Public Health England

Protecting and improving the nation's health

Laboratory surveillance of *Proteus*, *Morganella* and *Providencia* species bacteraemia in England, Wales and Northern Ireland: 2016

Health Protection Report
Volume 11 Number 21
16 June 2017

Laboratory surveillance of *Proteus*, *Morganella* and *Providencia* species bacteraemia in England, Wales and Northern Ireland: 2016

These analyses are based on *Proteus* spp., *Morganella* spp. and *Providencia* spp. bloodstream infections in England, Wales and Northern Ireland during 2009 to 2016. The data were extracted on 23 May 2017 from Public Health England's voluntary surveillance database, Secondary Generation Surveillance System (SGSS). Data for Wales and Northern Ireland were extracted separately (DataStore on 9 March 2017 and CoSurv on 24 April 2017, respectively) and are included in the geographical and species analyses only.

SGSS comprises a communicable disease module (CDR; formerly CoSurv/LabBase2) and an antimicrobial resistance module (AMR; formerly AmSurv). Compared to CDR's antimicrobial susceptibility data, the AMR module captures more comprehensive antibiogram data (involving all antibiotics tested); however, until the launch of SGSS in 2014 fewer laboratories used the AMR module. Therefore, antimicrobial resistance (defined as reduced- or non-susceptibility) trends cannot currently be undertaken using data from the AMR module, but data for 2016 were extracted to assess multidrug-resistance rates.

The data presented here may differ from data in previous publications due to inclusion of late reports.

Rates of laboratory reported bacteraemia were calculated using mid-year resident population estimates for the respective year and geography with the exception of 2016 rates, which were based on 2015 population estimates as population estimates for 2016 were not available at the time of producing this report [1]. Geographical analyses were based on residential postcode of the patient if known (otherwise GP postcode if known, or failing that the postcode of the reporting laboratory) with cases in England being assigned to one of nine local PHE Centres (PHECs) formed from administrative local authority boundaries.

This report includes analyses of the trends, age and sex distribution, geographical distribution cases of by *Proteus* spp., *Morganella* spp. and *Providencia* spp. bacteraemia in England, Wales and Northern Ireland. In addition, antimicrobial susceptibility five-year trends for England and Northern Ireland have been included in the report, as has a single year of

resistance to more than one antibiotic based on England's data reported to the AMR module (previously AmSurv) and extracted on 23 May 2017. A web appendix has been made available featuring the findings of this report including only data submitted via SGSS from laboratories in England.

Key Points

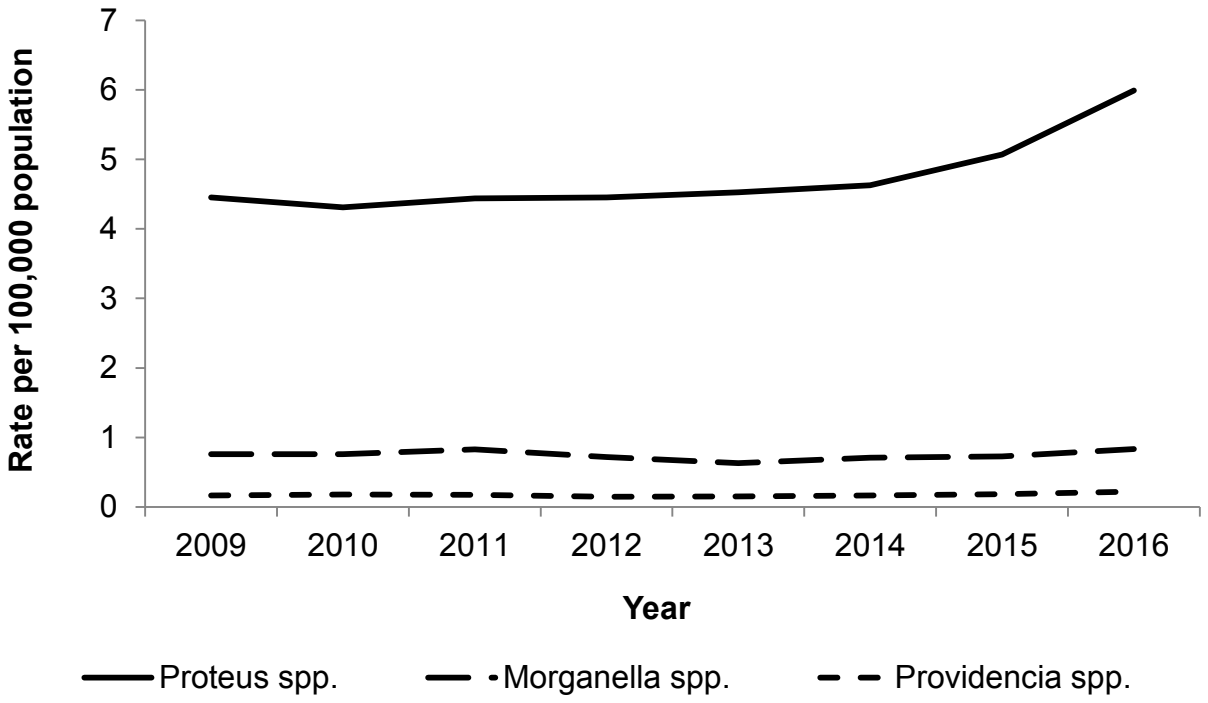
- in England, Wales and Northern Ireland, the overall rate of *Proteus* spp. bacteraemia was 6.0 per 100,000 population (n=3,580) in 2016; this has increased 16% from 4.5 per 100,000 population (n=2,538) in 2009
- in England, Wales and Northern Ireland, the overall rate of *Morganella* spp. bacteraemia was 0.8 per 100,000 population (n=498) in 2016; this has remained stable (0.8 per 100,000 population; n=433) since 2009
- in England, Wales and Northern Ireland, the overall rate of *Providencia* spp. bacteraemia was 0.22 per 100,000 population (n=133) in 2016; this has increased 53% from 0.17 per 100,000 population (n=95) in 2009
- in England, the North East PHE Centre had the highest reported incidence rate of *Proteus* spp. in 2016: 7.1 per 100,000 population
- in England, London PHE Centre had the highest reported incidence rate of both *Morganella* spp: 1.0 per 100,000 population and *Providencia* spp.: 0.4 per 100,000 population in 2016
- people aged ≥75 had a higher rate of *Proteus* spp., *Morganella* spp. and *Providencia* spp. compared with other age groups; bacteraemia rates were also higher in males vs. females in this age group
- the percentage of *Proteus mirabilis* and *Proteus vulgaris* bacteraemia reported with resistance to key antimicrobials in 2016 has increased compared with 2012
- the proportion of *Morganella morganii* causing bacteraemia in 2016 with resistance to gentamicin and cifrofloxacin has increased since 2012, while that resistant to ceftazidime and cefotaxime has decreased compared to 2012
- the proportion of *Providencia stuartii* causing bacteraemia reported with resistance to key antimicrobials in 2016 increased compared with 2012 with 100% non-susceptibility to ampicillin/amoxicillin since 2014 and emerging resistance to ertapenem in 2016.

Trends

In England, Wales and Northern Ireland, the overall rate of *Proteus* spp. bacteraemia in 2016 was 6.0 per 100,000 population (n=3,580), 25.7% higher than 4.5 per 100,000 population in 2009 (n=2,538; figure 1). In England, Wales and Northern Ireland, the overall rate of *Morganella* spp. bacteraemia in 2016 was 0.8 per 100,000 population (n=498), remaining stable since 2009 (0.8 per 100,000 population; n=433; figure 1). In England, Wales and Northern Ireland, the overall rate of *Providencia* spp. bacteraemia in 2016 was 0.22 per 100,000 population (n=133), this has increased by 53% from 0.17 per 100,000 population (n=95) in 2009 (figure 1).

Proteus miribilis. accounted for 2.0% of monomicrobial bloodstream infections (BSI; all reported bacteraemia and/or fungaemia) in 2016 making them the seventh most commonly reported cause of monomicrobial BSI [2]. In contrast, *M. morganii* accounted for 0.3% (ranked 39th) and *Providencia rettgeri* and *Providencia stuartii* accounted for <0.1% (ranked 103st & 109th) of monomicrobial BSI, respectively in 2016 [2]. *Proteus miribilis*., *M. morganii*, *Providencia rettgeri* and *Providencia stuartii* were identified in 2.4%, 0.6%, 0.1% and 0.1% of polymicrobial BSI, respectively in 2016 [2].

Figure 1. *Proteus* spp., *Morganella* spp. and *Providencia* spp. bacteraemia rate per 100,000 population (England, Wales and Northern Ireland): 2009 to 2016



Geographic distribution

The North East PHE Centre had the highest reported incidence rate of *Proteus* spp. bacteraemia in 2016, 7.1 per 100,000 population, followed by the East of England PHE Centre with 6.6 per 100,000 population. North West PHE Centre had the lowest reported incidence rate of *Proteus* spp. bacteraemia in 2016 (5.3 per 100,000 population). All PHE Centres have seen increases in their rates of *Proteus* spp. bacteraemia since 2012. The largest increase in the rate of *Proteus* spp. bacteraemia has been observed in the North East PHE Centre (66% between 2012 and 2016; table 1a).

Figure 2a. Geographical distribution of *Proteus* spp. bacteraemia rates per 100,000 population (England, Wales, Northern Ireland): 2016

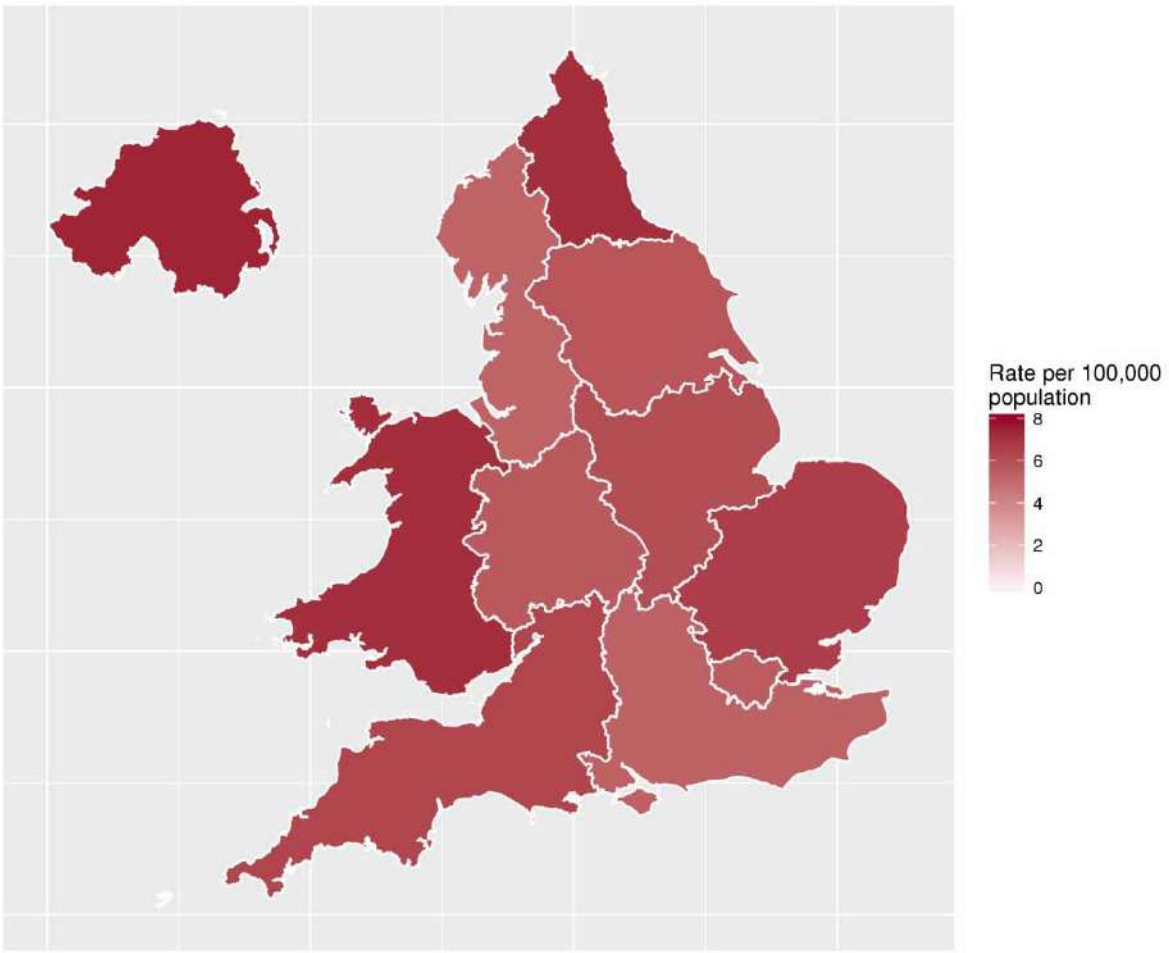
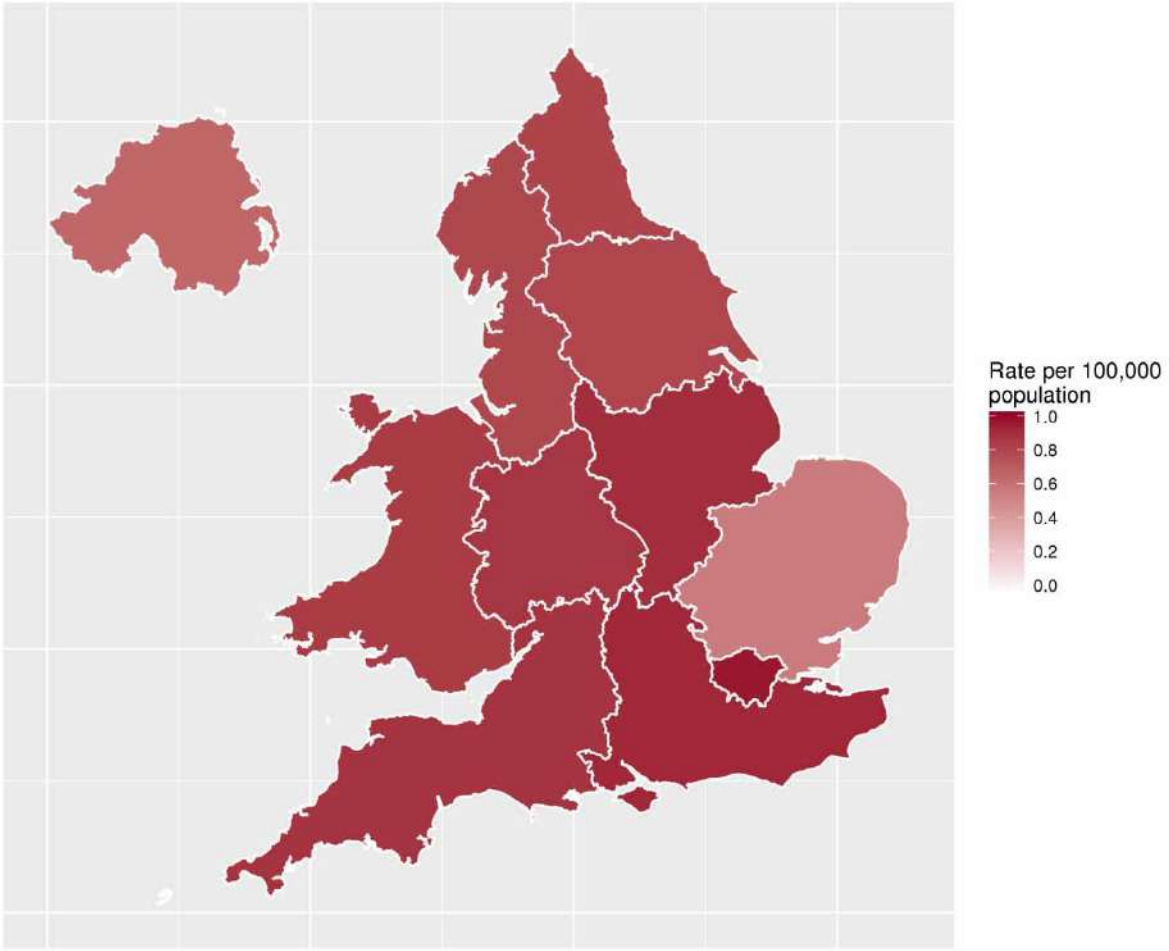


Table 1a. *Proteus* spp. bacteraemia per 100,000 population by region (England, Wales, Northern Ireland): 2012 to 2016

		Rate per 100,000 population				
Region	**PHE Centre**	**2012**	**2013**	**2014**	**2015**	**2016**
North of England	North East	4.3	4.8	5.8	5.4	7.1
	North West	4.2	4.1	4.1	5.2	5.3
	Yorkshire and Humber	4.3	3.9	4.2	4.4	5.8
Midlands and East of England	East Midlands	4.8	5.1	4.5	5.2	6.1
	East of England	4.9	4.9	5.4	5.3	6.6
	West Midlands	5.0	4.7	4.7	5.1	5.7
London	London	4.3	4.3	4.4	4.3	5.6
South of England	South East	3.4	3.9	3.9	4.6	5.4
	South West	4.6	4.6	4.4	5.6	6.4
England		4.4	4.4	4.5	4.9	5.9
Wales		5.1	5.7	6.4	6.9	7.1
Northern Ireland		6.1	6.2	5.8	5.9	7.5
England, Wales & Northern Ireland		**4.5**	**4.5**	**4.6**	**5.1**	**6.0**

Figure 2b. Geographical distribution of *Morganella* spp. bacteraemia rates per 100,000 population (England, Wales, Northern Ireland): 2016

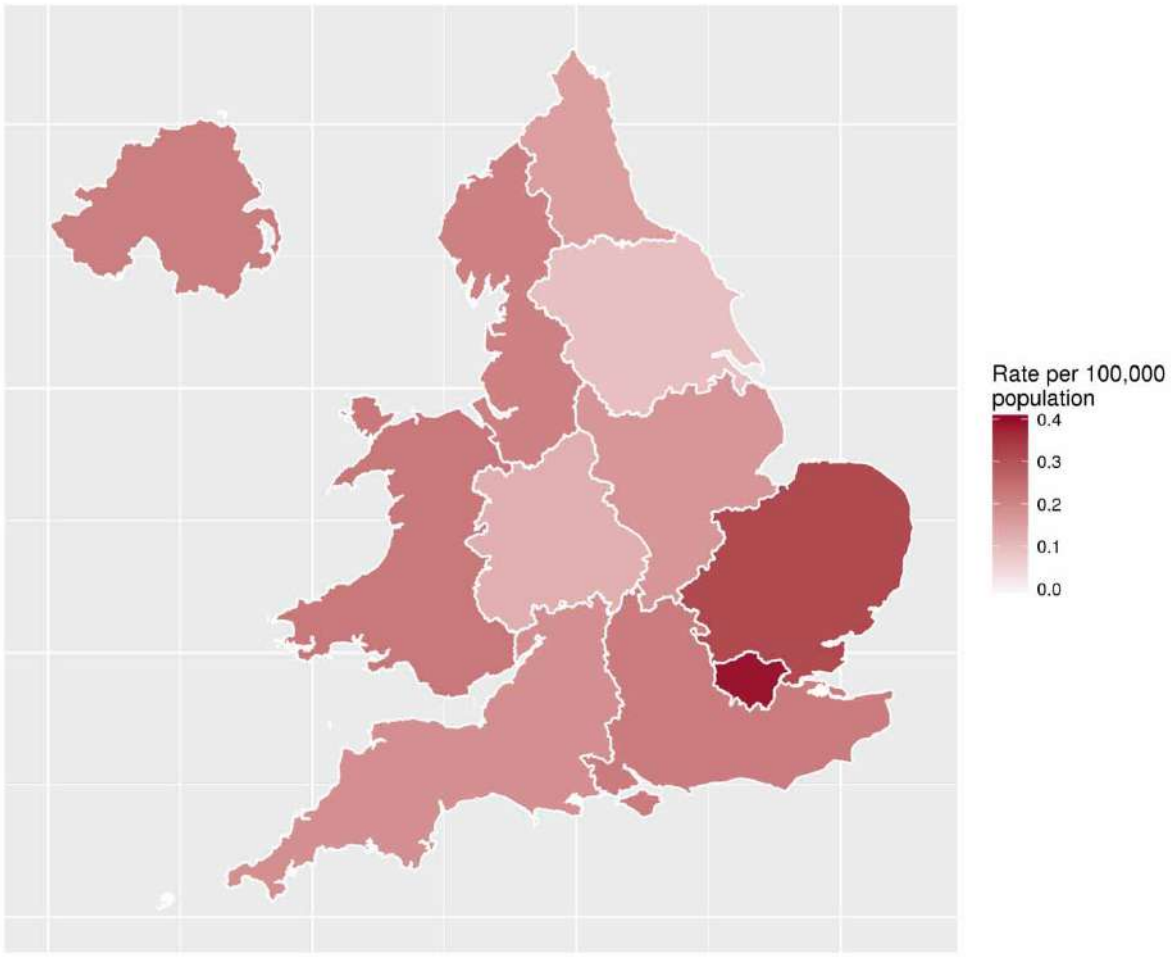


London PHE Centre had the highest reported incidence rate of *Morganella* spp. bacteraemia in 2016, 1.0 per 100,000 population, followed by the East Midlands and West Midlands, South West and South East, all with 0.9 per 100,000 population. East of England had the lowest reported incidence rate of *Morganella* spp. in 2016, 0.6 per 100,000 population. There has been an overall 16% increase in England, Wales and Northern Ireland compared with 2012, with decreases observed in East of England (15%), North West (5%) and Northern Ireland (16%; table 1b).

Table 1b. *Morganella* spp. bacteraemia per 100,000 population by region (England, Wales, Northern Ireland): 2012 to 2016

		Rate per 100,000 population				
Region	**PHE Centre**	**2012**	**2013**	**2014**	**2015**	**2016**
North of England	North East	0.6	0.4	0.7	0.4	0.8
	North West	0.8	0.5	0.7	0.7	0.8
	Yorkshire and Humber	0.7	0.4	0.4	0.6	0.8
Midlands and East of England	East Midlands	0.6	0.6	0.6	0.9	0.9
	East of England	0.6	0.8	0.7	0.5	0.6
	West Midlands	0.7	0.7	0.8	0.8	0.9
London	London	0.9	0.7	0.9	0.8	1.0
South of England	South East	0.6	0.6	0.6	0.9	0.9
	South West	0.5	0.7	0.8	0.7	0.9
England		0.7	0.6	0.7	0.7	0.8
Wales		0.9	1.0	0.9	1.2	0.8
Northern Ireland		0.8	0.7	0.5	0.5	0.6
England, Wales & Northern Ireland		**0.7**	**0.6**	**0.7**	**0.7**	**0.8**

Figure 2c. Geographical distribution of *Providencia* spp. bacteraemia rates per 100,000 population (England, Wales, Northern Ireland): 2016



London PHE Centre had the highest reported incidence rate of *Providencia* spp. bacteraemia in 2016 (0.4 per 100,000 population) followed by East of England, with 0.3 per 100,000 population. Yorkshire and Humber had the lowest reported incidence rate of *Providencia* spp. bacteraemia in 2016, <0.1 per 100,000 population. There was variability in the trends across PHE Centres, however, the aggregate rate has increased steadily by 53% since 2012 from 0.15 per 100,000 population in 2012 to 0.22 per 100,000 population in 2016.

Table 1c. *Providencia* spp. bacteraemia per 100,000 population by region (England, Wales, Northern Ireland): 2012 to 2016

		Rate per 100,000 population				
Region	**PHE Centre**	**2012**	**2013**	**2014**	**2015**	**2016**
North of England	North East	0.2	0.0	0.1	0.2	0.2
	North West	0.1	0.1	0.1	0.1	0.2
	Yorkshire and Humber	0.2	0.1	0.1	0.1	0.1
Midlands and East of England	East Midlands	0.2	0.1	0.1	0.2	0.2
	East of England	0.1	0.2	0.2	0.1	0.3
	West Midlands	0.1	0.1	0.3	0.0	0.1
London	London	0.2	0.3	0.2	0.3	0.4
South of England	South East	0.1	0.2	0.1	0.2	0.2
	South West	0.1	0.1	0.1	0.1	0.2
England		0.1	0.2	0.2	0.2	0.2
Wales		0.3	0.2	0.2	0.4	0.2
Northern Ireland		0.2	0.2	0.2	0.1	0.2
England, Wales & Northern Ireland		**0.1**	**0.2**	**0.2**	**0.2**	**0.2**

It is of note that in England and Northern Ireland, there are links from the different laboratories reporting clinically significant isolates to SGSS/CoSurv. Data from Wales is collected by extraction from a single laboratory information system used by all microbiology laboratories, where all positive blood cultures are extracted from all laboratories, including those not thought to be clinically significant.

Species distribution

The majority of *Proteus* spp. bacteraemia isolates were identified to species level (92%), similar to previous years (table 2a). In 2016, as in previous years, the predominant species was *P. mirabilis* accounting for 89% of bacteraemia, followed by *P. vulgaris* (3%). Reported blood isolates have increased steadily between 2012 and 2015, with an 18% increase observed between 2015 and 2016. There has been an overall increase of 38% since 2012.

Table 2a. Reports of *Proteus* spp. bacteraemia by species (England, Wales, Northern Ireland): 2012-2016

	2012		2013		2014		2015		2016	
	No.	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
***Proteus* spp.**	**2,600**	**100%**	**2,660**	**100%**	**2,741**	**100%**	**3,028**	**100%**	**3,580**	**100%**
P. hauseri	0	-	0	-	0	-	0	-	2	0%
P. mirabilis	2,276	88%	2,376	89%	2,466	90%	2,691	89%	3,175	89%
P. penneri	2	0%	4	0%	6	0%	3	0%	12	0%
P. vulgaris	94	4%	67	3%	85	3%	86	3%	101	3%
Proteus spp., other named	1	0%	-	-	1	0%	4	0%	2	0%
Proteus spp., sp. not recorded	227	9%	213	8%	183	7%	244	8%	288	8%

The majority of *Morganella* spp. bacteraemia isolates were identified to a species level (99%). Trends for *Morganella* spp. have risen with a 19% increase in reported blood isolates since 2012, with a steady increase since 2013 (table 2b).

Table 2b. Reports of *Morganella* spp. bacteraemia by species (England, Wales, Northern Ireland): 2012-2016

	2012		2013		2014		2015		2016	
	No.	%	No.	%	No.	%	No.	%	No.	%
***Morganella* spp.**	**419**	**100%**	**371**	**100%**	**421**	**100%**	**434**	**100%**	**498**	**100%**
M. morganii	419	100%	371	100%	421	100%	433	99%	496	99%
Morganella spp., species not recorded	0	-	0	-	0	-	1	<1%	2	<1%

All *Providencia* spp. were identified to species level in 2015, however, 95% were speciated in 2016. The most frequent species identified from blood isolates was *P. rettgeri* (46%), followed by *P. stuartii* (44%); of note, there has been a 97% increase in reported isolates of *P. rettgeri,* and a 72% increase in reported isolates of *P. stuartii* since 2012. There has been a 56% increase overall in reported *Providencia* spp. isolates across England, Wales and Northern Ireland since 2012.

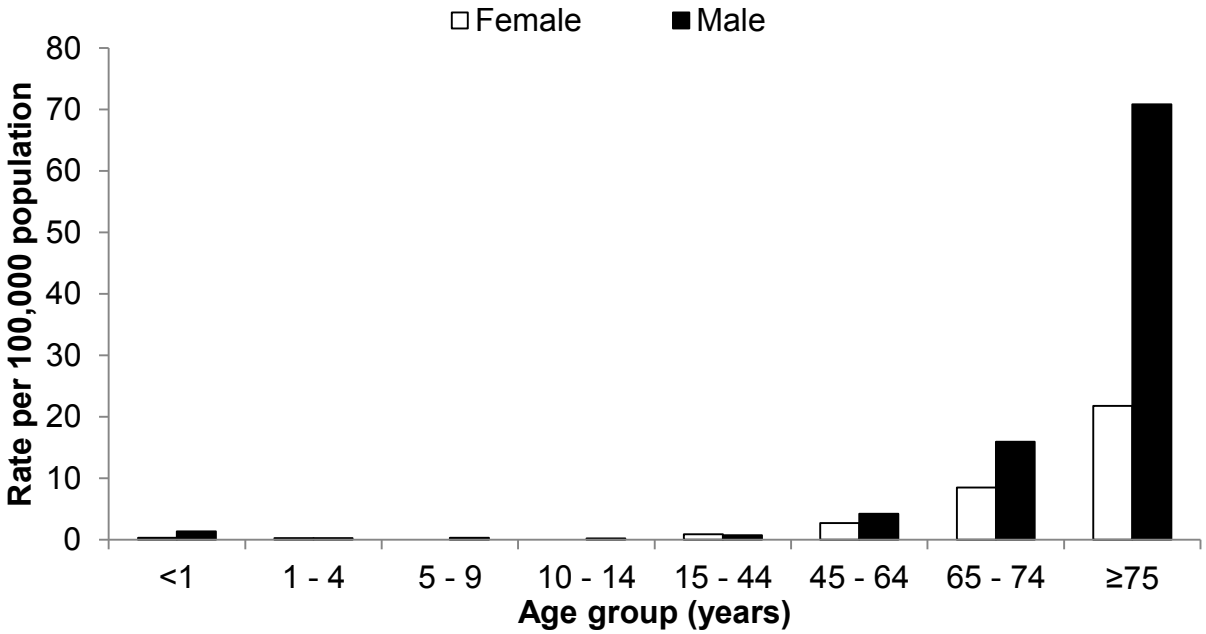
Table2c. Reports of *Providencia* spp. bacteraemia by species (England, Wales, Northern Ireland): 2012-2016

	2012		2013		2014		2015		2016	
	No.	%	No.	%	No.	%	No.	%	No.	%
***Providencia* spp.**	**85**	**100%**	**90**	**100%**	**98**	**100%**	**110**	**100%**	**133**	**100%**
P. alcalifaciens	7	8%	4	4%	1	1%	4	4%	3	2%
P. rettgeri	34	40%	31	34%	45	46%	43	39%	64	48%
P. rustigianii	1	1%	0	-	1	1%	0	-	0	-
P. stuartii	39	46%	52	58%	42	43%	63	57%	59	44%
Providencia spp., other named	2	2%	3	3%	4	4%	0	-	1	1%
Providencia spp., species not recorded	2	2%	0	-	5	5%	0	-	6	5%

Age and sex distribution

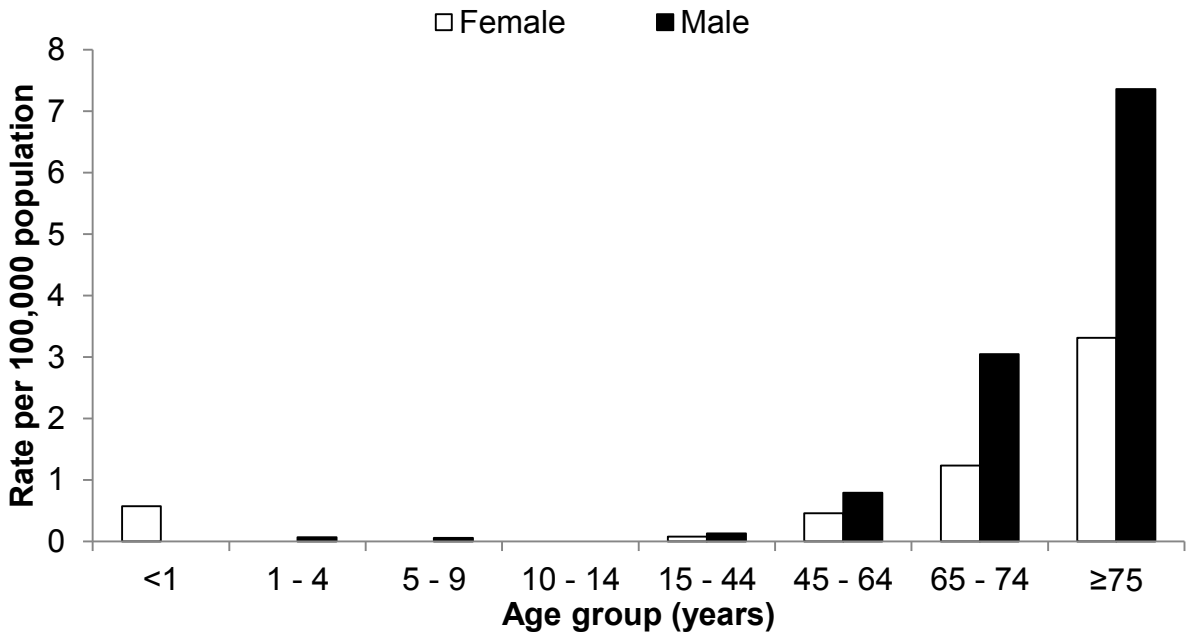
Age distribution of *Proteus* spp. bacteraemia for 2016 in England, Wales and Northern Ireland can be seen in figure 3a. The highest rate of *Proteus* spp. bacteraemia was observed in those aged 75 years or older (70.8 per 100,000 population), followed by those aged 65 to 74 years (15.9 per 100,000 population). There were few cases reported in children aged one to 14. Males had higher rates of *Proteus* spp. bacteraemia than females in all age groups, except the 15 to 44 years age group, however incidence in this age band is low (<1 per 100,000 population).

Figure 3a. *Proteus* spp. bacteraemia rates per 100,000 population by age and sex (England, Wales and Northern Ireland): 2016



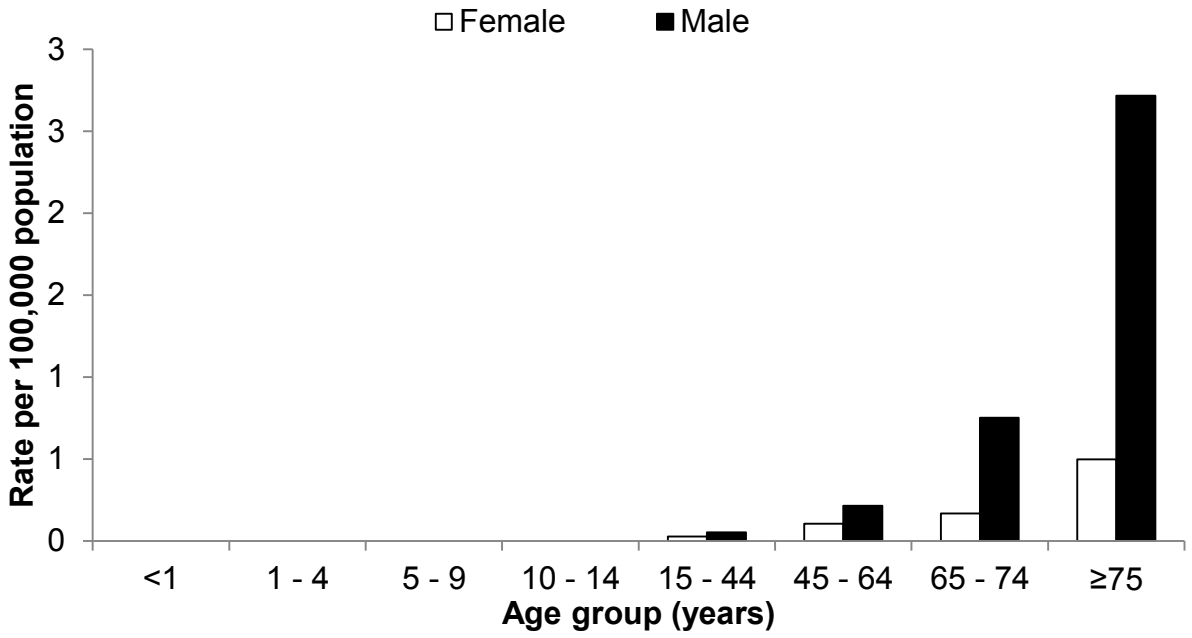
Age distribution of *Morganella* spp. bacteraemia for 2016 can be seen in figure 3b. The highest rate of *Morganella* spp. bacteraemia was observed in those aged 75 years or older (7.4 per 100,000 population), followed by those aged 65 to 74 years (3.0 per 100,000 population). Males had higher rates of *Morganella* spp. bacteraemia than females in all age groups, except in those less than one year of age, where there were no reported cases in males and the rate in females was 0.6 per 100,000 population. There were no *Morganella* spp. bacteraemias reported in females aged one to 14 years.

Figure 3b. *Morganella* spp. bacteraemia rates per 100,000 population by age and sex (England, Wales and Northern Ireland): 2016



Age distribution of *Providencia* spp. bacteraemia for 2016 can be seen in figure 3c. The highest rate of *Providencia* spp. bacteraemia was observed in those aged 75 years or older (2.7 per 100,000 population), followed by those aged 65 to 74 years (0.8 per 100,000 population). Males had higher rates of *Providencia* spp. bacteraemia than females in all age groups. This gender-disparity was greatest in those aged 75 years or older, with over a 5-fold difference (2.7 per 100,000 population in males versus 0.5 per 100,000 population in females in 2016). There were no *Providencia* spp. bacteraemias reported in persons less than 15 years of age.

Figure 3c. *Providencia* spp. bacteraemia rates per 100,000 population by age and sex (England, Wales and Northern Ireland): 2016



Antimicrobial resistance: England and Northern Ireland

The percentage of *Proteus mirabilis* and *Proteus vulgaris* isolates with susceptibility test results reported in 2016 ranged from 48%-90% and 40%-83%, respectively, for key antimicrobials (table 3a and 3b). The percentage of non-susceptible *P. mirabilis* bacteraemia isolates reported was ampicillin/amoxicillin (32%), gentamicin (9%), cefotaxime (3%), ceftazidime (2%), ciprofloxacin (8%), piperacillin/tazobactam (2%), ertapenem (<1%) and meropenem (<1%); which have remained relatively constant since 2012 (table 3a). The percentage of non-susceptible *P. vulgaris* bacteraemia isolates reported was ampicillin/amoxicillin (87%), gentamicin (8%), cefotaxime (6%), ceftazidime (4%), ciprofloxacin (5%), piperacillin/tazoabactam (0%), ertapenem (3%) and meropenem (0%), these have remained relatively stable since 2012; of note, ertapenem resistance emerged in 2014 (3%; table 3b). EUCAST report intrinsic resistance to ampicillin in *P. vulgaris* [3].

The percentage of *Morganella morganii* isolates with susceptibility test results reported in 2016 ranged from 45%-86% (table 3c) for key antimicrobials. The percentage of non-susceptible *M. morganii* bacteraemia isolates reported was ampicillin/amoxicillin (98%), gentamicin (12%), cefotaxime (18%), ceftazidime (18%), ciprofloxacin (17%), piperacillin/tazobactam (6%), ertapenem (1%) and meropenem (<1%); increased resistance to gentamicin (31%) and ciprofloxacin (45%), and decreased resistance to ceftazidime (13%) and cefotaxime (3%) has been observed since 2012 (table 3c). Resistance to meropenem and ertapenem emerged in 2013. EUCAST report intrinsic resistance to ampicillin/amoxicillin in *M. morganii* [3].

The percentage of *Providencia stuartii* isolates with susceptibility test results reported in 2016 ranged from 43%-82%, for key antimicrobials (table 3d). The percentage of non-susceptible *P. stuartii* bacteraemia isolates reported in 2016 was ampicillin/amoxicillin (91%), gentamicin (61%), cefotaxime (13%), ceftazidime (7%), ciprofloxacin (9%), piperacillin/tazoabactam (2%), ertapenem (5%) and meropenem (2%). Rates of *P. stuartii* resistance have increased to the reported antibiotics since 2012 and emerging resistance to cefotaxime has been observed since 2013 (table 3d). One-hundred percent non-susceptibility to ampicillin/amoxicillin has been observed in *P. stuartii* since 2014, with a slight decrease in resistance observed in 2016; however, high non-susceptibility is expected due to the possession of chromosomal β-lactamases in *P. stuartii* [3, 4].

Table 3a. Antimicrobial susceptibility for *Proteus mirabilis* bacteraemia (England and Northern Ireland): 2012 to 2016

	2012		2013		2014		2015		2016	
Antimicrobial agent	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***
Gentamicin	1,931	9	1,978	8	1,971	9	2,277	7	2,679	9
Ciprofloxacin	1,787	9	1,834	8	1,776	8	2,130	9	2,524	8
Ceftazidime	1,462	2	1,448	2	1,430	2	1,745	1	2,017	2
Cefotaxime	1,109	2	1,166	3	1,088	2	1,270	3	1,427	3
Meropenem	1,479	<1	1,619	-	1,623	<1	2,050	-	2,440	<1
Ertapenem	671	<1	871	<1	1,057	<1	1,672	<1	2,049	<1
Ampicillin\Amoxicillin	1,879	34	1,878	34	1,840	35	2,102	34	2,535	32
Piperacillin\Tazobactam	1,778	2	1,882	2	1,796	3	2,133	2	2,466	2
Total *P. mirabilis* bacteraemia reports	**2,144**		**2,217**		**2,287**		**2,493**		**2,972**	

* defined as reduced- or non-susceptibility

Table 3b. Antimicrobial susceptibility for *Proteus vulgaris* bacteraemia (England and Northern Ireland): 2012 to 2016

	2012		2013		2014		2015		2016	
Antimicrobial agent	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***
Gentamicin	74	4	55	4	68	1	63	8	79	1
Ciprofloxacin	64	-	53	-	61	2	60	7	74	1
Ceftazidime	56	7	37	8	54	6	47	4	62	3
Cefotaxime	43	9	29	7	34	9	35	6	38	5
Meropenem	61	-	47	-	62	-	59	-	69	-
Ertapenem	26	-	23	-	32	3	41	2	53	-
Ampicillin\Amoxicillin	71	94	55	95	62	94	57	88	75	93
Piperacillin\Tazobactam	70	-	54	2	63	-	62	3	73	-
Total *P. vulgaris* bacteraemia reports	**84**		**61**		**79**		**80**		**95**	

* defined as reduced- or non-susceptibility

Table 3c. Antimicrobial susceptibility for *Morganella morganii* bacteraemia (England and Northern Ireland): 2012 to 2016

	2012		2013		2014		2015		2016	
Antimicrobial agent	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***
Gentamicin	349	9	300	8	343	8	351	12	405	12
Ciprofloxacin	322	11	278	9	317	12	325	17	384	17
Ceftazidime	261	21	229	18	241	20	275	23	327	18
Cefotaxime	211	18	167	20	181	17	190	22	213	18
Meropenem	262	-	249	<1	289	-	319	<1	384	<1
Ertapenem	120	-	135	<1	178	-	257	<1	320	1
Piperacillin\Tazobactam	319	5	284	8	317	7	342	8	381	6
Total *M. morganii* bacteraemia reports	**391**		**339**		**393**		**397**		**470**	

* defined as reduced- or non- susceptibility

Table 3d. Antimicrobial susceptibility for *Providencia stuartii* bacteraemia (England and Northern Ireland): 2012 to 2016

	2012		2013		2014		2015		2016	
Antimicrobial agent	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***	**No. tested**	**% resistant***
Gentamicin	29	62	43	56	32	63	51	59	46	61
Ciprofloxacin	30	3	40	13	30	10	48	10	45	9
Ceftazidime	27	7	33	6	25	8	44	9	42	7
Cefotaxime	17	-	29	7	22	5	29	10	24	13
Meropenem	24	-	38	-	24	-	48	2	44	2
Ertapenem	12	-	18	-	20	-	33	3	38	5
Piperacillin\Tazobactam	29	3	41	5	31	3	49	8	44	2
Total *P. stuartii* bacteraemia reports	**37**		**47**		**39**		**60**		**56**	

* defined as reduced- or non-susceptibility

Tables 4a-d show the multi-drug resistance of *Proteus mirabilis, Proteus vulgaris, Morganella* spp. and *Providencia stuartii* respectively to third-generation cephalosporins, gentamicin or ciprofloxacin in a single year snapshot. Multi-drug resistance is rare, seen for 1-3% of all bacteraemia isolates due to *Proteus* spp., 4-9% due to *M. morganii* and 0-6% of *Providencia* spp. No multi-drug resistance (MDR) involving three or more antibiotics was detected in *M. morganii* or *P. vulgaris* in 2016. In 2016, less than 1% of bacteraemia isolates were MDR involving three or more antibiotics in *P. mirabilis* and 4% were MDR in *P. stuartii*, however in *P. stuartii,* these percentages may be due to small numbers.

Table 4a. Multi-drug antimicrobial testing and resistance summary for *Proteus mirabilis* bacteraemia (England): 2016

Antimicrobial combinations	No. tested	% resistant†
Gentamicin and Ciprofloxacin	2,648	3
Gentamicin and 3rd Generation Cephalosporins*	1,480	2
Ciprofloxacin and 3rd Generation Cephalosporins*	1,465	1
Gentamicin, Ciprofloxacin and 3rd Generation Cephalosporins*	2,605	1

*Cefotaxime, Ceftazidime, Ceftriaxone, Cefpodoxime
†defined as reduced- or non-susceptible

Table 4b. Multi-drug antimicrobial testing and resistance summary for *Proteus vulgaris* bacteraemia (England): 2016

Antimicrobial combinations	No. tested	% resistant†
Gentamicin and Ciprofloxacin	73	0
Gentamicin and 3rd Generation Cephalosporins*	38	0
Ciprofloxacin and 3rd Generation Cephalosporins*	39	0
Gentamicin, Ciprofloxacin and 3rd Generation Cephalosporins*	70	0

*Cefotaxime, Ceftazidime, Ceftriaxone, Cefpodoxime
†defined as reduced- or non-susceptible

Table 4c. Multi-drug antimicrobial testing and resistance summary for *Morganella* spp. bacteraemia (England): 2016

Antimicrobial combinations	No. tested	% resistant†
Gentamicin and Ciprofloxacin	428	9
Gentamicin and 3rd Generation Cephalosporins*	231	3
Ciprofloxacin and 3rd Generation Cephalosporins*	231	4
Gentamicin, Ciprofloxacin and 3rd Generation Cephalosporins*	417	4

*Cefotaxime, Ceftazidime, Ceftriaxone, Cefpodoxime
†defined as reduced- or non-susceptible

Table 4d. Multi-drug antimicrobial testing and resistance summary for *Providencia stuartii* bacteraemia (England): 2016

Antimicrobial combinations	No. tested	% resistant†
Gentamicin and Ciprofloxacin	52	6
Gentamicin and 3rd Generation Cephalosporins*	23	4
Ciprofloxacin and 3rd Generation Cephalosporins*	23	0
Gentamicin, Ciprofloxacin and 3rd Generation Cephalosporins*	50	2

*Cefotaxime, Ceftazidime, Ceftriaxone, Cefpodoxime
†defined as reduced- or non-susceptible

For treatment or antibiotic-resistant advice of these opportunistic pathogens or reference services (species identification, molecular comparison and confirmation of susceptibility testing results) laboratories may contact the Medical Microbiologists at PHE's Bacteriology Reference Department at Colindale on colindalemedmicro@phe.gov.uk and PHE's Antimicrobial Resistance and Healthcare Associated Infections (AMRHAI) Reference Unit in London [5].

Acknowledgements

These reports would not be possible without the weekly contributions from microbiology colleagues in laboratories across England, Wales, and Northern Ireland, without whom there would be no surveillance data. The support from colleagues within Public Health England, the AMRHAI Reference Unit, Public Health Wales and HSC Public Health Agency (Norther Ireland) in particular, is valued in the preparation of the report. Feedback and specific queries about this report are welcome and can be sent to hcai.amrdepartment@phe.gov.uk.

References

1. Office for National Statistics (2015). Population Estimates for UK, England and Wales, Scotland and Northern Ireland: mid-2015, https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2015.
2. Public Health England (2016). Polymicrobial bacteraemia and fungaemia in England, Wales, and Northern Ireland: 2016. *Health Protection Report* **11**(12), https://www.gov.uk/government/publications/polymicrobial-bacteraemia-and-fungaemia-in-england-wales-and-northern-ireland-2012.
3. European Committee on Antimicrobial Susceptiblity Testing (2016). EUCAST Expert Rules Version 3.1 Intrinsic Resistance and Exceptional Phenotypes Tables, http://www.eucast.org/fileadmin/src/media/PDFs/EUCAST_files/Expert_Rules/Expert_rules_intrinsic_exceptional_V3.1.pdf.
4. Stock I, Wiedemann B (1998). Natural antibiotic susceptibility of *Providencia stuartii*, *P. rettgeri*, *P. alcalifaciens* and *P. rustigianii* strains. *Journal of Medical Microbiology* **47**: 629-42.
5. PHE website. Antimicrobial Resistance and Healthcare Associated Infections (AMRHAI) Reference Unit, https://www.gov.uk/amrhai-reference-unit-reference-and-diagnostic-services.

About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-class science, knowledge
and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health, and are a distinct delivery organisation with operational autonomy to advise and support government, local authorities and the NHS in a professionally independent manner.

About *Health Protection Report*

Health Protection Report is a national public health bulletin for England and Wales, published by Public Health England. It is PHE's principal channel for the dissemination of laboratory data relating to pathogens and infections/communicable diseases of public health significance and of reports on outbreaks, incidents and ongoing investigations.

Public Health England, Wellington House, 133-155 Waterloo Road, London SE1 8UG
Tel: 020 7654 8000 www.gov.uk/phe
Twitter: @PHE_uk Facebook: www.facebook.com/PublicHealthEngland

Queries relating to this document should be directed to:
HIV and STI Department,
National Infection Service, PHE Colindale,
61 Colindale Avenue, London NW9 5EQ.
gumcad@phe.gov.uk

Published June 2017
PHE publications gateway number: 2017121