



Infection report

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Voluntary surveillance of bacteraemia caused by *Proteus* spp., *Morganella morganii* and *Providencia* spp., England, Wales and Northern Ireland: 2009-2013

These analyses are based on data extracted from the Public Health England (PHE) voluntary surveillance database, LabBase2, on 2 September 2014 for the period 2009 to 2013. The data presented here may differ from previous reports due to the inclusion of late reports.

Rates were calculated using 2013 mid-year resident population estimates based on the 2011 census for England, Wales, and Northern Ireland [1]. English sub-national geographical analyses were based on the residential location of the patient with reference to PHE Centre geographies; Wales and Northern Ireland were each analysed as a whole.

The report includes analyses on the trend, age and sex distribution, geographical distribution and the antimicrobial susceptibility in reported cases of *Proteus* spp., *Morganella morganii* and *Providencia* spp.

Key points

- The annual incidence of *Proteus* spp. (4.0 per 100,000 population), and *Providencia* spp. (0.2 per 100,000 per population) bacteraemia remained steady between 2009 and 2013
- The incidence of *Morganella morganii* reduced from 0.8 in 2011 to 0.6 in 2013
- In 2013, most *Proteus* spp. bacteraemias were attributed to *Proteus mirabilis* (90%)
- The majority of *Providencia* isolates determined to species level in 2013 were identified as *Providencia stuartii*, which accounted for 57% of these reports
- The majority of infections caused by Proteeae were in the eldest patient age group (≥ 75 years old); the number of reports decreased with age, with the exception of children aged < 1 year who had the highest paediatric rate. *Proteus* spp. dominated in each age group
- The rate of Proteeae bacteraemia was higher in male than female patients except for those aged 15-44 years
- Regionally, Northern Ireland and the East Midlands had the highest rates of *Proteus* spp. (6.3 and 5.7 per 100,000 population respectively) compared to the lowest regional rate from the Thames Valley (2.1 per 100,000 population)
- The region with the highest incidence of *M. morganii* bacteraemia was Devon, Cornwall and Somerset (1.0/100,000); Thames Valley (0.3/100,000) had the lowest incidence
- With the exception of amoxicillin, resistance of *P. mirabilis* has remained at $< 10\%$ for cefuroxime, cefotaxime, ceftazidime, ciprofloxacin, gentamicin, meropenem
- The only statistically significant change ($P < 0.025$) in antimicrobial susceptibility observed for *M. morganii* was the sudden increase in resistance (intermediate and full resistance) to imipenem (from 0% in 2012 to 16% in 2013)
- Dual resistance of third-generation cephalosporin and gentamicin in these pathogens is rare and was seen for only 2% of *Proteus* spp. and *M. morganii* bacteraemias in 2013

Trends in episode numbers and rates

The annual reported incidence of *Proteus* spp. (4.4 per 100,000 population), and *Providencia* spp. (0.2 per 100,000 per population) bacteraemia remained steady between 2009 and 2013 (figure 1). Between 2009 and 2013, there was little fluctuation in the total number of reports of *Proteus* spp. (from 2,490 to 2,565 reports) and *Providencia* spp. (from 93 to 86 reports) bacteraemia; there has been a slight decrease in *Morganella morganii* reports from 432 to 362 over the same period. In comparison, the total number of bacteraemia reports increased by 4% overall between 2009 (92,713) and 2013 (96,264).

Figure 1. *Proteus* spp., *Morganella morganii*, and *Providencia* spp. bacteraemia reports (England, Wales and Northern Ireland): 2009 to 2013

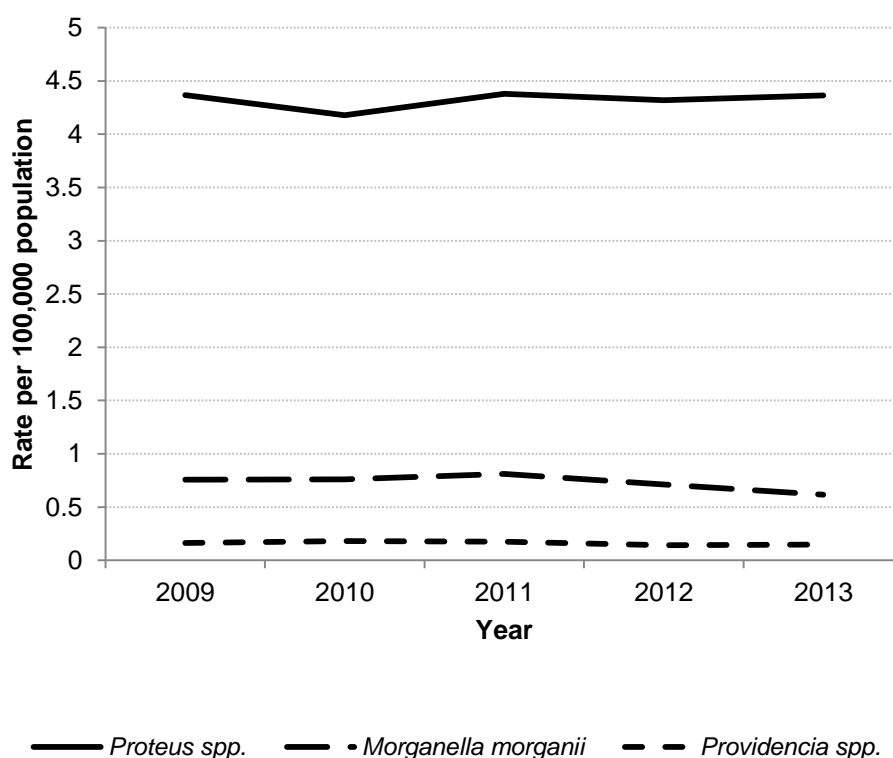


Table 1 gives a breakdown of reported Proteaceae bacteraemias by species from 2009 to 2013. In 2013, as previously, most *Proteus* spp. bacteraemias were attributed to *Proteus mirabilis* (90%). The majority of *Providencia* isolates determined to species level in 2013 were identified as *Providencia stuartii*, which accounted for 57% of these reports.

Table 1. Reports of *Proteus* spp., *Morganella morganii*, and *Providencia* spp. bacteraemia, by species: 2009-2013

	2009		2010		2011		2012		2013	
	No.	%	No.	%	No.	%	No.	%	No.	%
<i>Proteus</i> spp.	2490	100%	2403	100%	2539	100%	2523	100%	2565	100%
<i>Proteus mirabilis</i>	2133	86%	2091	87%	2220	87%	2241	89%	2314	90%
<i>Proteus vulgaris</i>	98	4%	94	4%	89	4%	90	4%	66	3%
<i>Proteus</i> spp., other named species	9	0%	10	0%	4	0%	2	0%	4	0%
<i>Proteus</i> spp., species not recorded	250	10%	208	9%	226	9%	190	8%	181	7%
<i>Morganella morganii</i>	432	100%	437	100%	471	100%	415	100%	362	100%
<i>Providencia</i> spp.	93	100%	103	100%	101	100%	82	100%	86	100%
<i>Providencia stuartii</i>	56	60%	63	61%	57	56%	39	48%	49	57%
<i>Providencia rettgeri</i>	25	27%	32	31%	27	27%	32	39%	30	35%
<i>Providencia</i> spp., other named species	3	3%	3	3%	10	10%	10	12%	7	8%
<i>Providencia</i> spp., species not recorded	9	10%	5	5%	7	7%	1	1%	0	0%

Age and sex distribution

Figure 2 shows the age distribution for cases of bacteraemia due to Proteeae in 2013. The majority of infections were in the eldest age group (≥ 75 years old), with rates reduced in younger agegroups. Children aged < 1 year had the highest paediatric rates compared to the other age-groups: by contrast, there were no reports of Proteeae bacteraemias for children aged 5-9 years, and no *M. morganii* or *Providencia* spp. bacteraemias reported for children aged 1-4 years or 10-14 years. Similarly to previous years, *Proteus* spp. dominated in each age group where reported.

Figure 3 illustrates the division of Proteeae bacteraemia between female and male patients. The rate of bacteraemias caused by Proteeae species was more than double in male patients compared to female patients in the two oldest age groups (65-74 years and ≥ 75 years old) and in children aged < 1 year. The only age-group where the rate was higher in females was in the 15 to 44 year olds.

Figure 2. *Proteus* spp., *M. morganii*, and *Providencia* spp. bacteraemia reports by age: 2013

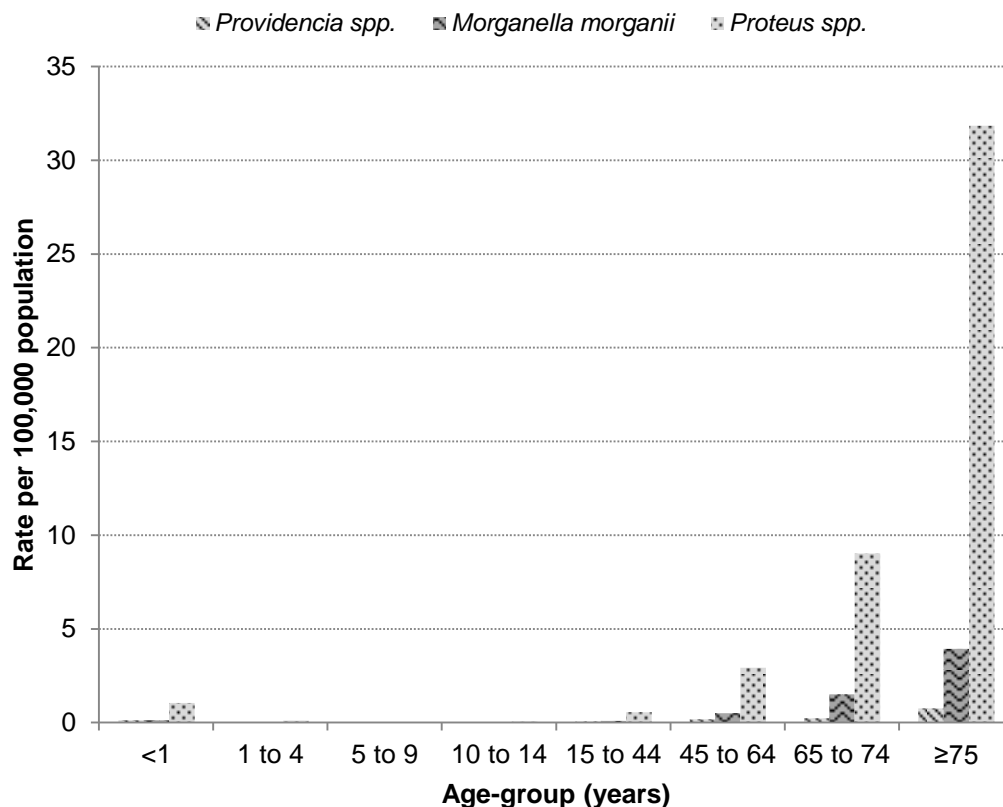
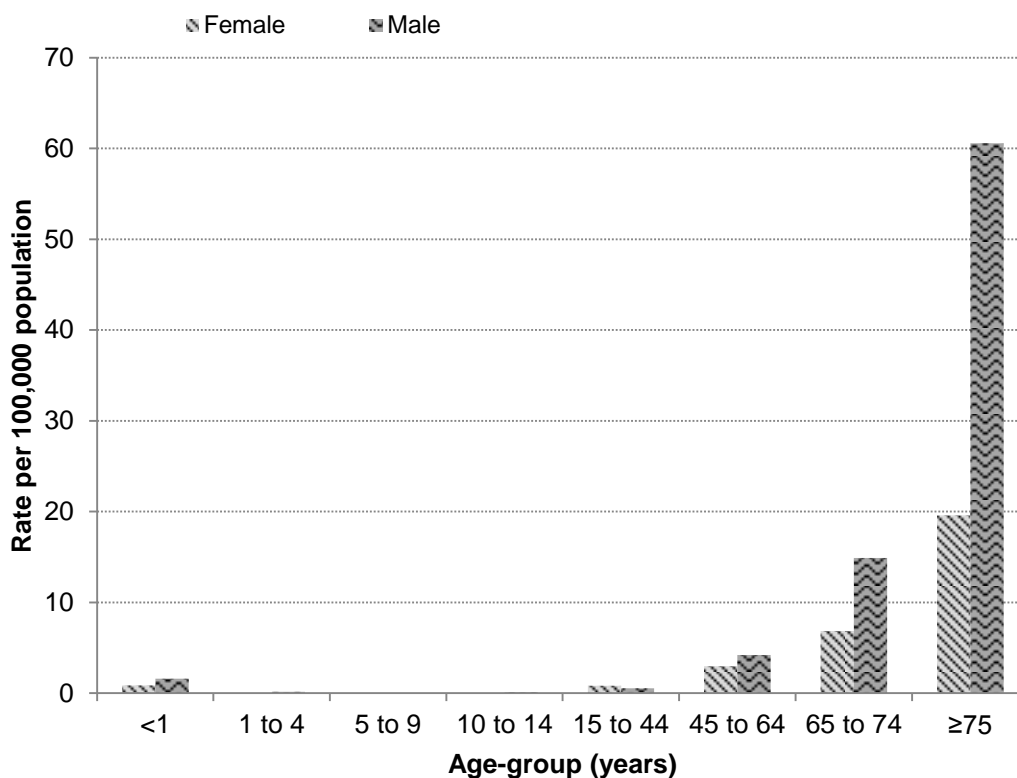


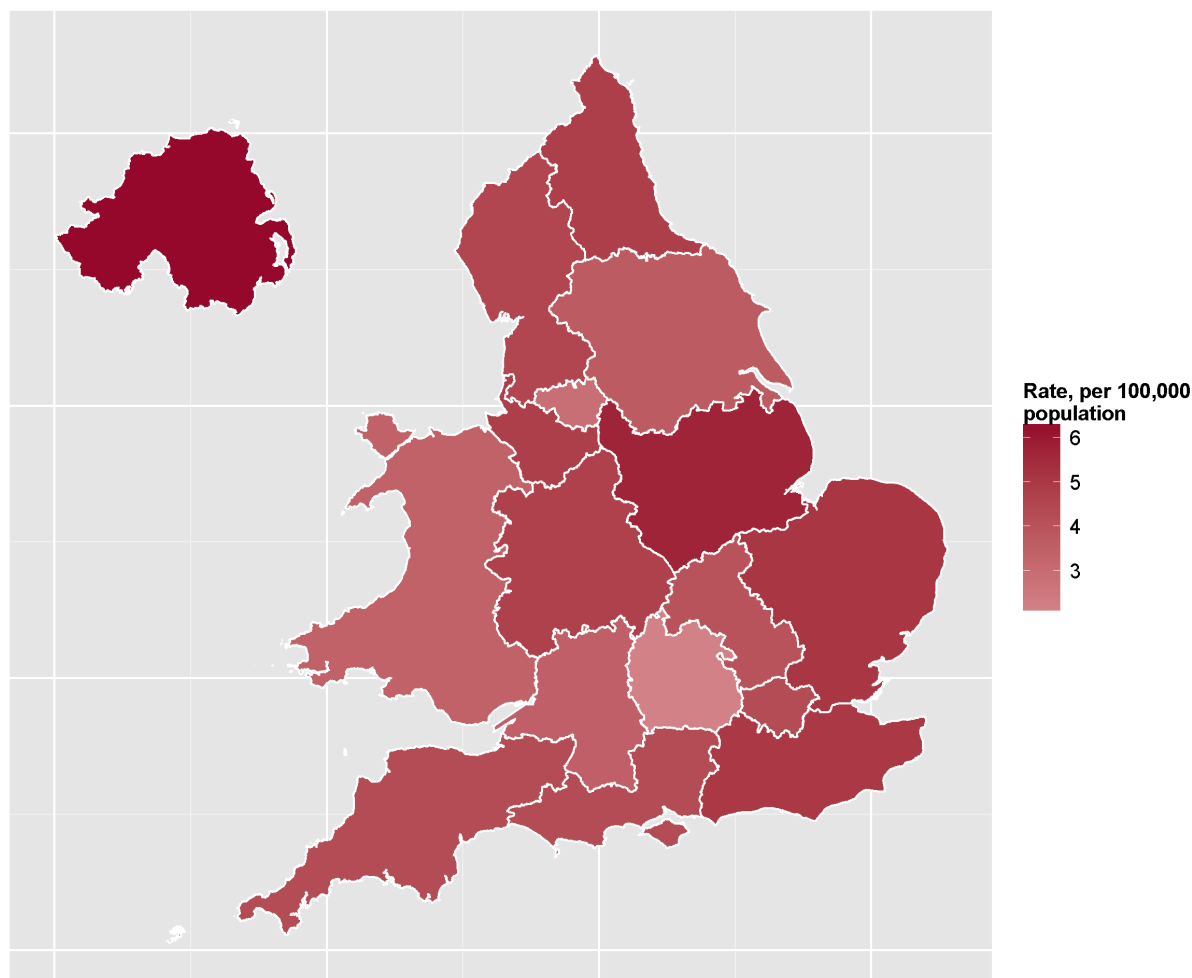
Figure 3. *Proteus* spp., *M. morganii*, and *Providencia* spp. bacteraemia reports by sex: 2013



Distribution by region

Figures 4 and 5 show regional distribution of *Proteus* spp. and *M. morganii* bacteraemia in 2013 with adjoining summary tables of the rate by region for the previous 5 years.

Figure 4. Region-specific rates [1] of *Proteus* spp. bacteraemia: England, Wales, and Northern Ireland, 2013



The regions/countries with the highest incidence of *Proteus* spp. bacteraemia in 2013 included Northern Ireland (6.3 cases per 100,000 population) and the East Midlands (5.7/100,000). Regions with low incidence included Thames Valley (2.1/100,000) and Greater Manchester (2.9/100,000). The overall reported incidence for England, Wales, and Northern Ireland was 4.0 per 100,000 population. It is important to note that regional incidence rates are affected by completeness of regional reporting.

Table 2. Five year reporting rate trend for *Proteus* spp. by Public Health England Centre and country in England Wales and Northern Ireland; 2009 to 2013

PHE Centre	Rate per 100,000 population				
	2009	2010	2011	2012	2013
London	4.5	3.8	4.6	4.4	4.3
South Midlands and Hertfordshire	4.4	3.1	2.9	4.1	4.0
East Midlands	5.7	5.6	5.5	5.2	5.7
Anglia and Essex	4.4	4.7	4.8	5.0	5.1
West Midlands	5.4	4.6	4.8	5.0	4.7
Cheshire and Merseyside	3.0	3.6	4.9	4.0	4.8
Cumbria and Lancashire	3.5	2.8	4.2	3.7	4.5
Greater Manchester	4.7	5.2	3.5	4.7	2.9
North East	4.7	3.6	4.4	4.3	4.8
Yorkshire and Humber	5.3	4.5	4.2	4.1	3.7
Avon, Gloucestershire and Wiltshire	2.3	3.1	4.2	3.8	3.5
Devon, Cornwall and Somerset	5.1	5.1	4.9	4.2	4.3
Wessex	3.2	4.0	4.4	4.5	4.3
Kent, Surrey and Sussex	4.6	4.5	4.1	3.7	5.0
Thames Valley	3.0	2.9	2.6	2.1	2.1
England	4.5	4.2	4.4	4.3	4.3
Wales	2.5	3.2	4.1	3.4	3.4
Northern Ireland (NI)	4.2	5.2	5.3	6.2	6.3
England, Wales and NI	4.4	4.2	4.4	4.3	4.4

Due to the smaller number of reports of *M. morganii*, the range in region-specific rates (figure 4) was small. The region with the highest incidence of *M. morganii* bacteraemia was Devon, Cornwall and Somerset (0.9/100,000), whereas Thames Valley (0.3/100,000) had the lowest incidence. The overall reported incidence for England, Wales, and Northern Ireland was 0.6 per 100,000 population in 2013. It is important to note that regional incidence rates are affected by completeness of regional reporting as well as the regional distribution of specialist care units.

Figure 5. Region-specific rates [1] of *M. morganii* bacteraemia: England, Wales, and Northern Ireland, 2013

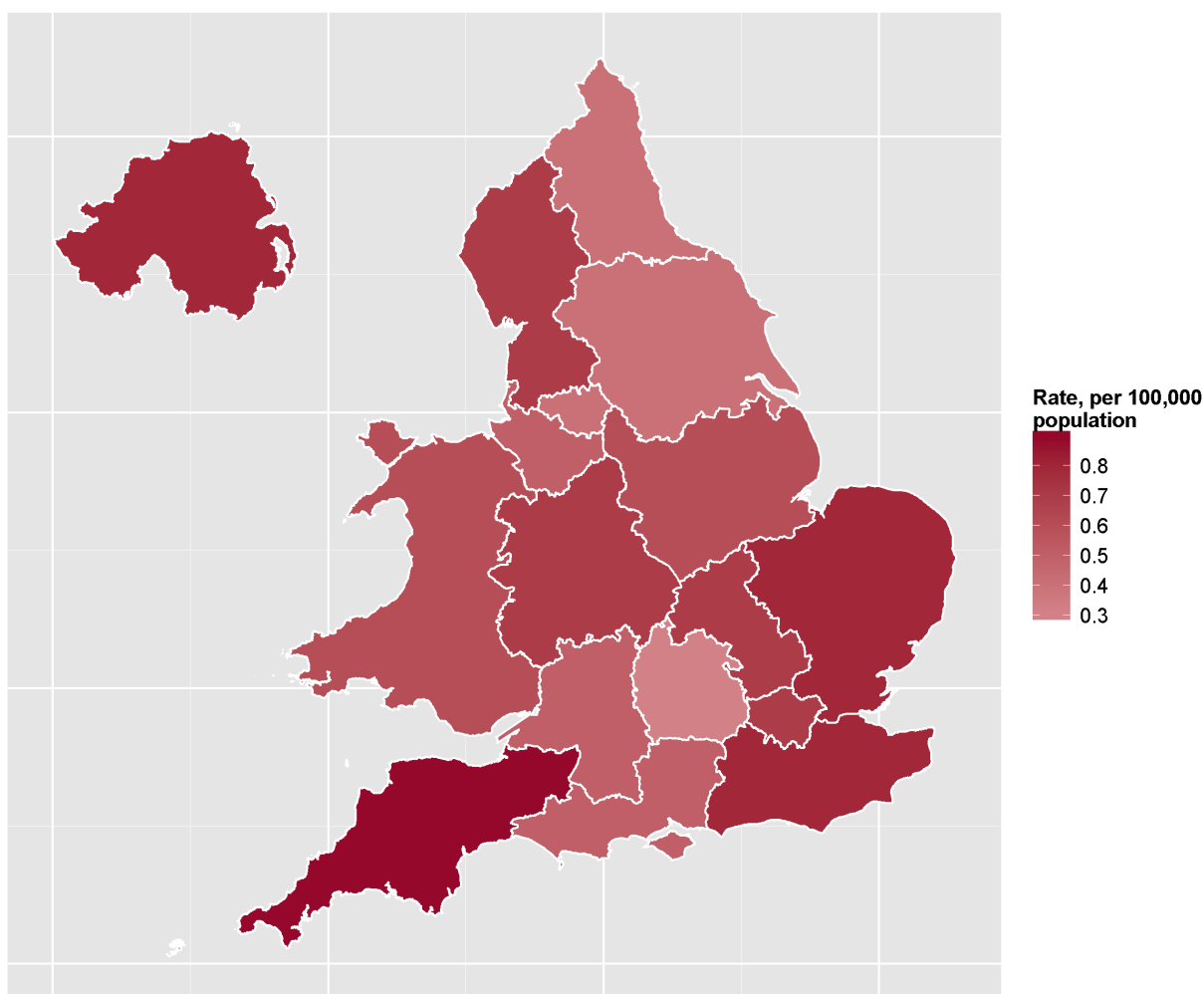


Table 3. Five year reporting rate trend for *M. morganii* by Public Health England Centre and country in England Wales and Northern Ireland; 2009 to 2013

PHE Centre	Rate per 100,000 population				
	2009	2010	2011	2012	2013
London	0.8	0.8	0.9	1.0	0.7
South Midlands and Hertfordshire	0.5	0.4	0.6	0.6	0.7
East Midlands	0.7	1.0	1.1	0.6	0.6
Anglia and Essex	0.5	0.7	0.9	0.6	0.8
West Midlands	0.9	0.7	0.8	0.7	0.7
Cheshire and Merseyside	0.5	0.8	0.5	0.7	0.5
Cumbria and Lancashire	0.8	0.7	0.7	1.2	0.7
Greater Manchester	0.9	0.8	0.9	0.7	0.4
North East	0.7	0.6	0.5	0.6	0.4
Yorkshire and Humber	1.0	0.9	1.0	0.7	0.4
Avon, Gloucestershire and Wiltshire	0.3	0.7	0.7	0.4	0.5
Devon, Cornwall and Somerset	1.2	0.9	0.6	0.5	0.9
Wessex	0.6	0.5	0.5	0.5	0.5
Kent, Surrey and Sussex	1.0	0.6	0.9	0.8	0.8
Thames Valley	0.8	0.6	0.5	0.3	0.3
England	0.8	0.7	0.8	0.7	0.6
Wales	0.7	1.0	1.2	0.7	0.6
Northern Ireland (NI)	0.8	0.8	0.7	0.8	0.8
England, Wales and NI	0.8	0.8	0.8	0.7	0.6

Antibiotic susceptibility data

Tables 4 to 8 present antibiotic susceptibility data for each of the four main species. Trend analysis was carried out using the Chi-square test in Stata.

Table 4. Antibiotic susceptibility data for reports of *Proteus mirabilis* bacteraemia, England, Wales, and Northern Ireland: 2009 to 2013

Antimicrobial	2009		2010		2011		2012		2013	
	No. tested	% resistant (%R)*	No. tested	%R*	No. tested	%R*	No. tested	%R*	No. tested	%R*
Amoxicillin	1660	32%	1690	33%	1793	34%	1911	34%	1911	34%
Cefuroxime	1323	1%	1311	2%	1458	2%	1479	1%	1507	2%
Cefotaxime	1044	0%	1005	1%	1074	2%	1163	2%	1221	3%
Ceftazidime	1380	1%	1383	1%	1518	2%	1515	2%	1521	2%
Ciprofloxacin	1622	6%	1677	5%	1776	7%	1860	9%	1912	8%
Gentamicin	1779	6%	1795	7%	1898	7%	2003	10%	2058	9%
Imipenem	524	6%	407	8%	339	9%	247	5%	230	8%
Meropenem	1113	0%	1183	0%	1364	0%	1500	0%	1649	0%
Total <i>P. mirabilis</i>	2133		2091		2220		2241		2314	

*reported as reduced- or non-susceptible

With the exception of amoxicillin, resistance of *P. mirabilis* to the other antibiotics has remained at <10%. The observed increase in the non-susceptibility of *P. mirabilis* to gentamicin (6-9%) and imipenem (6-8%) between 2009 and 2013 was statistically significant ($P<0.005$ and $P<0.025$ respectively). Although not statistically significant, appears to be an upward creep in resistance to cefotaxime. *Proteus* spp. are inherently among the least susceptible Enterobacteriaceae to imipenem, meaning that the reporting of some non-susceptibility by laboratories is not surprising. Unlike among *E. coli* and *Klebsiella*, cephalosporin resistance remains exceptional in *P. mirabilis* in the UK, although ESBLs or plasmid AmpC have disseminated in the species e.g. in Italy.

Table 5. Antibiotic susceptibility data for reports of *Proteus vulgaris* bacteraemia, England, Wales, and Northern Ireland: 2009 to 2013

Antimicrobial	2009		2010		2011		2012		2013	
	No. tested	% resistant (%R)*	No. tested	%R*	No. tested	%R*	No. tested	%R*	No. tested	%R*
Cefotaxime	50	6%	50	4%	39	3%	47	9%	32	6%
Ceftazidime	60	2%	61	3%	68	4%	59	7%	40	8%
Ciprofloxacin	63	5%	73	0%	75	3%	66	0%	57	0%
Gentamicin	78	3%	74	1%	77	4%	77	6%	59	5%
Imipenem	26	4%	18	6%	22	18%	8	0%	5	0%
Meropenem	43	0%	52	0%	57	0%	61	0%	48	0%
Total <i>P. vulgaris</i>	98		94		89		90		66	

*reported as reduced- or non-susceptible

There were no statistically significant changes in the susceptibility of isolates reported in 2013 compared to 2012; the 18% of *P. vulgaris* resistance to imipenem observed in 2011 is most likely due to a testing fluctuation; there has been no further evidence of imipenem-resistant isolates, although the number of tested isolates has remained fewer than 30 in all years.

Table 6. Antibiotic susceptibility data for reports of *Morganella morganii* bacteraemia, England, Wales, and Northern Ireland: 2009 to 2013

Antimicrobial	2009		2010		2011		2012		2013	
	No. tested	% resistant (%R)*	No. tested	%R*	No. tested	%R*	No. tested	%R*	No. tested	%R*
Cefotaxime	180	18%	216	21%	244	23%	224	19%	178	20%
Ceftazidime	253	22%	292	22%	309	24%	276	22%	245	19%
Ciprofloxacin	329	11%	358	12%	387	11%	341	11%	299	10%
Gentamicin	350	8%	382	8%	410	10%	367	9%	321	9%
Imipenem	117	3%	106	4%	85	4%	54	0%	49	16%
Meropenem	216	0%	255	0%	309	0%	272	0%	255	0%
Total <i>M. morganii</i>	432		437		471		415		362	

*reported as reduced- or non-susceptible

The only statistically significant change ($P < 0.025$) in antimicrobial resistance observed for *M. morganii* was the sudden increase in resistance to imipenem (from 0% in 2012 to 16% in 2013). Of the eight isolates non-susceptible to imipenem, six had reduced (intermediate) susceptibility (four were from the same laboratory but from different patients) and two were fully resistant; this is again most likely due to a testing fluctuation and borderline sensitivity. This proportion may be due to unrepresentative testing as the numbers of tested isolates has more than halved since 2009. The relatively unchanging proportion of isolates non-susceptible to cephalosporins contrasts the decrease in resistance reported in *Enterobacter* spp. between 2008-2012 (from 38% to 26% for cefotaxime and 36% to 29% for ceftazidime)[2]. This is notable because the principal mechanism of resistance (derepression of AmpC) is the same in both organisms.

Table 7. Antibiotic susceptibility data for reports of *Providencia stuartii* bacteraemia, England, Wales, and Northern Ireland: 2009 to 2013

Antimicrobial	2009		2010		2011		2012		2013	
	No. tested	% resistant (%R)*	No. tested	%R*	No. tested	%R*	No. tested	%R*	No. tested	%R*
Cefotaxime	29	3%	28	4%	25	8%	18	6%	31	6%
Ceftazidime	36	3%	41	5%	36	6%	28	7%	35	6%
Ciprofloxacin	42	10%	45	13%	48	8%	31	3%	42	12%
Gentamicin	43	21%	51	49%	46	52%	31	61%	45	56%
Imipenem	15	0%	11	0%	9	0%	6	0%	5	20%
Meropenem	25	0%	36	0%	34	0%	24	0%	37	0%
Total <i>P. stuartii</i>	56		63		57		39		49	

*reported as reduced- or non-susceptible

There were no statistically significant resistance trends for *P. stuartii*. *P. stuartii* remained universally susceptible to meropenem and the number of isolates tested for imipenem is very small, so the results should be interpreted with caution. Inherent resistance to gentamicin in this species is not very reliably detected, though EUCAST advises that all isolates should be reported as resistant to aminoglycosides except for amikacin and streptomycin owing to the production of a chromosomally mediated acetyltransferase [3].

Table 8. Combined third-generation cephalosporin and gentamicin susceptibility data for reports of *Proteus* spp. and *Morganella morganii* bacteraemia, England, Wales, and Northern Ireland: 2009 to 2013

Pathogen	2009		2010		2011		2012		2013	
	No. tested	% resistant (%R)*	No. tested	%R*	No. tested	%R*	No. tested	%R*	No. tested	%R*
<i>Proteus</i> spp.	1631	0%	1562	0%	1765	1%	1826	2%	1823	2%
<i>Morganella morganii</i>	267	3%	306	4%	331	3%	307	4%	261	2%

*reported as reduced- or non-susceptible

Dual resistance of third-generation cephalosporin and gentamicin in these pathogens is very rare, and was seen for only 2-4% of all bacteraemias due to *Proteus* spp. and *M. morganii* between 2009 and 2013. Isolates of *Providencia* spp. were excluded from this analysis because they are inherently resistant to gentamicin.

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References

1. Regional rates were calculated using mid-year 2011 resident population estimates published by the Office for National Statistics (ONS) (<http://www.statistics.gov.uk>)
 2. Public Health England. Health Protection Report: Voluntary surveillance of *Klebsiella*, *Enterobacter*, *Serratia*, and *Citrobacter* spp. bacteraemia in England, Wales and Northern Ireland: 2012. Vol 7, no 42.
<http://webarchive.nationalarchives.gov.uk/20140714084352/http://www.hpa.org.uk/Topics/InfectiousDiseases/InfectionsAZ/KlebsiellaSpecies/EpidemiologicalData/>
 3. Leclercq *et al.* EUCAST expert rules in antimicrobial susceptibility testing. *CLin Microbiol Infect* 2011;19:141-60
http://www.eucast.org/fileadmin/src/media/PDFs/EUCAST_files/EUCAST_SOPs/EUCAST-Expert-rules-v2-CMI.pdf
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