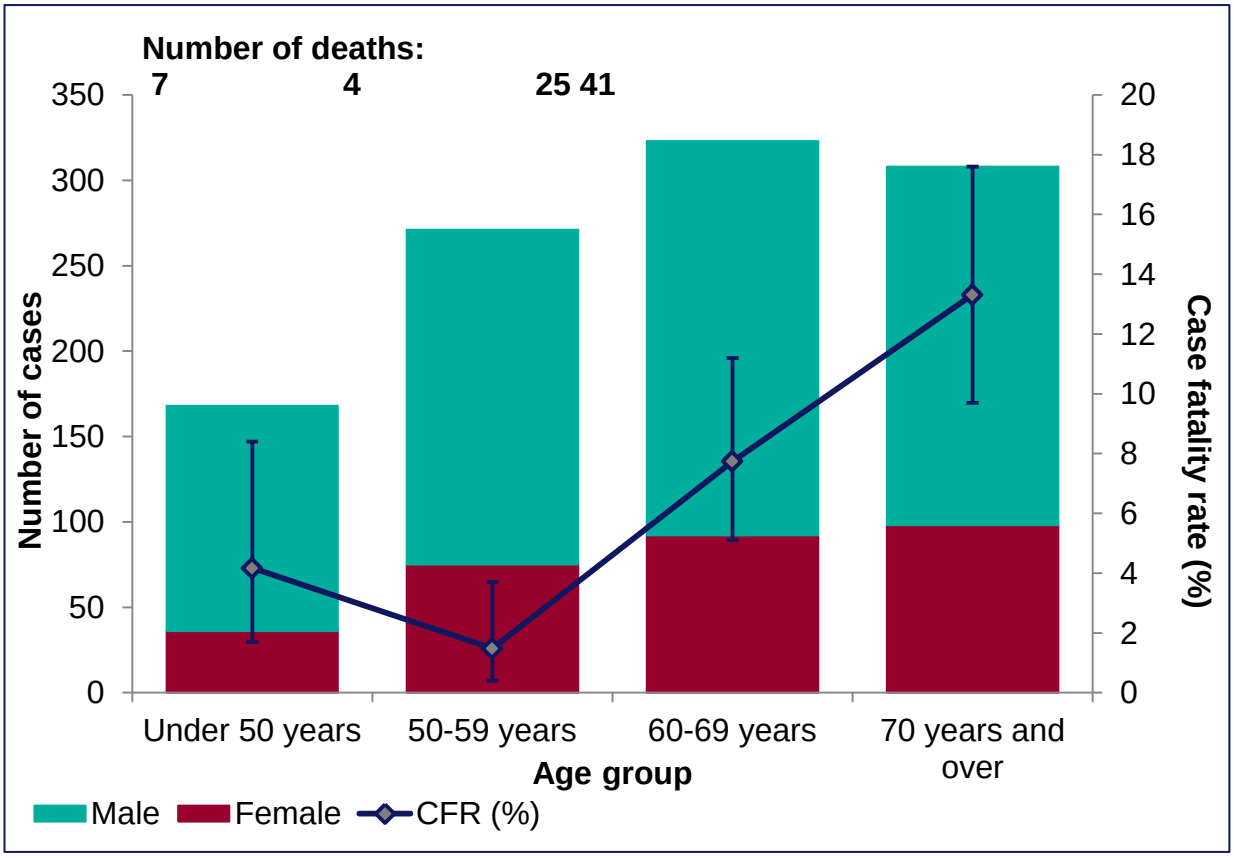
Table 7: Case fatality rates for confirmed cases of Legionnaires' disease by principal category of exposure, 2014 to 2016

	Cases	**Deaths**	**Case Fatality Rate** (%) **(95% CI)**
Community‡	580	57	9.8 (7.5 - 12.5)
Nosocomial	27	6	22.2 (8.6 - 42.3)
Travel Abroad	463	14	3.0 (1.7 - 5.0)
Total	**1070**	**77**	**7.2 (5.7 - 8.9)**

‡ includes travel UK cases

When studying the CFR for cases by category of exposure the highest CFR is observed in nosocomial cases, CFR (22.2%), Table 7, compared with those cases with a principal exposure considered to be in the community (9.8%). Conversely where cases are principally thought to have been exposed abroad the CFR is the lowest at 3.0% (95%CI 1.7 – 5.0), compared to cases in the other categories. This difference is statistically significant with a chi-squared test for association suggesting a strong association between exposure groups and fatality, (p-value; <0.0001, significant).

Figure 7: Number of confirmed cases of Legionnaires' disease by age and gender, with case fatality rate (%) and 95% CI, 2014 to 2016



Among 2016 cases, 21 of the 25 deaths were in males with a median age of 70 years and four females with a median age of 76 years. The age at death in females diagnosed with Legionnaires' disease has increased by more than 10 years since 2014 compared to the median age at death in males which decreased slightly from 74 to 70 years for the same time period.

When comparing age groups, Table 8, shows that the CFR was lower for the 50-59 year age group compared to the other age groups and as in previous years the CFR was highest in those age 70 years and over. When analysed statistically the chi-squared test

for trend indicates that there is strong evidence of a linear trend across all age groups and fatality as an outcome, (p-value, <0.0001; significant).

Table 8: Number of confirmed cases of Legionnaires' disease by age group with case fatality rate (%) and 95% CI, 2014 to 2016

Age group	**Cases**	**Deaths**	**Case Fatality Rate** (%) **(95% CI)**
Under 50 years	168	7	4.2 (2.5 - 40.2)
50 - 59 years	271	4	1.5 (1.1 - 2.2)
60 - 69 years	323	25	7.7 (2.6 - 3.5)
70 years and over	308	41	13.3 (3.6 - 4.3)

Microbiology

Urinary antigen testing remains the most frequent diagnostic test among cases of Legionnaires' disease in England and Wales, with a positive result in 98% of all cases, the majority, (88.2%), of which were confirmed by the national Legionella reference laboratory. This is consistent with previous years in England and Wales and higher than that observed across Europe (9). The proportion of culture positive cases continues to decrease from 23.2% in 2015 to 19.7% in 2016, Table 9, whilst the proportion of cases positive by polymerase chain reaction decreased very slightly by 1.2% since 2015, (29.3%).

Table 9: Legionnaires' disease cases by diagnostic test and year of onset, 2014 to 2016

Diagnostic test	**2014** (%)	**2015** (%)	**2016** (%)
Culture	82 (24.8)	89 (23.2)	70 (19.7)
Urinary antigen	321 (97.0)	375 (97.7)	348 (98.0)
Four-fold rise - (serology)	-	-	-
Single High Titre - (serology)	-	-	-
Polymerase Chain Reaction[º]	85 (25.7)	117 (30.5)	104 (29.3)

º includes positive tests with complete and partial sequence-based types deduced

NB: Individual cases may have been tested using one or more of the methods of diagnosis.

Table 10 indicates that the greatest proportion of cases in 2016 were infected by *L.pneumophila* serogroup unknown, similar to the proportion observed in 2015. This again relates to the widespread use of the urinary antigen test; although these tests are generally marketed to detect *L.pneumophila* serogroup 1, it has been shown that many of these test kits may give positive results for other serogroups as well. It is therefore, only those cases which are shown to be *L.pneumophila* serogroup 1 through other methods such as PCR testing that are classified as serogroup 1. No non-pneumophila *Legionella spp*. were confirmed in 2016.

Table 10: Legionnaires' disease cases by causative organism, 2014 to 2016

	2014 (% total cases)	**2015** (% total cases)	**2016** (% total cases)
***L.pneumophila* serogroup 1**	215 (65.0)	122 (31.8)	106 (29.9)
***L.pneumophila* serogroup 2-14**	4 (1.2)	6 (1.6)	4 (1.1)
***L.pneumophila* serogroup unknown**	110 (33.2)	255 (66.4)	245 (69.0)
***Legionella* species (non-pneumophila)**	2 (0.6)	1 (0.3)	-
Total	**331**	**384**	**355**

When a case tests positive locally for legionella infection and a lower respiratory tract sample is collected from the case and sent to the reference laboratory, culture and PCR testing is undertaken. Despite the difficulty in obtaining lower respiratory samples from patients the East Midlands and North West regions were able to obtain 50% or more samples from their cases for culture and/or PCR testing compared to the West Midlands and Wales who only managed to collect lower respiratory samples from 26.5 and 27.8% of cases respectively. Across England and Wales 79.0% of 138 lower respiratory tract samples tested by culture and/or PCR were found to be positive for *Legionella pneumophila* and of these 92.7% had a complete sequence type (ST) or a partial sequence-based type (SBT) determined from the tests.

Table 11: Number and proportion (%), of confirmed cases of Legionnaires' disease with a sequence type (ST) or a partial sequence-based type (SBT) by PHE centre 2016

Public Health England centres and Wales	**Confirmed cases**	**Respiratory samples** (%)	**Culture &/or PCR positive cases** (%)	**Cases with an ST or partial SBT** (%)
East Midlands	50	25 (50.0)	19 (76.0)	16 (84.2)
East of England	34	10 (29.4)	6 (60.0)	6 (100.0)
London	45	16 (35.6)	13 (81.3)	12 (92.3)
North East	14	5 (35.7)	3 (60.0)	3 (100.0)
North West	34	18 (52.9)	15 (83.3)	15 (100.0)
South East	53	25 (47.2)	20 (80.0)	19 (95.0)
South West	27	9 (33.3)	6 (66.7)	6 (100.0)
Wales	18	5 (27.8)	5 (100.0)	5 (100.0)
West Midlands	49	13 (26.5)	12 (92.3)	10 (83.3)
Yorkshire and Humber	31	12 (38.7)	10 (83.3)	9 (90.0)
Total	355	138 (38.9)	109 (79.0)	101 (92.7)

Culture and PCR testing not only enable the identification of infection by *L.pneumophila* non-serogroup 1 but culture can also identify infections caused by non-pneumophila species of Legionella. This underlines the value of respiratory specimens being collected and forwarded to the reference laboratory. Furthermore PCR testing has enabled the ST of the infecting strain to be identified which can prove invaluable in determining the potential source.

Table 12: Most prevalent STs of *L. pneumophila* identified in clinical isolates from confirmed cases of Legionnaires' disease, 2014 to 2016

Sequence type (ST)	**Number of cases with isolates**			
	2014 (%)	**2015** (%)	**2016** (%)	**Total** (%)
47	13 (3.9)	13 (3.4)	12 (3.4)	**38 (3.6)**
42	9 (2.7)	15 (3.9)	6 (1.7)	**30 (2.8)**
1	5 (1.5)	9 (2.3)	6 (1.7)	**20 (1.9)**
37	2 (0.6)	5 (1.3)	4 (1.1)	**11 (1.0)**
616	5 (1.5)	1 (0.3)	5 (1.4)	**11 (1.0)**
23	2 (0.6)	6 (1.6)	2 (0.6)	**10 (0.9)**
62	4 (1.2)	3 (0.8)	3 (0.8)	**10 (0.9)**
82	3 (0.9)	3 (0.8)	3 (0.8)	**9 (0.8)**
74	3 (0.9)	3 (0.8)	-	**6 (0.6)**
117	1 (0.3)	1 (0.3)	3 (0.8)	**5 (0.5)**

The 3 most common STs identified in clinical samples from cases with onset of symptoms during 2016 remains consistent with those strains most commonly identified in 2014 and 2015. In 2016, ST47 accounted for 3.6% of all cases with isolates, followed by ST42 (2.8%) and ST1 (1.9%).

Figure 8: Sequence type by principal category of exposure, 2016

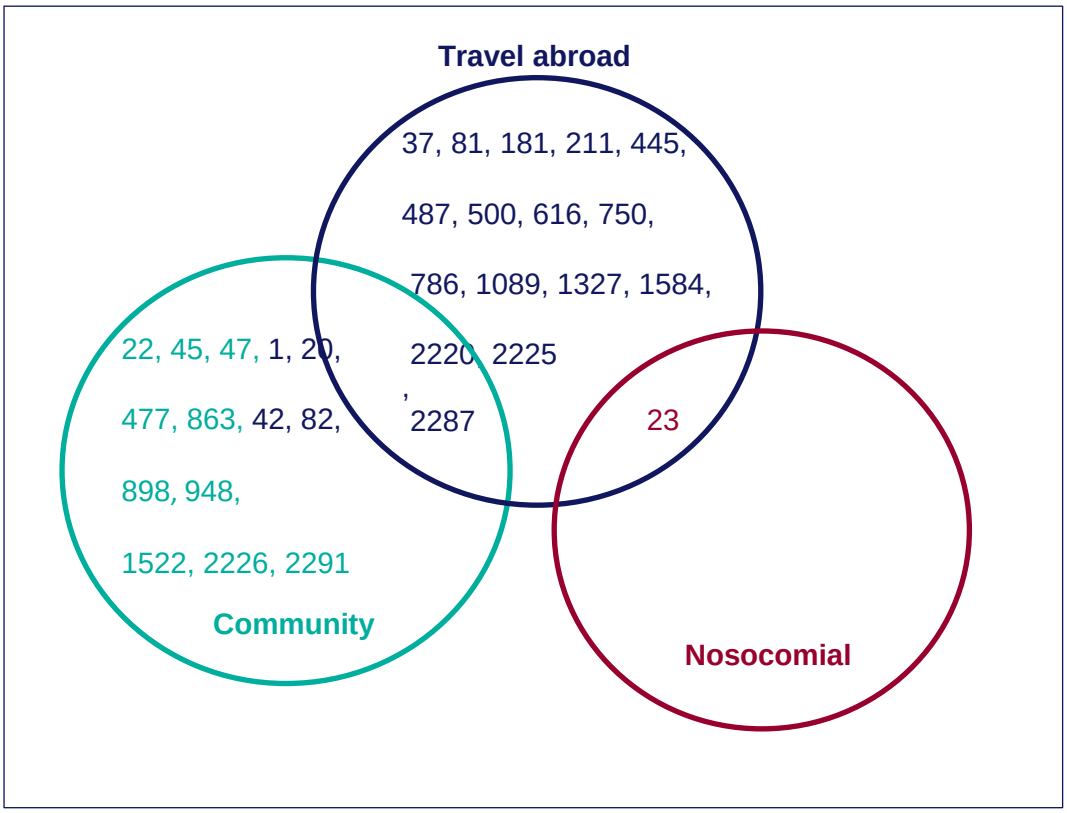


Figure 8 shows the distribution of STs according to the principal category of exposure and suggests that cases associated with travel abroad had a greatest diversity of STs compared to cases principally exposed to a source from within the community. Only four of the 31 STs identified in 2016 were found to be common to both the community and travel abroad exposure categories whilst ST23 was the only strain identified in one or more cases association with a healthcare facility. ST23 however was also identified among cases associated with travel abroad.

Table 13: Number and proportion (%), of confirmed cases of Legionnaires' disease with sequence type (ST) identified by principal category of exposure; 2014 to 2016

Category	**2014** (%)	**2015** (%)	**2016** (%)
Community‡	53 (28.5)	55 (28.6)	48 (23.8)
Nosocomial	2 (33.3)	6 (40.0)	1 (16.7)
Travel abroad	29 (20.9)	35 (19.8)	30 (20.4)
Total cases with ST	**84 (25.4)**	**96 (25.0)**	**79 (22.3)**

‡ includes travel UK cases

The proportion of travel associated cases where a complete sequence type is in line with previous years at about 20% however there has been a noticeable decease in the proportion of cases with complete sequence type thought to have acquired their infection from the community, Table 13. The greatest change however has been in the nosocomial category where the proportion of cases with an ST has fallen by more than a 50%.

Table 14: Sequence-based types uniquely associated with a specific country of travel, 2016

Strain	New ST – country of travel association″	Country of travel
750	Yes	Greece
2220	Yes	Greece
1089	No	India
445	Yes	Italy
786	Yes	Mexico
181	No	Spain
1584	Yes	Spain
2287	Yes	Spain
81	No	Turkey
487	Yes	Turkey
2225	Yes	Turkey
616	No	United Arab Emirates

″ New strain refers to any SBT not previously identified in a case from England and Wales in association with that country of travel

NB: This table only presents SBT's identified in cases associated with travel to a single country.

Table 14 lists strains that have been identified in cases with onset during 2016, associated with travel abroad and have a complete ST. The STs were compared against all strains previously identified in residents of England and Wales to determine whether strains may be specific to a particular country. Figure 8 showed that there were 21 different STs identified in cases associated with travel abroad and Table 14 shows that of these 12 STs could be uniquely assigned to a single country for example ST1089 was detected in a case associated with travel to India, the same strain had previously

been identified in association with travel to India. ST445 on the other hand had never previously been identified in a resident of England and Wales until 2016 when the strain was identified was identified in a case associated with travel to Italy.

Cases and clusters

The number of clusters and outbreaks identified in 2016 was lower than in the previous 2 years across all categories except Travel UK, Table 15. The number of cases associated with clusters and outbreaks can vary from year to year depending on the characteristics of the individual situation.

Table 15: Number of outbreaks/clusters involving cases of Legionnaires' disease in residents of England and Wales by category of exposure, 2014 to 2016

	2014		2015		2016	
	OB/Cl	**Cases**	**OB/Cl**	**Cases**	**OB/Cl**	**Cases**
Community	5	28 (2)	13	57 (3)	10	26
Nosocomial	-	-	3	9 (2)	2	4
Travel Abroad	18	45 (9)	19	44 (9)	10	20 (9)
Travel UK	2	4	2	5 (1)	3	6 (2)
Total	**25**	**77 (11)**	**37**	**115 (15)**	**25**	**56 (11)**

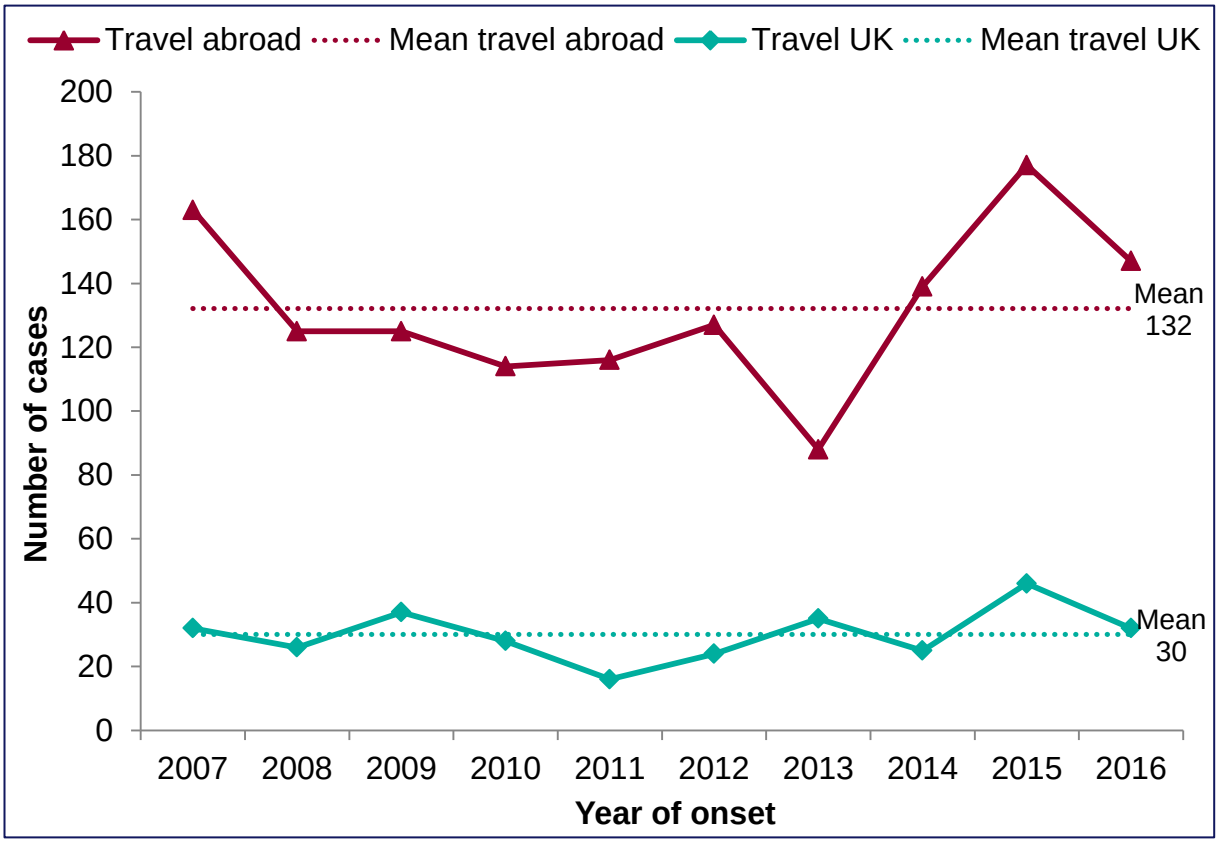
( ) cases with onset of symptoms in previous years that are included in the cluster/outbreak

Overall, the proportion of cases associated with one or more other cases , thereby forming a cluster or an outbreak, was 12.7% in 2016. This compares to 19.9% and 26.0% in 2014 and 2015 respectively.

Travel associated Legionnaires' disease (TALD)

The number of cases of Legionnaires' disease associated with travel has decreased both in terms of travel abroad and travel within the UK but numbers remain just above the mean for the decade 2007-2016 at 147cases associated with travel abroad and 32 associated with travel UK, Figure 9. This decrease is also supported when comparing the proportion of cases by category of exposure; the proportion of cases associated with travel abroad decreased from 46.1% in 2015 to 41.4% in 2016 and cases associated with travel within the UK decreased from 12.0% to 9.0%.

Figure 9: Number of confirmed cases of Legionnaires' disease associated with travel by year of onset of symptoms, 2007 to 2016



The 147 travel associated cases of Legionnaires' disease visited one or more of 42 different countries; 88.4% visited one or more European countries and 45.6% visited one or more non-European countries during their incubation period. The most popular destination visited by cases was the same as in previous years, Table 16. A total of 28 cases travelled to Spain for one or more nights of their incubation period whilst compared to 2015, UAE superseded Italy and Greece to become the second most common destination among cases of Legionnaires' disease in 2015 with 24 cases. The increase in case numbers associated with travel to UAE compared to previous years was also observed among residents in other European countries; this increase was not limited to one cluster or a single accommodation site. Detailed information has been previously published about this increase including travel health advice, (10-13)

The destination with the highest rate of travel associated Legionnaires' disease (TALD) was the UAE at a rate of 26.0 cases per million visits.

Table 16: Most prevalent travel destinations visited by the greatest number of confirmed cases of Legionnaires' disease in residents of England and Wales with onset of symptoms in 2016

Country	LD cases	Visits by UK residents	Rate of cases (per million visits)
Spain	28	14,676,000	1.9
United Arab Emirates	24	922,000	26.0
Italy	14	4,089,000	3.4
Greece	9	2,480,000	3.6
France	8	8,542,000	0.9
Turkey	8	1,057,000	7.6
Indonesia	6	882,000	6.8
Thailand	6	467,000	12.9
India	4	990,000	4.0
Bulgaria	3	429,000	7.0
Cruise	3	642,000	4.7
Germany	3	2,732,000	1.1
Malta	3	651,000	4.6
Mexico	3	502,000	6.0

There were 10 incidents identified in 2016 that involved 2 or more England and Wales residents who travelled abroad during their incubation period and stayed at the same accommodation site. In addition to these travel associated clusters a further 32 incidents were identified by the European surveillance scheme involving accommodation sites that formed clusters of 2 or more cases of Legionnaires' disease, where at least one case was a resident of England and Wales.

Table 17 lists the countries in which these 32 travel associated clusters were identified. A total of 14 European and non-European countries had these travel-associated clusters identified in which cases from 2 or more participating countries were involved. Each of these destinations experienced between one and 7 such clusters of varying size during 2016.

Table 17: Destinations associated with clusters involving residents of England and Wales with onset of symptoms during 2016

Country of Travel	No. Clusters	No. Associated EAW Cases
Belgium	1	1
Bulgaria	1	6
China	1	1
Croatia	1	1
Greece	3	4
Italy	5	6
Malaysia	1	1
Mauritius	2	4
Russia	1	1
Spain	4	6
Thailand	2	3
Turkey	1	1
United Arab Emirates	7	14
United Kingdom	2	4

Discussion

In 2016 the national surveillance scheme for Legionnaires' disease in residents of England and Wales has seen a small decrease in actual case numbers compared to 2015 but remains above the mean number of cases over the past decade. There is also a decrease in the number of non-pneumonic cases of Legionellosis and a decrease in presumptive cases compared to 2014 and 2015. Most of the well documented characteristics for Legionnaires' disease observed for many years are generally depicted in the 2016 cases in England and Wales, with small variations that are expected.

The case fatality rate in 2016 has remained low at 7.0% with the number of deaths increasing with age but as seen in previous years the 50 to 59 years age group have a low CFR. A like for like comparison of CFR by age group for cases with onset of symptoms from 2013 to 2015 compared to 2014 to 2016 shows that the CFR for each age group has decreased. This downward trend for the first time is shown to be statistically significant. One explanation for this improvement in outcome of cases is that there has been an improvement in the treatment of Legionnaires' disease, possibly due to greater awareness of the disease among clinicians leading to earlier diagnosis and administration of the appropriate treatment.

A comparison of the CFR by category of exposure from 2014 to 2016 shows a higher CFR among nosocomial cases but a lower CFR among those thought to have been exposed following travel abroad and those exposed in the community.

One area that continues to be of concern is the method of diagnosis; despite the continued promotion of culture being the gold standard method of diagnosis for Legionnaires' disease the number and proportion of cases reported to have positive culture and PCR tests continues to decrease in England and Wales. In 2016 98% of cases were diagnosed primarily using urinary antigen testing. This seems understandable when considering the ease of obtaining a sample and rapid turnover time for the test result. However it is the request for lower respiratory samples for urinary antigen positive cases that continues to be challenging and may be explained by the simple fact that once a clinician has a confirmed diagnosis for their patient, treatment can be administered and the need for further tests are not considered. There is also the impact of further testing that clinicians need to consider; for example in possible healthcare associated cases testing a case by culture and PCR can identify the clinical ST which could potentially exclude the healthcare facility as the source of infection.

A potential consequence of the decrease in culture and PCR testing may be the reason behind no diagnoses being made for cases infected with non-pneumophila species od Legionella. Urinary antigen tests predominately detect *L.pneumophila* serogroup 1 and in order to diagnose Legionella infection caused by other *Legionella spp*. lower respiratory samples would be needed for analysis by culture and PCR. If no lower respiratory sample is collected from the patient then the diagnosis of Legionnaires' disease by less common species is unlikely to occur.

Of note is the observation that during 2016 culture and PCR testing was carried out predominately among cases in the community or travel abroad exposure categories; 23.8% and 20.4% of complete SBT's were identified in the community and travel abroad categories respectively. In contrast to the previous 2 years the proportion of nosocomial cases in 2016 with a complete SBT was less than half with 33.3% and 40.0% in 2014 and 2015 compared to 16.7% in 2016.

A final observation of Legionnaires' disease in England and Wales during 2016 is the comparison of clusters and outbreaks to previous years, Table 13. The number and size of clusters and outbreaks varies from year to year, this is shown by the difference in the total number of incidents identified in 2015 compared to 2016 with 37 incidents and 25 incidents in 2015 and 2016 respectively. When comparing 2014 data to that of 2016; both years identified 25 incidents however in 2014 the total number of cases involved in the 25 incidents was higher (77 cases) compared to only 56 cases associated with the 25 incidents in 2016. This comparison suggests that the clusters and outbreaks in 2014 were larger in size than those in 2016, as demonstrated when comparing the community acquired incidents; 2016 saw double the number of incidents involving a fewer number of cases associated with the community compared to the same in 2014. This could indicate an improvement in the identification of clusters such that a greater number of clusters are being identified and managed more rapidly thereby preventing further cases.

There has also been a noteworthy change in the number and size of clusters and outbreaks associated with cases that travelled abroad during their incubation period during 2016. The number of incidents identified in 2016 is almost half the number identified in 2014 and 2015 with the total number of cases associated with the incidents decreasing by more than 50%. In 2016 10 travel associated clusters were identified, involving a total of 20 cases, indicating that each cluster involved 2 cases from England and Wales. The observed decrease in this category of exposure may be due to the fall in the proportion of travel associated cases during 2016 compared to previous years.

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