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# Laboratory surveillance of *Pseudomonas* and *Stenotrophomonas* spp bacteraemia in England, Wales and Northern Ireland: 2018

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# Laboratory surveillance of *Pseudomonas* and *Stenotrophomonas* spp. bacteraemia in England, Wales and Northern Ireland: 2018

These analyses are based on data related to bloodstream infection caused by *Pseudomonas* spp. and *Stenotrophomonas* spp. reported by laboratories between 2009 and 2018. Data for England were extracted on 22 November 2019 from Public Health England's (PHE) voluntary surveillance database, the Second Generation Surveillance System (SGSS). Data for Wales and Northern Ireland were extracted separately (DataStore on 23 July 2019 and CoSurv on 13 November 2019, 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 [1]. Geographical analyses were based on the residential postcode of the patient if known (otherwise GP postcode, if known, or, failing that, the postcode of the laboratory) with cases in England being assigned to one of nine local PHE Centres (PHECs). The geography of the PHECs is determined by the boundaries of administrative local authorities.

This report includes analyses on the trends, and the age, sex, and geographical distribution of cases of *Pseudomonas* spp. and *Stenotrophomonas* 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 (AMR) trends since 2015 are reported for England based on SGSS AMR data. A web appendix is available, which features England-only findings of this report, including data submitted via 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 2018, there were 4,745 reported cases of *Pseudomonas* spp. bacteraemia in England, Wales, and Northern Ireland. Between 2009 and 2018, the rate of bacteraemia increased by 10.7% (from 7.0 to 7.8 reports per 100,000 population); however, a year-to-year comparison shows a 3.5% decrease in rates since 2017 (8.1 per 100,000 population)
- in 2018, there were 434 reported cases of *Stenotrophomonas* spp. bacteraemia in England, Wales, and Northern Ireland. Between 2009 and 2018, the rate of bacteraemia decreased by 22.2% (from 0.9 to 0.7 reports per 100,000 population)
- in England, the largest increases in *Pseudomonas* spp. bacteraemia rates between 2014 and 2018 were observed in the North East (42.2%; from 5.4 to 7.7 reports per 100,000 population) followed by the South East (32.6%; from 7.0 to 9.2 reports per 100,000 population) PHE Centres, while a decrease was seen in the North West (4.2%; from 5.5 to 5.3 reports per 100,000 population)
- between 2014 and 2018, the largest increase in *Stenotrophomonas* spp. bacteraemia rates in England was observed in Yorkshire and Humber PHE Centre (49.6%; from 0.6 to 0.9 reports per 100,000 population), while the largest decreases were seen in North West PHE Centre (51.1%; from 1.1 to 0.6 reports per 100,000 population) and in London (47.2%; from 1.3 to 0.7 reports per 100,000 population)
- in 2018, *Pseudomonas aeruginosa* accounted for 80% of the all blood isolates of the *Pseudomonas* genus and was the most common *Pseudomonas* species
- in 2018, the highest *Pseudomonas* bacteraemia rates were observed among those aged 75 years or older (59.0 and 23.0 reports per 100,000 population for males and females, respectively), and males 65 to 74 with 23.0 reports per 100,000 population.
- in 2018, the highest *Stenotrophomonas* spp. bacteraemia rates were seen among males under 1 year of age (1.7 reports per 100,000 population), males over the age of 75 years (1.5 reports per 100,000 population), and males between 65 and 74 years of age (1.4 reports per 100,000 population)
- between 2015 and 2018, resistance patterns for *Pseudomonas aeruginosa* and *Stenotrophomonas* spp. for key antimicrobial agents remained relatively stable

## Trends

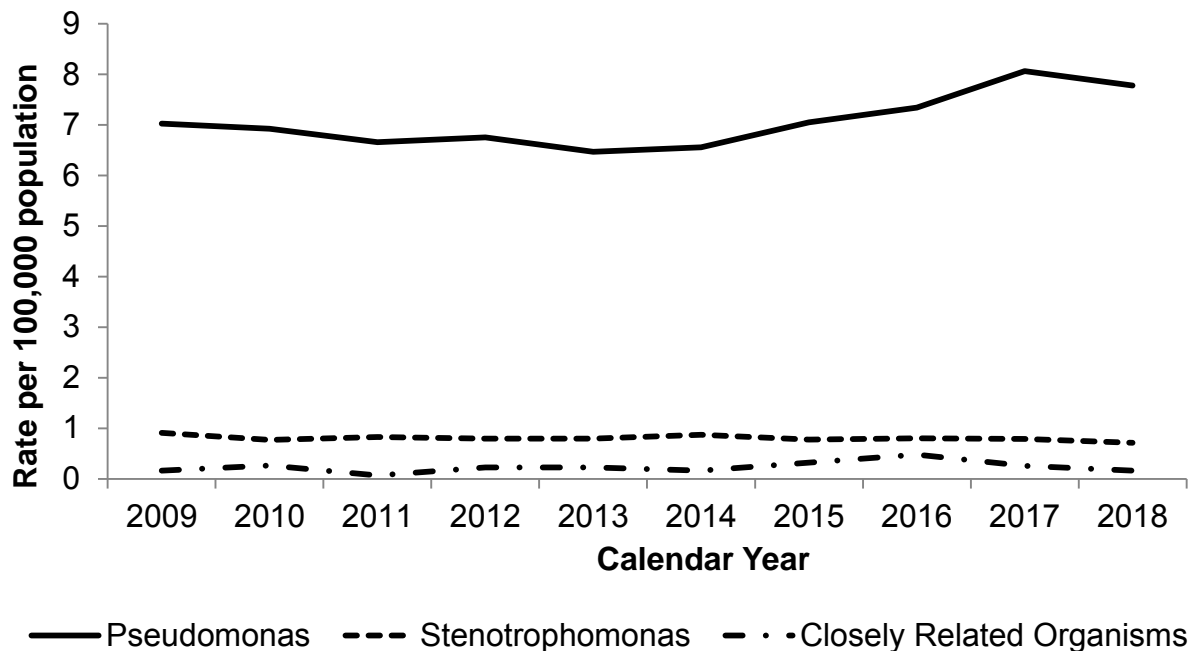
Figure 1. shows the trend is the rate (per 100,000 population) of laboratory-reported bacteraemia due to *Pseudomonas* spp., *Stenotrophomonas* spp., and closely related genera (*Brevudimonas*, *Burkholderia*, *Comamonas*, *Ralstonia*, and *Shewanella*) in England, Wales, and Northern Ireland between 2009 and 2018.

In 2018, there were 4,745 reported cases of *Pseudomonas* spp. bacteraemia in England, Wales, and Northern Ireland. Between 2009 and 2018, the rate of *Pseudomonas* spp. bacteraemia increased by 10.7% (from 7.0 per 100,000 population to 7.8 per 100,000 population, respectively). However, bacteraemia rates have fluctuated during this period, dropping steadily to their lowest in 2013 (6.5 per 100,000 population), before beginning to rise until 2017, when they were the highest in this period (8.1 per 100,000 population). Compared to 2017, bacteraemia rates decreased by 3.5% in 2018.

In 2018, there were 434 reported cases of *Stenotrophomonas* spp. bacteraemia in England, Wales, and Northern Ireland. Bacteraemia rates decreased by 22.2% between 2009 and 2018 (from 0.9 per 100,000 population to 0.7 per 100,000 population, respectively).

For closely related genera, bacteraemia rates remained relatively stable between 2009 and 2018.

**Figure 1. Bacteraemia rates per 100,000 population due to *Pseudomonas* spp., *Stenotrophomonas* spp., and related genera (England, Wales, and Northern Ireland): 2009 to 2018**



## Geographic distribution: *Pseudomonas* spp.

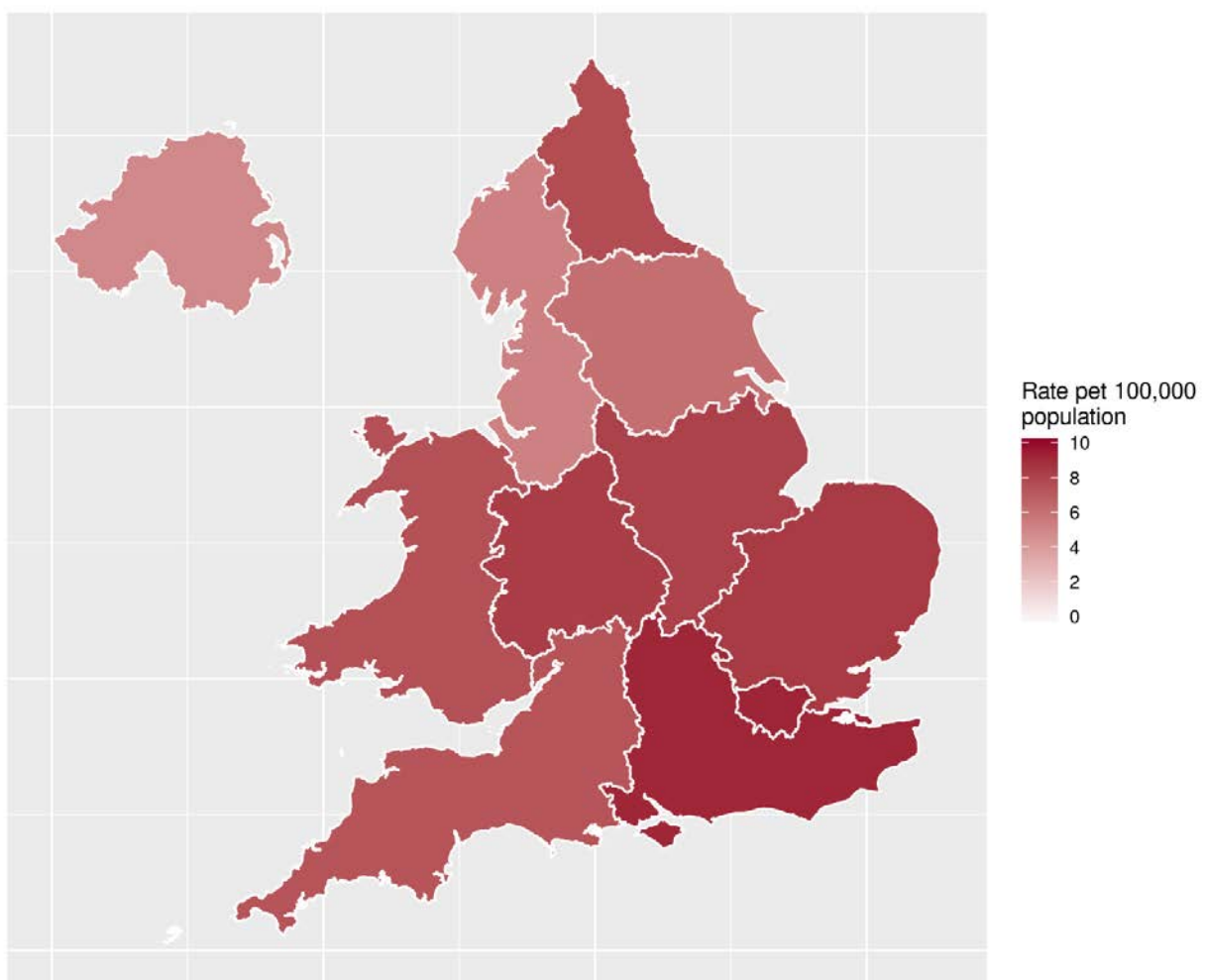
In 2018, the overall rate of *Pseudomonas* spp. bacteraemia was 7.8 per 100,000 population across England, Wales, and Northern Ireland. Individually, this was 7.9, 7.5, and 4.9 per 100,000 population for England, Wales, and Northern Ireland, respectively (Figure 2a). England and Wales saw increases of 19.7% and 10.3% in *Pseudomonas* spp. bacteraemia rates since 2014, respectively, whereas there was a decrease of 7.5% in Northern Ireland (Table 1a).

In England, the rate varied by PHE Centre, ranging from 9.3 to 5.3 per 100,000 population in London and North West, respectively (Table 1a). For England, rates increased every year until 2017. For Wales and Northern Ireland, rates have fluctuated over this period. Between 2017 and 2018, all three nations saw decreases in bacteraemia rates (3.7%, 1.3%, and 12.5% for England, Wales, and Northern Ireland, respectively; Table 1a).

For PHE Centres within England, the largest increases in *Pseudomonas* spp. bacteraemia rates in the 2014-2018 period were seen in North East (42.6%, from 5.4 to 7.7 per 100,000

population) and the South East (31.4%; from 7.0 to 9.2 per 100,000 population). The only PHEC to see a decrease in this period was North West (3.6%; from 5.5 to 5.3 per 100,000 population). In the 2017-2018 period, all PHECs in England except London and South East saw decreases in bacteraemia rates. The largest decreases were seen in North West (17.2%; from 6.4 to 5.3 per 100,000 population) and South West (14.1%; from 8.5 to 7.3 per 100,000 population).

**Figure 2a. Geographical distribution of *Pseudomonas* spp. bacteraemia rates per 100,000 population (England, Wales, and Northern Ireland): 2018**



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**Table 1a. Rate of *Pseudomonas* spp. bacteraemia per 100,000 population by PHE Centre (England, Wales, and Northern Ireland): 2014 to 2018**

Region	PHE Centre	Rate per 100,000 population				
		2014	2015	2016	2017	2018
London	London	8.2	7.8	8.0	9.1	9.3
Midlands and East of England	West Midlands	7.1	7.7	7.0	8.4	8.3
	East Midlands	6.3	6.8	7.0	8.3	8.2
	East of England	6.8	8.1	8.2	8.7	8.5
North of England	North East	5.4	6.1	6.9	8.1	7.7
	Yorkshire and Humber	4.7	6.2	6.0	6.3	6.1
	North West	5.5	5.9	6.1	6.4	5.3
South of England	South West	6.6	6.8	8.4	8.5	7.3
	South East	7.0	7.6	8.1	9.1	9.2
England		6.6	7.1	7.4	8.2	7.9
Northern Ireland		5.3	5.9	5.7	5.6	4.9
Wales		6.8	6.8	7.5	7.6	7.5
<b>England, Wales &amp; Northern Ireland</b>		<b>6.6</b>	<b>7.0</b>	<b>7.3</b>	<b>8.1</b>	<b>7.8</b>

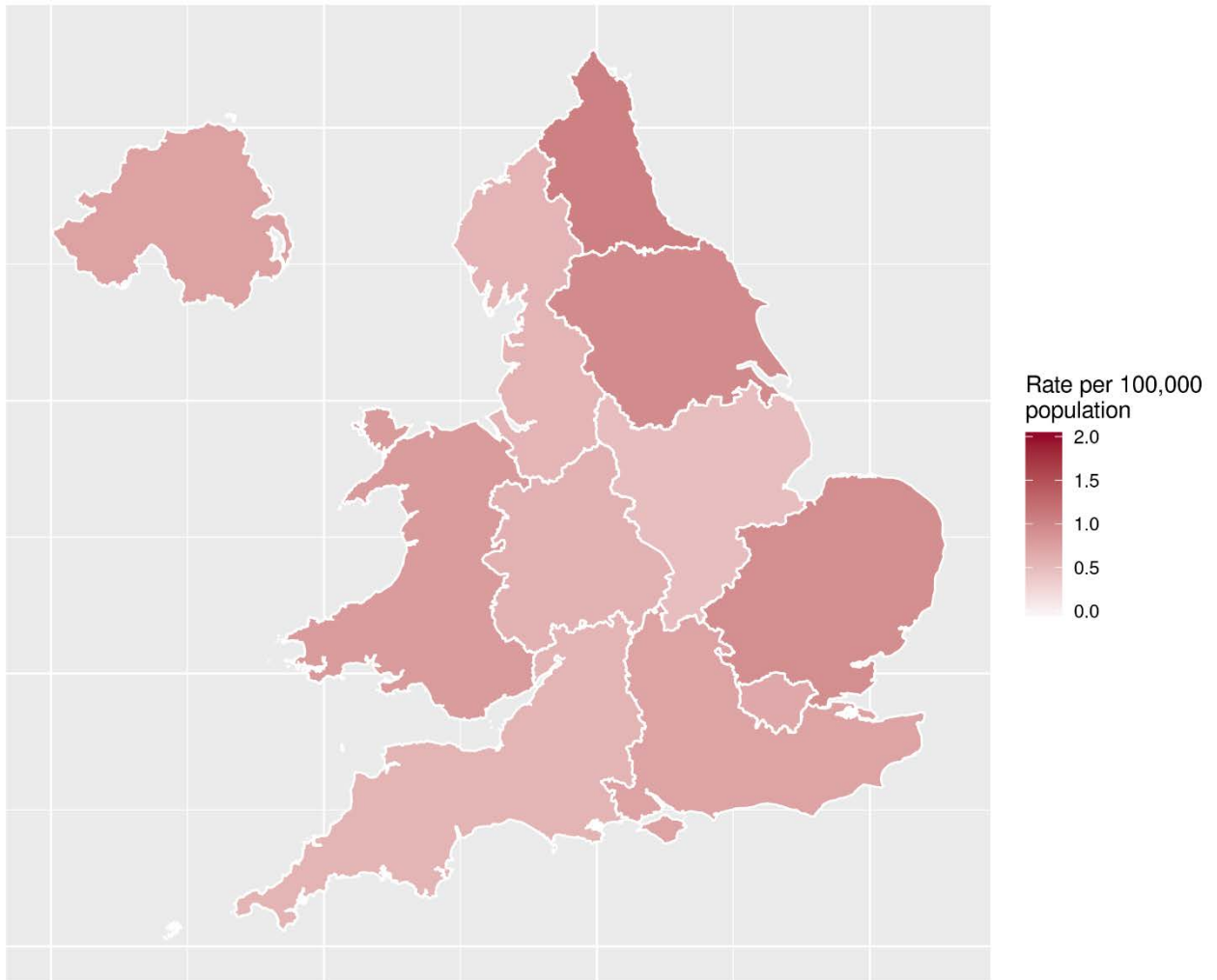
## Geographic distribution: *Stenotrophomonas* spp.

In 2018, the overall rate of *Stenotrophomonas* spp. bacteraemia was 0.7 per 100,000 population across England, Wales, and Northern Ireland. Individually, this was 0.7, 0.8, and 0.7 per 100,000 population for England, Wales, and Northern Ireland, respectively (Figure 2b).

Since 2014, *Stenotrophomonas* spp. bacteraemia rates have fallen in all three nations. England, Wales, and Northern Ireland have seen decreases of 22.2%, 11.1%, and 36.4% respectively (Table 1b). For England, rates decreased every year in this period. For Wales and Northern Ireland, rates rose in 2015 and then decreased every year since then.

In England, the rate varied by PHE Centre, ranging from 1.1 to 0.5 per 100,000 population in North East and East Midlands, respectively (Table 1b). For PHE Centres within England, the largest increases in *Stenotrophomonas* spp. bacteraemia rates in the 2014-2018 period were seen in Yorkshire and Humber (50%, from 0.6 to 0.9 per 100,000 population) and East of England (12.5%; from 0.8 to 0.9 per 100,000 population). The largest decreases in bacteraemia rates were seen in North West (45.5%; from 1.1 to 0.6 per 100,000 population) and East Midlands (37.5%; from 0.8 to 0.5 per 100,000 population).

**Figure 2b. Geographical distribution of *Stenotrophomonas* spp. bacteraemia rates per 100,000 population (England, Wales, and Northern Ireland): 2018**



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**Table 1b. Rate of *Stenotrophomonas* spp. bacteraemia per 100,000 population by PHE Centre (England, Wales, and Northern Ireland): 2014 to 2018**

Region	PHE Centre	Rate per 100,000 population				
		2014	2015	2016	2017	2018
London	London	1.3	0.9	0.9	0.8	0.7
Midlands and East of England	West Midlands	0.6	0.5	0.8	0.5	0.6
	East Midlands	0.8	0.5	0.8	0.8	0.5
	East of England	0.8	0.8	0.7	0.8	0.9
North of England	North East	1.0	0.8	0.8	1.0	1.1
	Yorkshire and Humber	0.6	0.6	0.6	0.6	0.9
	North West	1.1	0.9	0.8	0.9	0.6
South of England	South West	0.7	0.6	0.8	0.7	0.6
	South East	0.7	0.7	0.7	0.8	0.7
England		0.9	0.7	0.8	0.8	0.7
Northern Ireland		1.1	1.2	1.2	1.0	0.7
Wales		0.9	1.4	1.3	1.2	0.8
<b>England, Wales &amp; Northern Ireland</b>		<b>0.9</b>	<b>0.8</b>	<b>0.8</b>	<b>0.8</b>	<b>0.7</b>

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

## Species distribution

In 2018, 4,745 *Pseudomonas* spp. isolates from blood in England, Wales, and Northern Ireland were identified at the genus level. This was a 22% increase since 2014, when 3,885 isolates were identified. In 2018, 92% (4,346/4,745) of *Pseudomonas* isolates from blood were identified to species level. However, this is impacted by the limitations of the MALDI-ToF analysis, which does not reliably distinguish between closely related species such as those in the *P. fluorescens* and *P. putida* groups (Table 2a). The proportion identified to species level was broadly similar to previous years. *P. aeruginosa* was the most commonly isolated species in 2018, accounting for 80% of all isolates of the *Pseudomonas* genus. *P. aeruginosa* is the third most common cause of Gram-negative bacteraemia and, along with *Escherichia coli* and *Klebsiella* spp., and is one of the key pathogens on which the government is focussing its ambition to halve healthcare-associated Gram-negative blood stream infections by financial year 2023/24 [2].

In 2018, 434 *Stenotrophomonas* spp. isolated from blood in England, Wales, and Northern Ireland were identified at the genus level. This was a 16% decrease since 2014, when 516 cases were identified at the genus level. In 2018, 99% (429/434) of *Stenotrophomonas* spp. bacteraemia isolates were identified at the species level (Table 2b). This proportion is similar to that in previous years, except 2014, which saw an unusually large number of cases without a recorded species. The most commonly isolated *Stenotrophomonas* species in 2018 was *S. maltophilia*, at 98% (427/434). *S. maltophilia* is the only known opportunistic pathogen in the *Stenotrophomonas* genus, which makes it likely that the small number of isolated without species data are *S. maltophilia* [3].

*Burkholderia* spp. and *Brevudimonas* spp. were the most commonly reported related organisms\* between 2014 and 2018 in the closely related organisms category. In 2018, these accounted for 45% (49/109) and 39% (43/109) of all closely related organisms, respectively (Table 2c).

\* Related organisms include genera where at least one species has previously been classified as *Pseudomonas* spp. or *Stenotrophomonas* spp.

**Table 2a. Reports of *Pseudomonas* spp. bacteraemia by species (England, Wales, and Northern Ireland): 2014 to 2018**

	2014		2015		2016		2017		2018	
	No.	%	No.	%	No.	%	No.	%	No.	%
<b><i>Pseudomonas</i> spp.</b>	<b>3,885</b>	<b>100</b>	<b>4,211</b>	<b>100</b>	<b>4,424</b>	<b>100</b>	<b>4,887</b>	<b>100</b>	<b>4,745</b>	<b>100</b>
<i>P. aeruginosa</i>	3,171	82	3,428	81	3,556	80	4,024	82	3,778	80
<i>P. alcaligenes</i>	4	<1	7	<1	8	<1	5	<1	4	<1
<i>P. citronellolis</i>	0	0	0	0	0	0	1	<1	2	<1
<i>P. fluorescens</i> group*	56	1	38	1	44	1	30	1	30	1
<i>P. koreensis</i>	1	<1	2	<1	1	<1	8	<1	2	<1
<i>P. libanensis</i>	0	0	0	0	0	0	1	<1	1	<1
<i>P. luteola</i>	2	<1	4	<1	8	<1	11	<1	9	<1
<i>P. mendocina</i>	7	<1	5	<1	6	<1	17	<1	13	<1
<i>P. oleovorans</i>	0	0	1	<1	5	<1	1	<1	2	<1
<i>P. otitidis</i>	1	<1	0	0	0	0	0	0	2	<1
<i>P. paucimobilis</i>	63	<1	56	1	65	1	62	1	54	1
<i>P. putida</i> group**	87	2	103	2	140	3	172	4	163	3
<i>P. stutzeri</i>	94	2	92	2	84	2	81	2	84	2
<i>P. thomasii</i>	0	0	1	<1	1	<1	0	0	0	0
<i>Pseudomonas</i> spp., other named	78	2	44	1	34	1	21	<1	19	<1
<i>Pseudomonas</i> spp., sp. not recorded	320	8	428	10	468	11	449	9	380	8

\* *P. fluorescens* and *P. tolaasii*

\*\* *P. putida*, *P. fulva*, *P. montellii*, *P. moselii*, and *P. oryzihabitans*

**Table 2b. Reports of *Stenotrophomonas* spp. bacteraemia by species (England, Wales, and Northern Ireland): 2014 to 2018**

	2014		2015		2016		2017		2018	
	No.	%	No.	%	No.	%	No.	%	No.	%
<b><i>Stenotrophomonas</i> spp.</b>	<b>516</b>	<b>100</b>	<b>464</b>	<b>100</b>	<b>483</b>	<b>100</b>	<b>477</b>	<b>100</b>	<b>434</b>	<b>100</b>
<i>S. acidaminiphila</i>	0	0	1	<1	0	0	3	1	2	<1
<i>S. maltophilia</i>	473	92	456	98	479	99	469	98	427	98
<i>Stenotrophomonas</i> spp., sp. not recorded	43	8	7	2	4	1	5	1	5	1

**Table 2c. Reports of closely related organism bacteraemia by genus (England, Wales, and Northern Ireland): 2014 to 2018**

	2014		2015		2016		2017		2018	
	No.	%	No.	%	No.	%	No.	%	No.	%
<b>Related organisms</b>	<b>94</b>	<b>100</b>	<b>121</b>	<b>100</b>	<b>112</b>	<b>100</b>	<b>112</b>	<b>100</b>	<b>109</b>	<b>100</b>
<i>Brevundimonas</i> spp.	40	43	38	31	36	32	38	34	43	39
<i>Burkholderia</i> spp.	31	33	64	53	62	55	49	44	49	45
<i>Comamonas</i> spp.	13	14	12	10	9	8	9	8	10	9
<i>Ralstonia</i> spp.	8	9	4	3	4	4	10	9	2	2
<i>Shewanella</i> spp.	2	2	3	2	1	1	6	5	5	5

## Age and sex distribution

Figure 3a depicts *Pseudomonas* spp. bacteraemia rates per 100,000 population among men and women across different age groups in England, Wales, and Northern Ireland in 2018. The bacteraemia rate was highest among older groups ( $\geq 75$  years and 65 to 74 years of age) and those below the age of one year. The rate of bacteraemia per 100,000 population in these age groups was higher amongst males compared to females ( $\geq 75$  years: 59.0 vs. 23.1; 65 to 74 years: 23.0 vs. 13.8; under 1: 12.1 vs. 8.3).

**Figure 3a. *Pseudomonas* spp. bacteraemia rates per 100,000 population by age group and sex (England, Wales, and Northern Ireland): 2018**

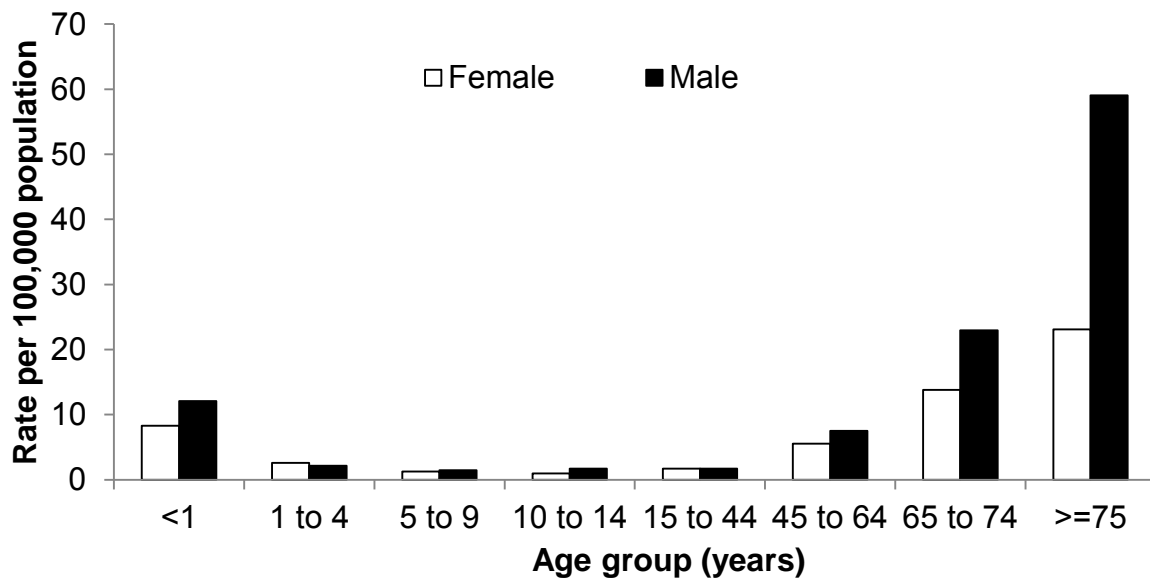
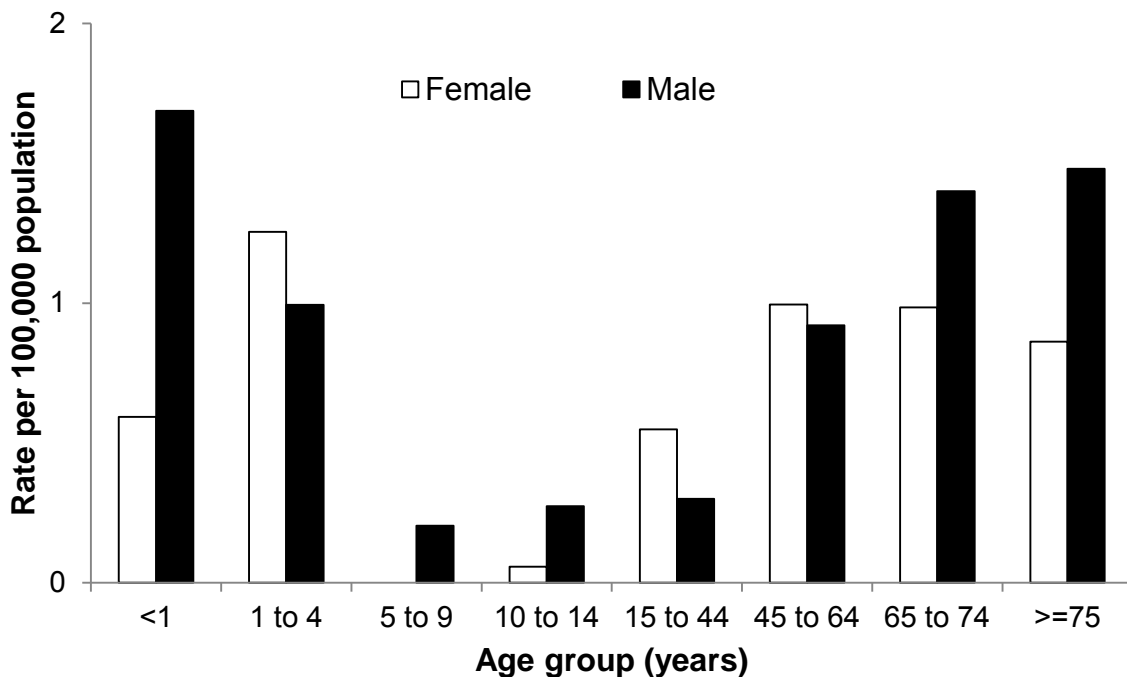


Figure 3b depicts *Stenotrophomonas* spp. bacteraemia rates per 100,000 population among men and women across different age groups in England, Wales, and Northern Ireland in 2018. Rates were higher in those under 5 years of age and those 45 years of age or older. Rates were higher in males compared to females in those under one year of age (1.7 vs. 0.6), those between 10 and 14 years of age (0.3 vs. 0.1), those between 65 and 74 years of age (1.4 vs. 1.0), and those 75 years of age or older (1.5 vs. 0.9). There were no reported *Stenotrophomonas* spp. bacteraemia cases among females in the 5 years to 9 years age group in 2018.

**Figure 3b. *Stenotrophomonas* spp. bacteraemia rates per 100,000 population by age group and sex (England, Wales, and Northern Ireland): 2018**



## Antimicrobial resistance: England and Northern Ireland

The percentage of *Pseudomonas aeruginosa* and *Stenotrophomonas* spp. bacteraemia isolates with susceptibility test results reported in 2018 ranged from 89-97% and 93% for key antimicrobials, respectively.

Susceptibility results reported for key antimicrobials against *P. aeruginosa* are presented in Table 3a. Between, 2015 and 2018, resistance patterns for key antimicrobials agents remained largely stable. There were slight increases observed in resistance to gentamicin (4% to 5%), ciprofloxacin (7% to 8%), meropenem (5% to 6%), and piperacillin/tazobactam (6% to 7%), and slight decreases observed in resistance to imipenem (10% to 9%) and tobramycin (4% to 3%). Resistance to ceftazidime and amikacin remained stable over this period at 6% and 2%, respectively.

These results are in line with *P. aeruginosa* being resistance to multiple antibiotic agents through intrinsic and adaptive mechanisms [4]. The resistance patterns to imipenem, meropenem, and ciprofloxacin presented in this report indicate the organism's ability to acquire resistance to antibiotic agents through three main mechanisms – the alteration in DNA gyrase by mutation in *gyrA* or *gyrB* genes, decreased drug accumulation by decreased permeability of the cell wall, and enhanced efflux [5]. The loss of OprD in *P. aeruginosa* cells affect carbapenem uptake, underlying the non-susceptibility to imipenem and meropenem [4,6]. Mutations in *gyrA*, *gyrB*, *parC*, and *parE* are believed to be involved in resistance to ciprofloxacin by reducing binding affinity to fluoroquinolones [4,5].

Antibiotic susceptibility results for co-trimoxazole in *Stenotrophomonas* spp. isolates are presented in Table 3b. This antimicrobial was selected because it is the drug of choice for treatment on *S. malthophilia* [7,8]. Between 2015 and 2018, resistance to co-trimoxazole has fluctuated between 6% and 8%.

Table 4 presents analysis of *Pseudomonas* spp. (including *P. aeruginosa*) isolates resistant to more than one antibiotic reagent in England in 2018. Overall, the percentage of resistance reported for the different antimicrobial combinations (gentamicin, ciprofloxacin, and ceftazidime) were similar, and multi-drug resistance is rare ( $\leq 2\%$ ) in the listed combinations. For advice on treatment of antibiotic-resistant infections due to these organisms or for reference services including species identification and confirmation of susceptibility testing results, laboratories should contact PHE's AMRHA Reference Unit in London [9].

**Table 3a. Antimicrobial susceptibility for *Pseudomonas aeruginosa* bacteraemia (England and Northern Ireland): 2015 to 2018**

Antimicrobial agent	2015			2016			2017			2018		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
Gentamicin	96	<1	4	96	<1	3	95	<1	4	95	<1	5
Ciprofloxacin	90	2	7	90	2	7	89	2	8	91	<1	8
Ceftazidime	93	<1	6	93	<1	6	92	1	7	93	<1	6
Meropenem	92	3	5	91	3	6	90	4	6	90	4	6
Imipenem	88	3	10	87	2	11	86	3	11	89	2	9
Tobramycin	96	<1	4	97	<1	3	97	0	3	97	0	3
Amikacin	97	1	2	97	1	2	96	2	2	97	2	2
Piperacillin\Tazobactam	91	3	6	90	3	7	86	7	7	92	2	7

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

**Table 3b. Antimicrobial susceptibility for *Stenotrophomonas* bacteraemia (England and Northern Ireland): 2015 to 2018**

Antimicrobial agent	2015			2016			2017			2018		
	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)	S (%)	I (%)	R (%)
Co-trimaxazole	93	0	7	94	0	6	92	0	8	93	0	7

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

**Table 4. Multi-drug antimicrobial testing and resistance summary for *Pseudomonas* bacteraemia (England): 2015 to 2018**

Antimicrobial Agent	2015		2016		2017		2018	
	No. Tested	R (%)	No. Tested	R (%)	No. Tested	R (%)	No. Tested	R (%)
Gentamicin and Ciprofloxacin	3452	2	3882	2	4249	2	4104	2
Gentamicin and Ceftazidime	3367	1	3777	1	4151	2	4050	1
Ciprofloxacin and Ceftazidime	3335	2	3762	2	4128	2	4021	2
Gentamicin, Ciprofloxacin and Ceftazidime	3302	1	3688	1	3993	1	3874	1

\*R = resistant



## Acknowledgements

These reports would not be possible without the ongoing 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 PHE AMRHAI Reference Unit, Public Health Wales and HSC Public Health Agency (Northern Ireland) in particular is valued in the preparation of this report. Feedback and any specific enquiries regarding this report should be sent to [hcai.armdepartment@phe.gov.uk](mailto:hcai.armdepartment@phe.gov.uk).

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*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.

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