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Laboratory surveillance of *Proteus*, *Morganella* and *Providencia* species bacteraemia in England, Wales and Northern Ireland: 2017

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These analyses are based on *Proteus* spp., *Morganella* spp. and *Providencia* spp. bloodstream infections in England, Wales and Northern Ireland during 2009 to 2017. The data were extracted on 17 May 2018 from Public Health England's voluntary surveillance database, Secondary Generation Surveillance System (SGSS). Data for Wales and Northern Ireland were extracted separately (DataStore on 12 Feb 2018 and CoSurv on 24 April 2018, respectively) for inclusion in the geographical and species analyses.

Rates of laboratory reported bacteraemia were calculated using mid-year resident population estimates for the respective year and geography with the exception of 2017, which were based on 2016 population estimates, as data were not yet available at the time of producing this report. Geographical analyses were based on the patient's residential postcode. Where this information was unknown, the postcode of the patient's General Practitioner was used. Failing that, the postcode of the reporting laboratory was used. Cases in England were further assigned to one of nine local PHE Centres (PHECs), formed from the 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. Single-agent antimicrobial susceptibility trends since 2015 are reported for England and Northern Ireland based on SGSS AMR and CoSurv data, respectively. Multi-drug antimicrobial resistance trends since 2015 are reported for England, based on SGSS AMR data. A [web appendix](#) is available featuring the findings of this report including only data submitted to SGSS from laboratories in England.

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

Key points

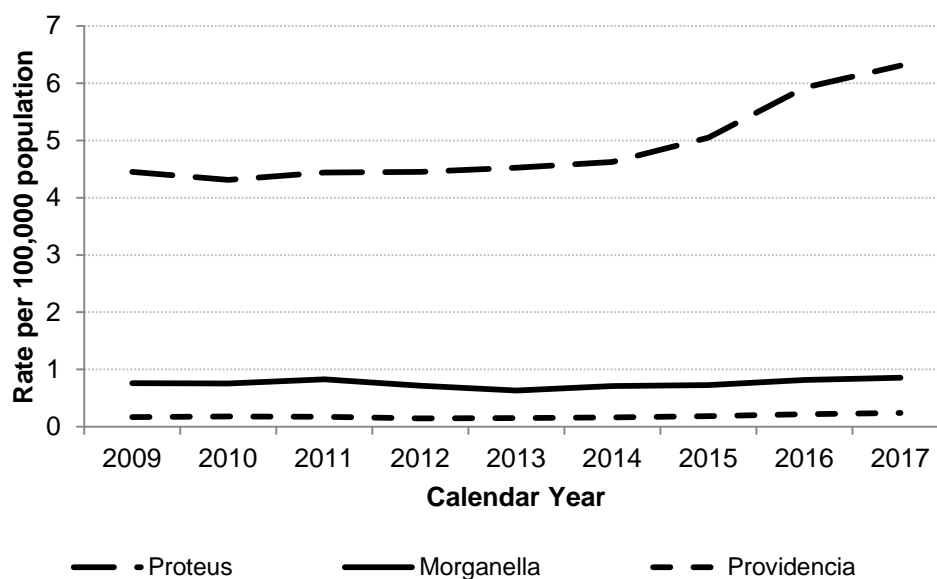
- in England, Wales and Northern Ireland, the overall rate of *Proteus* spp. bacteraemia was 6.3 per 100,000 population (n=3,801) in 2017; this has increased 40% from 4.5 per 100,000 population (n=2,538) in 2009
- in England, Wales and Northern Ireland, the overall rate of *Morganella* spp. bacteraemia was 0.9 per 100,000 population (n=518) in 2017; this has increased slightly (from 0.8 per 100,000 population; n=433) since 2009
- in England, Wales and Northern Ireland, the overall rate of *Providencia* spp. bacteraemia was 0.2 per 100,000 population (n=147) in 2017; this has increased 20% from 0.17 per 100,000 population (n=95) in 2009
- in England, the East of England PHE Centre had the highest reported incidence rate of *Proteus* spp. in 2017: 7.8 per 100,000 population
- in England, London PHE Centre had the highest reported incidence rate of *Providencia* spp.: 0.5 per 100,000 population in 2017
- 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* showing resistance to gentamycin and piperacillin/tazobactam has increased in 2017 compared to 2015. Whereas for the same time periods, we observe a decrease in resistance of *Proteus vulgaris* to key antimicrobials including gentamycin, ciprofloxacin and piperacillin/Tazobactam
- the proportion of *Morganella morganii* causing bacteraemia in 2017 with resistance to gentamicin, ceftazidime and piperacillin/tazobactam has increased since 2015
- the proportion of *Providencia stuartii* causing bacteraemia reported with resistance to key antimicrobials in 2017 decreased compared with 2015 in cefotaxime, ertapenem, and piperacillin/Tazobactam, whilst gentamicin showed an increase in resistance when comparing the same time period.

Trends

In England, Wales and Northern Ireland, the overall rate of *Proteus* spp. bacteraemia in 2017 was 6.3 per 100,000 population (n=3,801), 40.0% 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 2017 was 0.9 per 100,000 population (n=515), showing a slight increase since 2009 (0.8 per 100,000 population; n=433; Figure1). In England, Wales and Northern Ireland, the overall rate of *Providencia* spp. bacteraemia in 2017 was 0.20 per 100,000 population (n=147), this has increased by 17.6% from 0.17 per 100,000 population (n=95) in 2009 (Figure 1).

Proteus mirabilis accounted for 1.9% of monomicrobial bloodstream infections (BSI; all reported bacteraemia and/or fungaemia) in 2017 making them the eighth most commonly reported cause of monomicrobial BSI (1).

Figure 1. *Proteus* spp., *Morganella* spp. and *Providencia* spp. bacteraemia rate per 100,000 population (England, Wales and Northern Ireland): 2009 to 2017



Geographic distribution

The Northern Ireland PHE Centre had the highest reported incidence rate of *Proteus* spp. bacteraemia in 2017, 9.4 per 100,000 population, followed by the East of England PHE Centre with 7.8 per 100,000 and Wales with 7.4 per 100,000. Yorkshire PHE Centre had the lowest reported incidence rate of *Proteus* spp. bacteraemia in 2017 (6.0 per 100,000 population). All PHE Centres have seen increases in their rates of *Proteus* spp. bacteraemia since 2013. The largest increase in the rate of *Proteus* spp. bacteraemia has been observed in the South East PHE Centre (62% between 2013 and 2017; Table 1a).

Figure 2a. Geographical distribution of *Proteus* spp. bacteraemia rates per 100,000 population (England, Wales, Northern Ireland): 2017

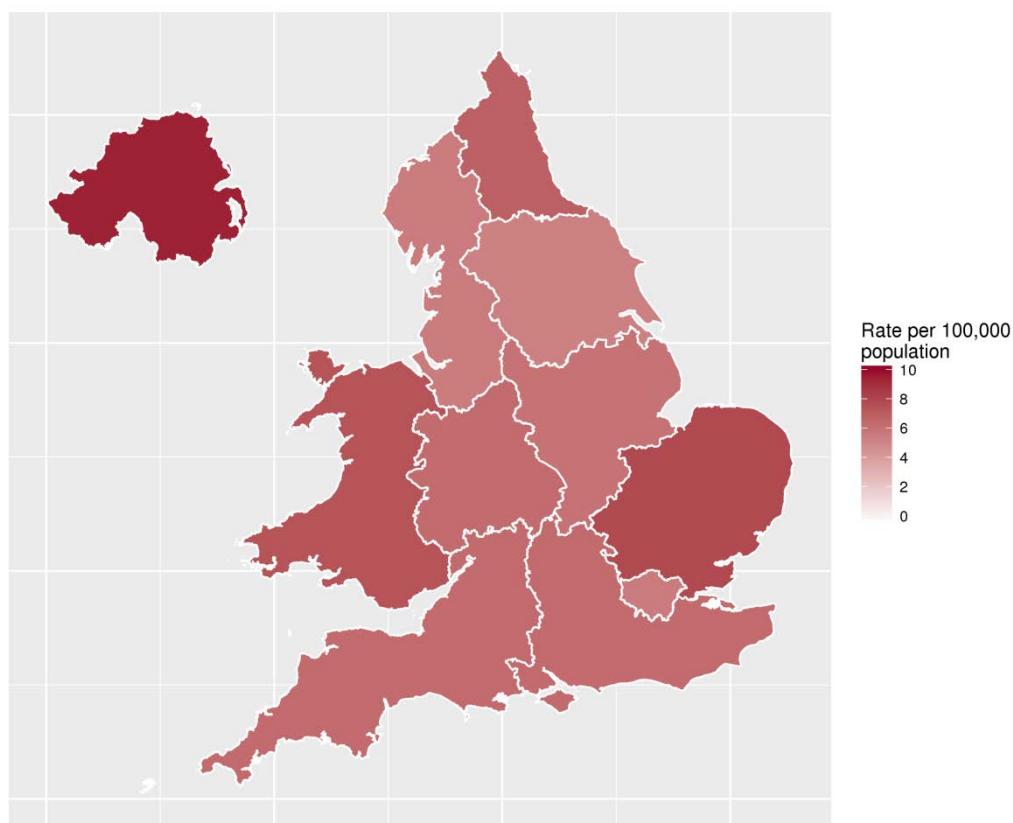
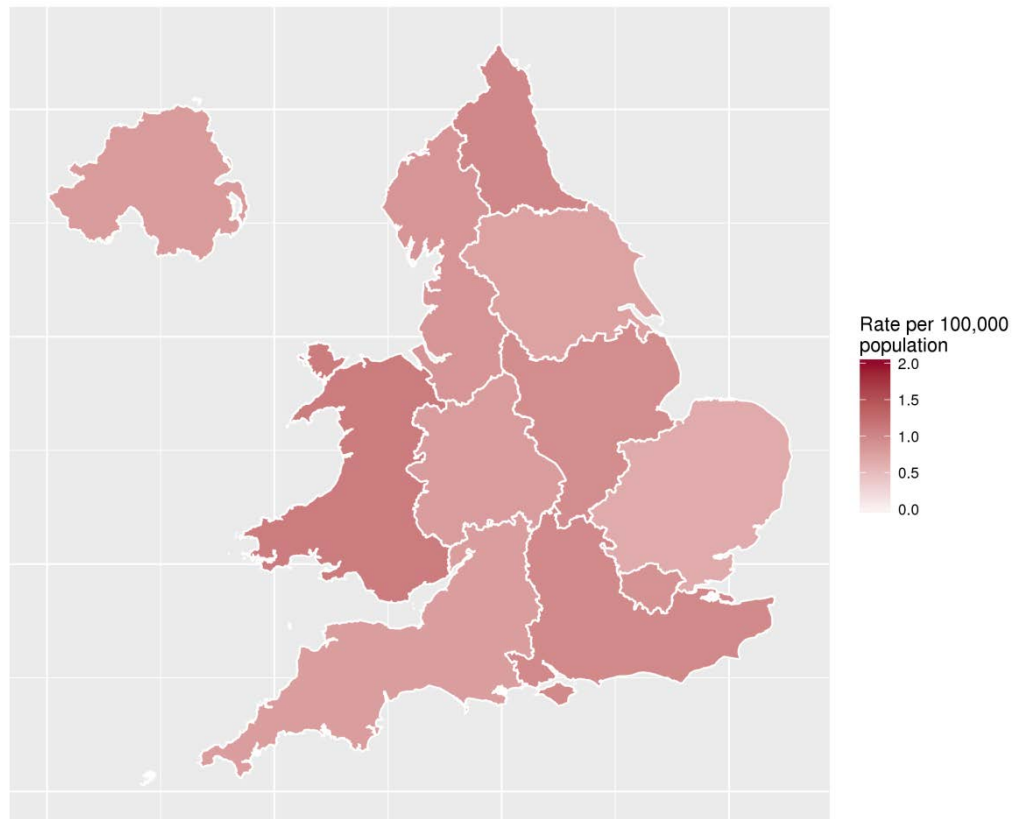


Table 1a. *Proteus* spp. bacteraemia per 100,000 population by region (England, Wales, Northern Ireland): 2013 to 2017

Region	PHE Centre	Rate per 100,000 population				
		2013	2014	2015	2016	2017
London	London	4.3	4.4	4.3	5.5	5.5
Midlands and East of England	West Midlands	4.7	4.7	5.1	5.6	6.3
	East Midlands	5.1	4.5	5.2	6.1	5.9
	East of England	4.9	5.4	5.3	6.6	7.8
North of England	North East	4.8	5.8	5.4	7.1	6.8
	Yorkshire and Humber	3.9	4.3	4.4	5.8	5.3
	North West	4.1	4.1	5.2	5.3	5.5
South of England	South West	4.6	4.4	5.4	6.1	6.3
	South East	3.9	3.9	4.6	5.4	6.3
England		4.4	4.5	4.9	5.8	6.1
Northern Ireland		6.2	5.8	5.9	7.4	9.4
Wales		5.7	6.4	6.9	7.1	7.4
England, Wales & Northern Ireland		4.5	4.6	5.1	5.9	6.3

Figure 2b. Geographical distribution of *Morganella* spp. bacteraemia rates per 100,000 population (England, Wales, Northern Ireland): 2017

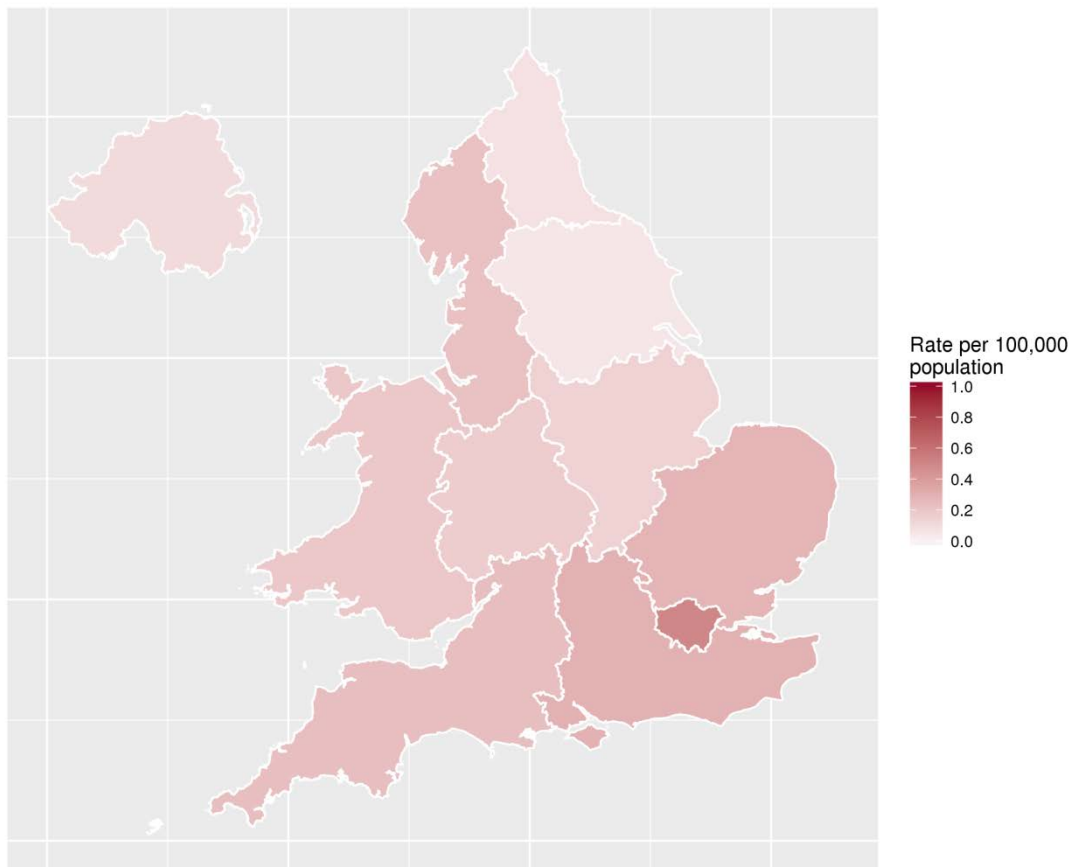


The incidence rate of *Morganella* spp. bacteraemia in 2017 ranged from 0.7 to 1.1 per 100,000 population across all PHE Centres, with an overall 50% increase in England, Wales and Northern Ireland compared (from 0.6 to 0.9) since 2013.

Table 1b. *Morganella* spp. bacteraemia per 100,000 population by region (England, Wales, Northern Ireland): 2013 to 2017

Region	PHE Centre	Rate per 100,000 population				
		2013	2014	2015	2016	2017
London	London	0.7	0.9	0.8	1.0	0.9
Midlands and East of England	West Midlands	0.7	0.8	0.8	0.9	0.8
	East Midlands	0.6	0.6	0.9	0.9	0.9
	East of England	0.8	0.7	0.5	0.5	0.7
North of England	North East	0.4	0.7	0.4	0.8	1.0
	Yorkshire and Humber	0.4	0.4	0.6	0.8	0.7
	North West	0.5	0.7	0.7	0.8	0.9
South of England	South West	0.7	0.8	0.7	0.8	0.8
	South East	0.6	0.6	0.9	0.9	1.0
England		0.6	0.7	0.7	0.8	0.8
Northern Ireland		0.7	0.5	0.5	0.6	0.8
Wales		1.0	0.9	1.2	0.8	1.1
England, Wales & Northern Ireland		0.6	0.7	0.7	0.8	0.9

Figure 2c. Geographical distribution of *Providencia* spp. bacteraemia rates per 100,000 population (England, Wales, Northern Ireland): 2017



London PHE Centre had the highest reported incidence rate of *Providencia* spp. bacteraemia in 2017 (0.5 per 100,000 population) followed by South East and East of England, each with 0.3 per 100,000 population. North East had the lowest reported incidence rate of *Providencia* spp. bacteraemia in 2017, <0.1 per 100,000 population. The overall rate for England, Wales and Northern Ireland has remained stable at 0.2 per 100,000 population from 2013 to 2017.

Table 1c. *Providencia* spp. bacteraemia per 100,000 population by region (England, Wales, Northern Ireland): 2013 to 2017

Region	PHE Centre	Rate per 100,000 population				
		2013	2014	2015	2016	2017
London	London	0.3	0.2	0.3	0.4	0.5
Midlands and East of England	West Midlands	0.1	0.3	0.0	0.1	0.2
	East Midlands	0.1	0.1	0.2	0.2	0.1
	East of England	0.2	0.2	0.1	0.3	0.3
North of England	North East	0.0	0.1	0.2	0.2	0.1
	Yorkshire and Humber	0.1	0.1	0.1	0.1	0.1
	North West	0.1	0.1	0.1	0.2	0.2
South of England	South West	0.1	0.1	0.1	0.2	0.2
	South East	0.2	0.1	0.2	0.2	0.3
England		0.2	0.2	0.2	0.2	0.3
Northern Ireland		0.2	0.2	0.1	0.2	0.1
Wales		0.2	0.2	0.4	0.2	0.2
England, Wales & Northern Ireland		0.2	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 are extracted 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 (89%), similar to previous years (Table 2a). In 2017, as in previous years, the predominant species was *P. mirabilis*, accounting for 90% of bacteraemia, followed by *P. vulgaris* (2.4%). The number of reported blood isolates has increased steadily between 2013 and 2017, with a 5.5% increase observed between 2016 and 2017. There has been an overall increase of 69.8% since 2013.

Table 2a. Reports of *Proteus* spp. bacteraemia by species (England, Wales, Northern Ireland): 2013-2017

	2013		2014		2015		2016		2017	
	No.	%	No.	%	No.	%	No.	%	No.	%
<i>P. hauseri</i>	0	0.0	0	0.0	0	0.0	2	0.1	8	0.2
<i>P. mirabilis</i>	2106	88.9	2185	89.7	2377	88.3	2828	88.1	3042	89.6
<i>P. penneri</i>	4	0.2	6	0.2	3	0.1	12	0.4	8	0.2
<i>P. vulgaris</i>	58	2.4	77	3.2	78	2.9	91	2.8	80	2.4
<i>Proteus</i> spp., other named	0	0.0	1	0.0	4	0.1	2	0.1	3	0.1
<i>Proteus</i> spp., sp. not recorded	201	8.5	168	6.9	230	8.5	275	8.6	255	7.5
<i>Proteus</i> spp.	2369	100	2437	100	2692	100	3210	100	3396	100

The majority of *Morganella* spp. bacteraemia isolates were identified to a species level (90%). Trends for *Morganella* spp. Isolates have risen year on year by 70% from 2013 to 2017 (Table 2b).

Table 2b. Reports of *Morganella* spp. bacteraemia by species (England, Wales, Northern Ireland): 2013-2017

	2013		2014		2015		2016		2017	
	No.	%	No.	%	No.	%	No.	%	No.	%
<i>M. morganii</i>	326	100	383	100	388	100	453	100	466	100
<i>Morganella</i> spp., sp. not recorded	-	-	-	-	1	0	2	0	-	0
<i>Morganella</i> spp.	326	100	383	100	389	100	455	100	466	100

The majority of *Providencia* spp. were identified to species level, 92%. The most frequent species identified from blood isolates was *P. rettgeri* (50%), followed by *P. stuartii* (46.8%); of note, there has been a 141% increase in reported isolates of *P. rettgeri*, and a 44% increase in reported isolates of *P. stuartii* since 2013. There has been a 72% increase overall in reported *Providencia* spp. isolates across England, Wales and Northern Ireland since 2013.

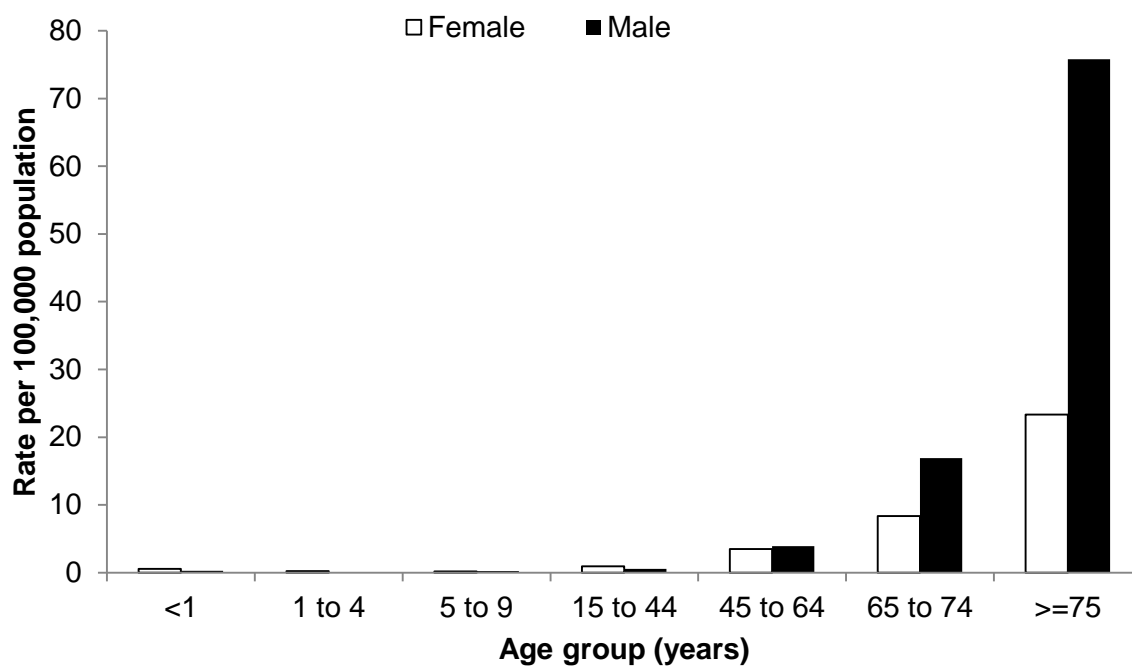
Table 2c. Reports of *Providencia* spp. bacteraemia by species (England, Wales, Northern Ireland): 2013-2017

	2013		2014		2015		2016		2017	
	No.	%	No.	%	No.	%	No.	%	No.	%
<i>P. alcalifaciens</i>	4	4.9	0	0.0	3	3.1	2	1.6	1	0.7
<i>P. rettgeri</i>	29	35.8	41	46.6	34	35.4	60	49.2	70	50.4
<i>P. rustigianii</i>	0	0.0	1	1.1	0	0.0	0	0.0	0	0.0
<i>P. stuartii</i>	45	55.6	38	43.2	59	61.5	55	45.1	65	46.8
<i>Providencia</i> spp., other named	3	3.7	4	4.5	0	0.0	0	0.0	0	0.0
<i>Providencia</i> spp., sp. not recorded	0	0.0	4	4.5	0	0.0	5	4.1	3	2.2
<i>Providencia</i> spp.	81	100	88	100	96	100	122	100	139	100

Age and sex distribution

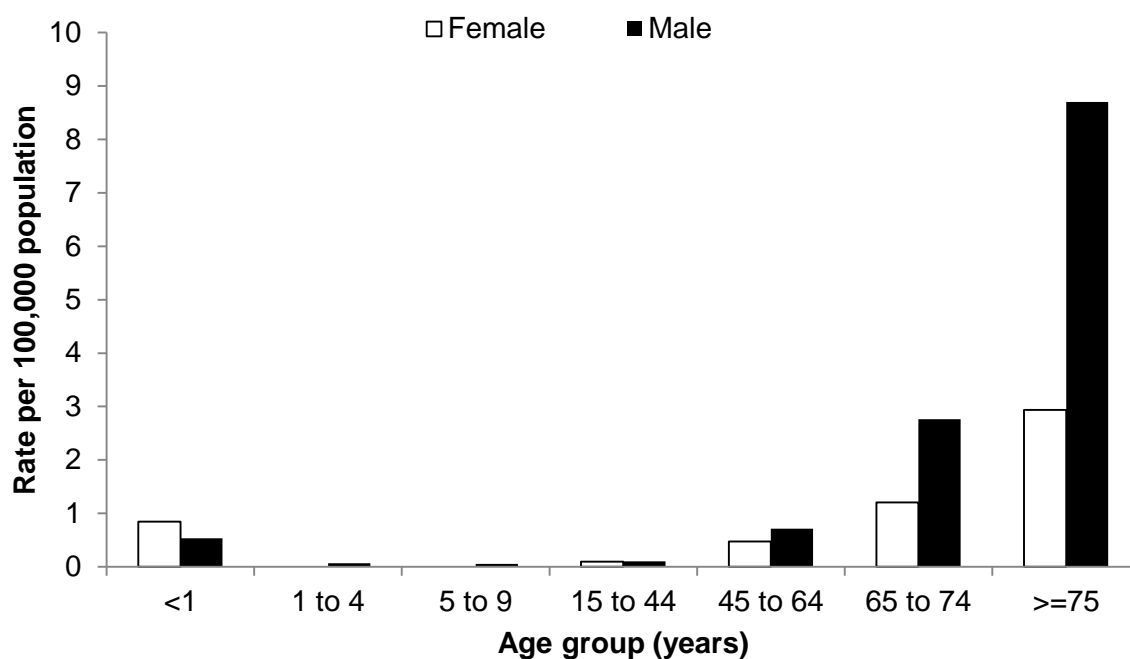
Age distribution of *Proteus* spp. bacteraemia for 2017 in England, Wales and Northern Ireland can be seen in Figure 3a. The highest rate of *Proteus* spp. bacteraemia was observed in those aged 75 years or older (76.0 per 100,000 population), followed by males aged 65 to 74 years (17.0 per 100,000 population). 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 age group (1.0 compared to 0.6 per 100,000 in females and males, respectively).

Figure 3a. *Proteus* spp. bacteraemia rates per 100,000 population by age and sex (England, Wales and Northern Ireland): 2017



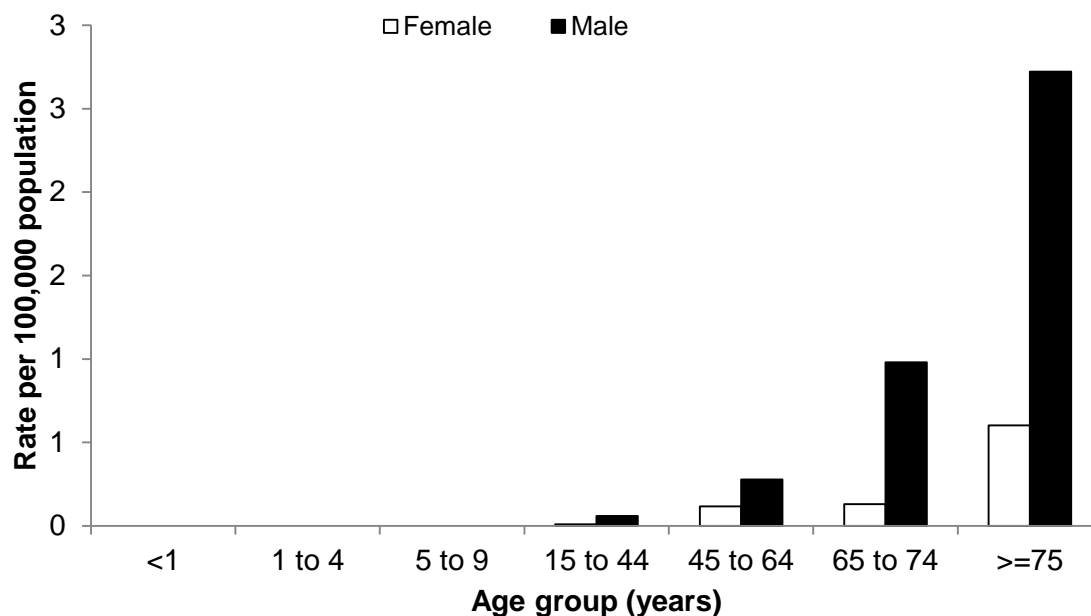
Age distribution of *Morganella* spp. bacteraemia for 2017 can be seen in Figure 3b. The highest rate of *Morganella* spp. bacteraemia was observed in males aged 75 years or older (8.7 per 100,000 population), followed by females aged 75 years and over (2.9 per 100,000 population). There were few cases reported in children aged one to 14. Males had higher rates of *Morganella* spp. bacteraemia than females in all age groups, except the <1 year old group.

Figure 3b. *Morganella* spp. bacteraemia rates per 100,000 population by age and sex (England, Wales and Northern Ireland): 2017



Age distribution of *Providencia* spp. bacteraemia for 2017 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 (1.0 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 almost a 5-fold difference (2.7 per 100,000 population in males versus 0.6 per 100,000 population in females in 2017). 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): 2017



Antimicrobial resistance: England and Northern Ireland

The percentage of *Proteus mirabilis* and *Proteus vulgaris* isolates with susceptibility test results reported in 2017 ranged from 70-100% and 8.7-100%, respectively, for key antimicrobials (Table 3a and 3b). The percentage of resistant *P. mirabilis* bacteraemia isolates reported was ampicillin/amoxicillin (33%), gentamicin (8%), cefotaxime (1%), ceftazidime (1%), ciprofloxacin (7%), piperacillin/tazobactam (1%), ertapenem (<1%) and meropenem (<1%) (Table 3a). The percentage of resistant *P. vulgaris* bacteraemia isolates reported was ampicillin/amoxicillin (91%), gentamicin (1%), cefotaxime (5%), ceftazidime (1%), ciprofloxacin (0%), piperacillin/tazobactam (0%), ertapenem (0%) and meropenem (0%). Single-agent antimicrobial resistance rates have remained stable for *P. mirabilis* since 2015. For *P. vulgaris* bacteraemia, increased resistance was observed since 2015 to cefotaxime (3% to 5%) and decreased resistance to gentamicin (6% to 1%), ciprofloxacin (5% to 0%) and piperacillin/tazobactam (2% to 0%).

The percentage of *Morganella morganii* isolates with susceptibility test results reported in 2017 ranged from 1-100% (Table 3c) for key antimicrobials. The percentage of resistant *M. morganii* bacteraemia isolates reported was ampicillin/amoxicillin (99%), gentamicin (11%), cefotaxime (19%), ceftazidime (21%), ciprofloxacin (12%), piperacillin/tazobactam (6%), ertapenem (0%) and meropenem (0%); increased resistance to ceftazidime (17% to 21%), cefotaxime (17% to 19%) and piperacillin/tazobactam (4% to 6%) has been observed since 2015 (Table 3c). EUCAST report intrinsic resistance to ampicillin/amoxicillin in *M. morganii* (2).

The percentage of *Providencia stuartii* isolates with susceptibility test results reported in 2017 ranged from 7-100%, for key antimicrobials (Table 3d). The percentage of resistant *P. stuartii* bacteraemia isolates reported in 2017 was ampicillin/amoxicillin (93%), gentamicin (63%), cefotaxime (0%), ceftazidime (2%), ciprofloxacin (9%), piperacillin/tazobactam (2%), ertapenem (0%) and meropenem (0%). Rates of *P. stuartii* resistance have decreased in cefotaxime (3% to 0%), ceftazidime (4% to 2%), ampicillin/amoxicillin (98% to 93%) and piperacillin/tazobactam (4% to 2%), with increase in resistance seen in gentamicin (50% to 63%) since 2015, Table 3d). The high resistance seen with ampicillin/amoxicillin is expected due to the possession of chromosomal β -lactamases in *P. stuartii* (2, 3).

Table 3a. Antimicrobial susceptibility* for *Proteus mirabilis* bacteraemia (England and Northern Ireland): 2015 to 2017

Antimicrobial agent	2015			2016			2017		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
Gentamicin	92.12	0.89	6.99	90.13	1.22	8.64	90.82	1.28	7.91
Ciprofloxacin	91.93	1.90	6.17	92.05	1.43	6.51	92.04	1.37	6.59
Ceftazidime	98.06	0.95	1.00	97.63	1.23	1.14	98.23	0.97	0.81
Cefotaxime	97.55	0.58	1.87	97.10	0.77	2.12	98.04	0.54	1.43
Meropenem	100.00	0.00	0.00	99.82	0.11	0.07	99.93	0.03	0.03
Ertapenem	99.56	0.38	0.05	99.69	0.09	0.22	99.92	0.00	0.08
Ampicillin\Amoxicillin	66.15	0.09	33.76	66.52	0.04	33.45	66.99	0.00	33.01
Piperacillin\Tazobactam	98.29	0.92	0.79	97.91	0.99	1.10	97.12	1.63	1.26

*S = susceptible; I = intermediate (reduced susceptibility); R = resistant

Table 3b. Antimicrobial susceptibility* for *Proteus vulgaris* bacteraemia (England and Northern Ireland): 2015 to 2017

Antimicrobial agent	2015			2016			2017		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
Gentamicin	93.65	0.00	6.35	98.77	0.00	1.23	98.75	0.00	1.25
Ciprofloxacin	93.44	1.64	4.92	98.72	0.00	1.28	100.00	0.00	0.00
Ceftazidime	94.12	3.92	1.96	92.31	4.62	3.08	97.06	1.47	1.47
Cefotaxime	92.11	5.26	2.63	92.31	2.56	5.13	92.11	2.63	5.26
Meropenem	100.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	0.00
Ertapenem	97.78	2.22	0.00	100.00	0.00	0.00	100.00	0.00	0.00
Ampicillin\Amoxicillin	8.62	0.00	91.38	8.22	0.00	91.78	8.70	0.00	91.30
Piperacillin\Tazobactam	98.36	0.00	1.64	100.00	0.00	0.00	100.00	0.00	0.00

*S = susceptible; I = intermediate (reduced susceptibility); R = resistant

Table 3c. Antimicrobial susceptibility* for *Morganella morganii* bacteraemia (England and Northern Ireland): 2015 to 2017

Antimicrobial agent	2015			2016			2017		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
Gentamicin	89.97	0.26	9.76	89.32	0.44	10.24	87.09	1.43	11.48
Ciprofloxacin	84.81	2.76	12.43	84.44	4.00	11.56	82.52	5.54	11.94
Ceftazidime	77.24	5.77	16.99	82.54	2.12	15.34	76.19	2.91	20.90
Cefotaxime	78.90	4.59	16.51	85.25	1.64	13.11	79.20	1.60	19.20
Meropenem	100.00	0.00	0.00	99.55	0.23	0.23	100.00	0.00	0.00
Ertapenem	99.67	0.33	0.00	99.22	0.26	0.52	99.75	0.25	0.00
Ampicillin\Amoxicillin	1.42	0.00	98.58	2.12	0.00	97.88	0.89	0.00	99.11
Piperacillin\Tazobactam	93.94	2.48	3.58	95.09	1.34	3.57	91.63	2.42	5.95

*S = susceptible; I = intermediate (reduced susceptibility); R = resistant

Table 3d. Antimicrobial susceptibility* for *Providencia stuartii* bacteraemia (England and Northern Ireland): 2015 to 2017

Antimicrobial agent	2015			2016			2017		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
Gentamicin	42.86	7.14	50.00	42.37	8.47	49.15	33.33	3.33	63.33
Ciprofloxacin	91.23	0.00	8.77	88.89	1.85	9.26	86.21	5.17	8.62
Ceftazidime	96.08	0.00	3.92	91.67	2.08	6.25	97.96	0.00	2.04
Cefotaxime	97.30	0.00	2.70	92.00	4.00	4.00	100.00	0.00	0.00
Meropenem	98.18	1.82	0.00	98.04	0.00	1.96	100.00	0.00	0.00
Ertapenem	95.45	0.00	4.55	95.24	0.00	4.76	98.00	2.00	0.00
Ampicillin\Amoxicillin	1.89	0.00	98.11	9.62	0.00	90.38	7.27	0.00	92.73
Piperacillin\Tazobactam	96.43	0.00	3.57	98.25	0.00	1.75	96.08	1.96	1.96

*S = susceptible; I = intermediate (reduced susceptibility); R = resistant

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. Multi-drug resistance is rare (<1%) with the exceptions of *P. mirabilis* and *P. stuartii* resistance to gentamicin and ciprofloxacin, and *Morganella* spp. resistance to combinations of gentamicin, ciprofloxacin and third generation cephalosporins.

Table 4a. Multi-drug antimicrobial testing and resistance summary* for *Proteus mirabilis* bacteraemia (England): 2015 to 2017

Antimicrobial agent	2015			2016			2017		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
Gentamicin and Ciprofloxacin	97.38	0.50	2.11	96.71	0.94	2.34	96.98	0.49	2.53
Gentamicin and 3rd Generation Cephalosporins [†]	99.36	0.14	0.50	98.57	0.34	1.09	98.96	0.17	0.87
Gentamicin and Meropenem	100.00	0.00	0.00	99.88	0.12	0.00	100.00	0.00	0.00
Ciprofloxacin and 3rd Generation Cephalosporins [†]	99.30	0.05	0.65	98.75	0.38	0.87	99.09	0.35	0.56
Ciprofloxacin and Meropenem	100.00	0.00	0.00	99.84	0.08	0.08	99.96	0.00	0.04
3rd Generation Cephalosporins [†] and Meropenem	100.00	0.00	0.00	99.88	0.12	0.00	100.00	0.00	0.00

*S = susceptible; I = intermediate (reduced susceptibility); R = resistant

[†] Cefotaxime, Ceftazidime, Ceftriaxone, Cefpodoxime

Table 4b. Multi-drug antimicrobial testing and resistance summary* for *Proteus vulgaris* bacteraemia (England): 2015 to 2017

Antimicrobial agent	2015			2016			2017		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
Gentamicin and Ciprofloxacin	96.55	1.72	1.72	100.00	0.00	0.00	100.00	0.00	0.00
Gentamicin and 3rd Generation Cephalosporins [†]	100.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	0.00
Gentamicin and Meropenem	100.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	0.00
Ciprofloxacin and 3rd Generation Cephalosporins [†]	100.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	0.00
Ciprofloxacin and Meropenem	100.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	0.00
3rd Generation Cephalosporins [†] and Meropenem	100.00	0.00	0.00	100.00	0.00	0.00	100.00	0.00	0.00

*S = susceptible; I = intermediate (reduced susceptibility); R = resistant

[†] Cefotaxime, Ceftazidime, Ceftriaxone, Cefpodoxime

Table 4c. Multi-drug antimicrobial testing and resistance summary* for *Morganella morganii* bacteraemia (England): 2015 to 2017

Antimicrobial agent	2015			2016			2017		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
Gentamicin and Ciprofloxacin	92.70	1.69	5.62	91.18	2.09	6.73	90.27	3.32	6.42
Gentamicin and 3rd Generation Cephalosporins [†]	94.93	0.28	4.79	96.07	0.46	3.46	94.77	1.09	4.14
Gentamicin and Meropenem	100.00	0.00	0.00	99.76	0.24	0.00	100.00	0.00	0.00
Ciprofloxacin and 3rd Generation Cephalosporins [†]	92.51	1.73	5.76	95.08	1.17	3.75	94.42	1.12	4.46
Ciprofloxacin and Meropenem	100.00	0.00	0.00	99.76	0.00	0.24	100.00	0.00	0.00
3rd Generation Cephalosporins [†] and Meropenem	100.00	0.00	0.00	99.52	0.24	0.24	100.00	0.00	0.00

*S = susceptible; I = intermediate (reduced susceptibility); R = resistant

[†] Cefotaxime, Ceftazidime, Ceftriaxone, Cefpodoxime

Table 4d. Multi-drug antimicrobial testing and resistance summary* for *Providencia stuartii* bacteraemia (England): 2015 to 2017

Antimicrobial agent	2015			2016			2017		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
Gentamicin and Ciprofloxacin	92.73	0.00	7.27	94.23	1.92	3.85	85.96	7.02	7.02
Gentamicin and 3rd Generation Cephalosporins [†]	96.23	0.00	3.77	96.00	2.00	2.00	98.15	0.00	1.85
Gentamicin and Meropenem	98.11	1.89	0.00	97.92	0.00	2.08	100.00	0.00	0.00
Ciprofloxacin and 3rd Generation Cephalosporins [†]	96.30	0.00	3.70	98.00	0.00	2.00	100.00	0.00	0.00
Ciprofloxacin and Meropenem	98.15	1.85	0.00	97.83	0.00	2.17	100.00	0.00	0.00
3rd Generation Cephalosporins [†] and Meropenem	98.11	1.89	0.00	97.83	0.00	2.17	100.00	0.00	0.00

*S = susceptible; I = intermediate (reduced susceptibility); R = resistant

[†] Cefotaxime, Ceftazidime, Ceftriaxone, Cefpodoxime

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 [4].

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References

1. Public Health England (2017). 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>.
2. European Committee on Antimicrobial Susceptibility Testing, EUCAST (2016). 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.
3. 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.
4. Public Health England website. Antimicrobial Resistance and Healthcare Associated Infections (AMRHAI) Reference Unit: <https://www.gov.uk/amrhai-reference-unit-reference-and-diagnostic-services>.

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