



Infection report

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Laboratory surveillance of polymicrobial bacteraemia and fungaemia in England, Wales and Northern Ireland: 2016

These analyses are based on all laboratory reports bacteraemia and fungaemia (bloodstream infections) in England, Wales and Northern Ireland from 2009 to 2016. Data for laboratories in England were extracted on 10 March 2017 from Public Health England's voluntary surveillance database, the Second Generation Surveillance System (SGSS), communicable disease module (CDR; formerly CoSurv/LabBase2). Data for Wales and Northern Ireland were extracted separately (DataStore on 24 February and CoSurv on 17 February 2017, respectively).

Rates of bloodstream infection 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 estimates as 2016 data were not available at the time of producing this report [1]. Geographical analyses were based on residential postcode, 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 9 local PHE Centres (PHECs) formed from administrative local authority boundaries.

Bacteraemia and fungaemia episodes for a given species were calculated using a 14-day rolling window whereby successive laboratory identifications of the same species within 14 days of the last identification are grouped into a single episode. These within-species episodes are then grouped into monomicrobial or polymicrobial patient episodes.

Patient episodes of polymicrobial bacteraemia and/or fungaemia were defined as the isolation of two or more different bacterial and/or fungal species isolated from the same patient, on the same day. Therefore, bacteraemia and/or fungaemia from a patient with three distinct bacterial species (A, B and C) identified from positive blood cultures taken on the same day will be as a single polymicrobial patient episode (A + B + C).

The rates of bacteraemia and fungaemia episodes in this report should be interpreted with caution as the data are derived from largely voluntary reports, but also includes notifiable diseases [2]. In addition, it is possible that some reports may reflect an increase in the reporting

of potential skin commensals/contaminants including as components within polymicrobial combinations

The report includes analyses on the trends, age and sex distribution and geographical distribution of cases of polymicrobial and monomicrobial bloodstream infections.

A [web appendix is available](#) featuring the findings of this report including only data submitted via SGSS from laboratories in England.

The data presented here may differ in some instances from data in earlier publications due to the change in surveillance systems and the inclusion of late reports.

Key points

- the total number of bacteraemia/fungaemia reports from England, Wales, and Northern Ireland increased by 42.1% between 2012 and 2016 (n=106,433 in 2012 and n=151,224 in 2016)
- in 2016, 13,630 (10.1%) of the 135,608 bacteraemia and fungaemia patient episodes were identified as polymicrobial, a 65.9% increase from the 8,215 (8.5%) of 97,115 in 2012 and a 20.8% increase is observed in comparison to the 11,285 of 119,847 in 2015
- a total of 583 different species were identified from the 13,630 polymicrobial patient episodes reported in 2016, 556 (95.4%) bacterial and 27 (4.6%) fungal
- 11,777 (86.4%) polymicrobial episodes in 2016 involved two different organisms, 1,552 (11.4%) involved three, and 301 (2.2%) involved four or more organisms
- 445 (3.3%) of the 13,630 polymicrobial patient episodes in 2016 involved both bacterial and fungal isolates
- the 2016 population rates (per 100,000 population) of polymicrobial patient episodes were 23.4 for England, 16.7 for Wales and 16.4 for Northern Ireland; and for monomicrobial bacteraemia or fungaemia were 204.0 for England, 215.7 for Wales and 189.8 for Northern Ireland
- in England, the highest rates of polymicrobial bacteraemia/fungaemia were observed in the South West (36.7 per 100,000 population), and North West (26.6); the lowest rates were observed in the North East (19.1), and South East (19.8)
- the highest rate of polymicrobial bacteraemia/fungaemia was observed for males and females aged 75 years and over (146.7 and 83.1 per 100,000 population, respectively), and males and females aged less than one year (80.6 and 63.8 per 100,000, respectively) these trends remain the same for monomicrobial bacteraemia and fungaemia rates.

Trends

In 2016, 135,608 patient episodes with a monomicrobial or polymicrobial bacteraemia and/or fungaemia were identified from reports received from laboratories in England, Wales and Northern Ireland (**Table 1**). This represented a 39.6% increase in patient episodes since 2012 (97,115 episodes).

Between 2009 and 2016 the rate of laboratory reports of bacteraemia and/or fungaemia episodes rose from 152.2 to 204.2 per 100,000 population and 14.0 to 22.4 per 100,000 population, respectively (Figure 1). This increase was characterised by two separate phases. Between 2009 and 2014, the rates rose gradually by 4.3% (from 152.2 to 154.9 per 100,000 population) for monomicrobial episodes, and 12.5% (from 14.0 to 15.7 per 100,000 population) for polymicrobial episodes. Thereafter the increase accelerated: between 2014 and 2016, the rate of monomicrobial episodes rose by 28.6% (from 158.7 to 204.2 per 100,000 population) and that of polymicrobial episodes by 45.2% (from 15.7 to 22.8 per 100,000 population).

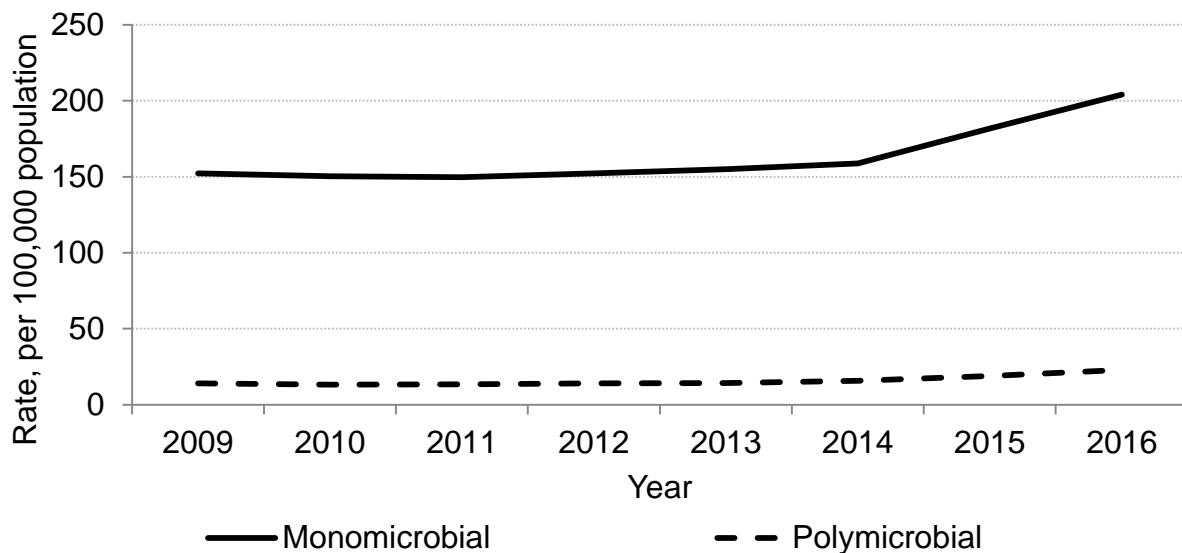
The observed increase in bacteraemia and fungaemia episodes (31.5%) between 2014 and 2016 may be partly due to more extensive laboratory reporting to PHE following the switch from LabBase2 to SGSS in October 2014. Other relevant and potentially contributory laboratory changes included the widespread adoption of MALDI-TOF, changes in PCR testing in a number of laboratories and, national policy changes and public health interventions resulting in an increase in blood cultures being taken [3, 4].

It should be noted that the SGSS transition was associated with a 68.8% increase of skin organisms (predominantly coagulase-negative staphylococci; CONS) being reported from blood in 2016 compared to (pre-SGSS) 2014. Due to limitations of the data, we are unable to determine if these skin commensals represent contaminants or true bloodstream infections; therefore, all cases including potential skin commensals have been reported.

Among all reported CONS positive blood cultures, 72.7% of these isolates have not been speciated, with 54.8% unspicated in 2016. The most common species observed within this group are *Staphylococcus epidermidis* (28.6% of all reported CONS blood cultures in 2016). Of note, the reporting of CONS blood cultures has increased 71.2% compared to 2014 from 15,872 to 27,239 positive blood cultures. This is in part due to the changes in laboratory surveillance and differences between LabBase2 and SGSS:CDR module

implemented in October 2014. For this reason, CONS have been retained as an unspciated group for all analysis within this report.

Figure 1. Trends in the rate of monomicrobial and polymicrobial bacteraemia and/or fungaemia (per 100,000 population) in England, Wales and Northern Ireland: 2009-2016



Based on positive blood specimens reported in 2016, 13,630 (10.1%) of bacteraemia and fungaemia episodes were identified as polymicrobial and 121,978 (89.9%) as monomicrobial. The proportion of patients with a polymicrobial infection increased with a 67.7% increase in the absolute number of polymicrobial episodes compared by 2016 compared to 2012 (**Table 1**). However, this time period covers the transition to SGSS. There was a 20.8% increase in polymicrobial bacteraemias and fungaemias between 2015 and 2016 with a similar 21.2% increase between 2014 and 2015, whereas there was only a 10.9% increase between 2013 and 2014, prior to the launch of SGSS.

Table 1. Trends in reports of bacteraemia and fungaemia in England, Wales and Northern Ireland: 2012-2016

	2012	2013	2014	2015	2016
Total reported bacteraemia [†]	104,620	107,185	112,198	130,700	149,068
Total reported fungaemia [†]	1,813	1,836	1,737	1,951	2,156
Number of patient bacteraemia episodes	95,447	97,755	101,758	118,072	133,754
Number of patient fungaemia episodes	1,668	1,693	1,597	1,775	1,854
Number of polymicrobial patient episodes [‡]	8,215	8,393	9,310	11,285	13,630
Percentage of patient episodes that are polymicrobial	8.5%	8.4%	9.0%	9.4%	10.1%

[†] Total reports can include multiple records for individual patient; i.e. in a polymicrobial infection, there is a separate record for each organism isolated from that patient.

[‡] Defined as an infection with two or more organisms (bacteria or fungi) with a positive blood culture sample on the same day

Of the 13,630 patient episodes with a polymicrobial bloodstream infection, 11,777 involved two different species, 1,552 involved three species, and 301 involved four or more distinct species (Table 2); 445 polymicrobial patient episodes involved both bacterial and fungal isolates. There were 583 organisms isolated from the reported 13,630 polymicrobial bloodstream infections, of which 556 (95.4%) were bacteria and 27 (4.6%) were fungi.

Table 2. Number of species involved in polymicrobial bacteraemia and/or fungaemia patient episodes, England, Wales and Northern Ireland: 2016

No. organisms	No. episodes	%
Two	11,777	86.4%
Three	1,552	11.4%
Four	248	1.8%
Five	45	0.3%
More than five	8	0.1%
Total	13,630	100.0%

The most frequently reported organisms involved in polymicrobial infections were *Escherichia coli* (15.2%) followed by coagulase-negative staphylococci (CONS) (13.7%) then by coliforms that were not further identified (6.4%; **Table 3**). A total of 583 different species were isolated from patients with polymicrobial infections in 2016 (**Table 4**). The top 25 organisms, as ranked by their monomicrobial episode counts are presented in Table 4; the comprehensive species/organism level table is available online in full as a web appendix.

For comparison, the dominant agents of monomicrobial bacteraemias are *Escherichia coli* (27.9%) followed by CONS (17.7%) and, *Staphylococcus aureus* (8.4%; **Table 3**) with a total of 753 different species isolated from patients with monomicrobial infections in 2016 (**Table 4**, [see online appendix for full table](#)).

The identification of the different species, including those less well known, is in part a reflection of changing laboratory technology and the widespread use of MALDI-TOF. The changing relative frequency of the various species may therefore be influenced by the laboratory methodology used to identify organisms.

Table 3. The 10 most frequently reported species or organism category in polymicrobial and monomicrobial bacteraemia and/or fungaemia, England, Wales and Northern Ireland: 2016

Rank	Polymicrobial	Rank	Monomicrobial
1	<i>Escherichia coli</i>	1	<i>Escherichia coli</i>
2	<i>Coagulase-negative staphylococci</i>	2	<i>Coagulase-negative staphylococci</i>
3	'Coliform'	3	<i>Staphylococcus aureus</i>
4	<i>Klebsiella pneumoniae</i>	4	<i>Klebsiella pneumoniae</i>
5	<i>Enterococcus faecalis</i>	5	<i>Streptococcus pneumoniae</i>
6	<i>Staphylococcus aureus</i>	6	<i>Pseudomonas aeruginosa</i>
7	<i>Enterococcus faecium</i>	7	<i>Proteus mirabilis</i>
8	<i>Staphylococcus</i> other named	8	<i>Enterococcus faecalis</i>
9	<i>Proteus mirabilis</i>	9	<i>Streptococcus</i> group A
10	<i>Pseudomonas aeruginosa</i>	10	<i>Streptococcus</i> group B

Table 4. Reports of monomicrobial and polymicrobial bacteraemia and fungaemia by species or organism category, England, Wales and Northern Ireland: 2016

Organism	Bacteraemia / fungaemia					
	Monomicrobial			Polymicrobial		
	n [†]	%‡	Rank	n [†]	%‡	Rank
<i>Escherichia coli</i>	33,996	27.87	1	4,377	14.97	1
Coagulase-negative staphylococci	22,411	18.37	2	3,896	13.32	2
<i>Staphylococcus aureus</i>	10,246	8.40	3	1,163	3.98	6
<i>Klebsiella pneumoniae</i>	5,399	4.43	4	1,536	5.25	4
<i>Streptococcus pneumoniae</i>	5,083	4.17	5	235	0.80	22
<i>Pseudomonas aeruginosa</i>	2,756	2.26	6	678	2.32	10
<i>Proteus mirabilis</i>	2,435	2.00	7	688	2.35	9
<i>Enterococcus faecalis</i>	2,299	1.88	8	1,262	4.32	5
<i>Streptococcus</i> group A	2,033	1.67	9	198	0.68	26
<i>Streptococcus</i> group B	1,884	1.54	10	204	0.70	24
<i>Enterococcus faecium</i>	1,858	1.52	11	823	2.81	7
<i>Staphylococcus</i> other named	1,570	1.29	12	780	2.67	8
<i>Streptococcus</i> group G	1,110	0.91	13	126	0.43	37
<i>Enterobacter cloacae</i>	1,031	0.85	14	413	1.41	13
<i>Streptococcus</i> group C	1,021	0.84	15	147	0.50	35
<i>Klebsiella oxytoca</i>	1,005	0.82	16	527	1.80	12
<i>Micrococcus luteus (sarcina)</i>	851	0.70	17	119	0.41	40
<i>Serratia marcescens</i>	743	0.61	18	162	0.55	29
<i>Diphtheroids</i>	737	0.60	19	281	0.96	18
<i>Candida albicans (stellatoidea)</i>	693	0.57	20	150	0.51	34
<i>Bacteroides fragilis</i>	692	0.57	21	199	0.68	25
<i>Bordetella pertussis</i>	681	0.56	22	0	-	100
<i>Streptococcus mitis</i> group	616	0.51	23	400	1.37	14
<i>Micrococcus sp</i>	613	0.50	24	87	0.30	48
<i>Propionibacterium freudenreichii</i>	590	0.48	25	127	0.43	36
Total *	121,978	100.00		29,246	100.00	

† Total reports can include multiple records for individual patient; i.e. in a polymicrobial infection, there is a separate record for each organism isolated from that patient.

‡ As a percentage of totals

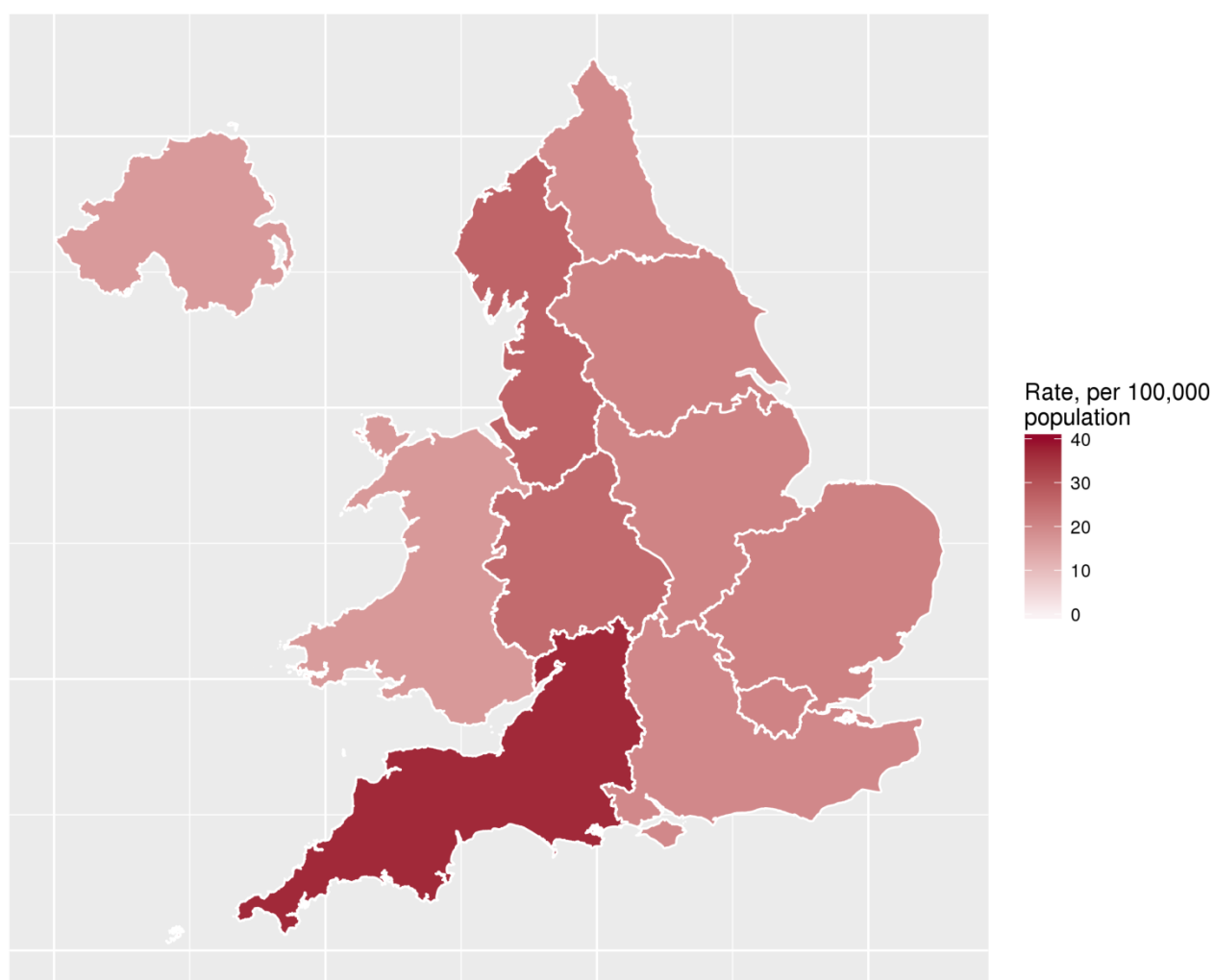
* Represents the full total, the remaining results can be found on the online appendix

NB: Treponema and Helicobacter have been removed from the analysis.

Geographic distribution

The rates of laboratory reports of polymicrobial bacteraemia and/or fungaemia in 2016 were similar in Wales and Northern Ireland at 16.7 and 16.4 per 100,000 population respectively, whereas rates were substantially higher in England at 23.4 per 100,000 population (figure 2). Among England's PHE Centres, the lowest rates were observed in the North East (19.1 per 100,000 population), and South East (19.8) and highest rates in the South West (36.7), and North West (26.6). Caution should be taken when comparing these infection rates with those in previous reports due to differences in geographical distribution of reporting laboratories by region.

Figure 2. Regional distribution of polymicrobial bacteraemia and/or fungaemia episodes per 100,000 population in England, Wales and Northern Ireland: 2016



Compared to 2012, the rate of polymicrobial bacteraemia and fungaemia episodes increased 69.2% in England, and 64.0% in Northern Ireland (**Table 5**).

In Wales, the rate has remained relatively stable between 2013-2015 (14.2-14.9 per 100,000 population). However, in comparison to 2012, we observe a 3.1% decrease (from 17.1 per 100,000 population in 2012 to 16.6 per 100,000 population in 2016) and we observe a 13.7% increase in the rate of polymicrobial bacteraemias and fungaemias compared to 2013.

Table 5. Polymicrobial bacteraemia and/or fungaemia episodes per 100,000 population by region (England, Wales and Northern Ireland): 2012 to 2016

Region	PHE Centre	Rate, per 100,000 population				
		2012	2013	2014	2015	2016
North of England	North East	12.1	12.8	15.9	13.7	19.1
	North West	16.1	17.2	18.6	21.2	26.6
	Yorkshire and Humber	11.1	10.5	11.4	18.7	21.0
Midlands and East of England	East Midlands	13.0	12.6	12.9	17.1	20.6
	East of England	11.1	10.2	12.9	16.7	21.0
	West Midlands	13.5	16.0	19.1	22.4	25.4
London	London	17.3	18.0	18.5	18.1	20.7
South of England	South East	11.9	11.5	11.3	14.7	19.8
	South West	17.8	18.5	22.3	29.6	36.7
England		14.0	14.3	15.9	19.2	23.4
Wales		17.3	14.3	14.4	15.2	16.7
Northern Ireland		11.1	12.5	13.3	16.6	16.4
England, Wales and Northern Ireland		14.1	14.3	15.7	18.9	22.8

These rates should be interpreted with caution, as they may reflect changes in laboratory reporting in addition to increases in the incidence of polymicrobial bacteraemia and/or fungaemia.

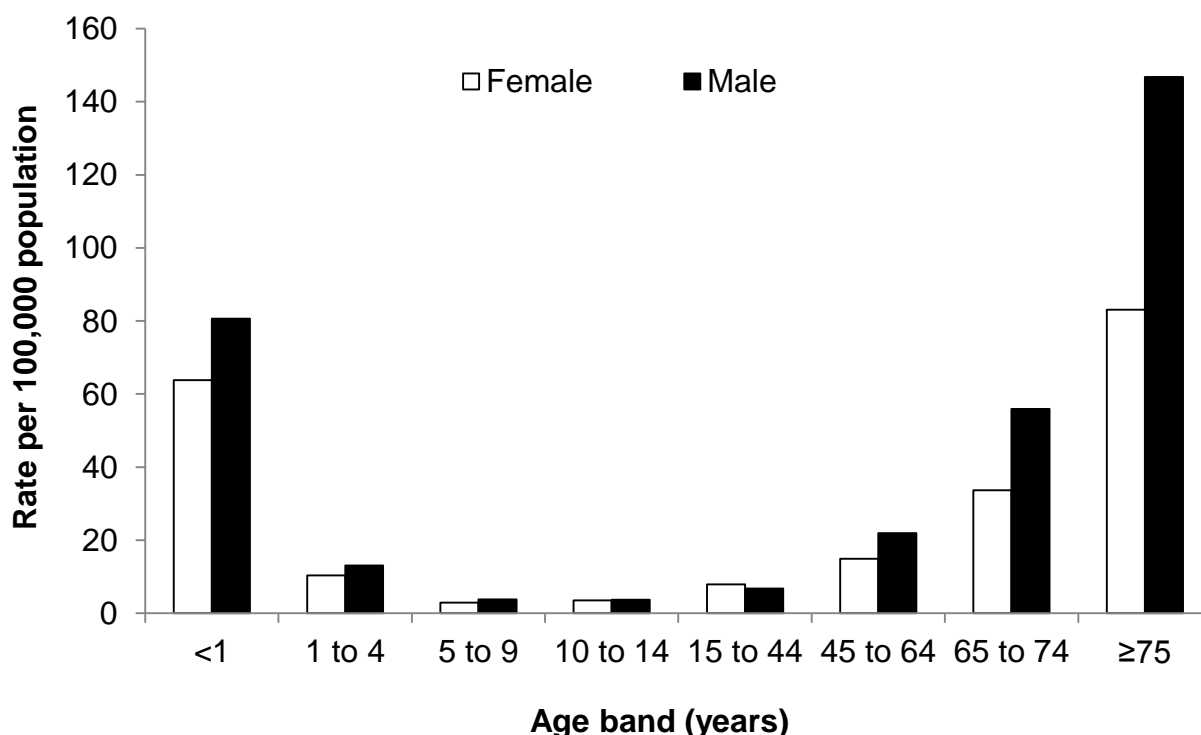
Age and sex distribution

The highest rate of polymicrobial bloodstream infection in England and Northern Ireland was observed for males and females aged 75 years and older (146.7 and 83.1 per 100,000 population respectively), followed by males and females less than one year of age (80.6 and 63.8 per 100,000 population respectively) (figure 3a). These are similar to the age-specific patterns observed in 2014 [5].

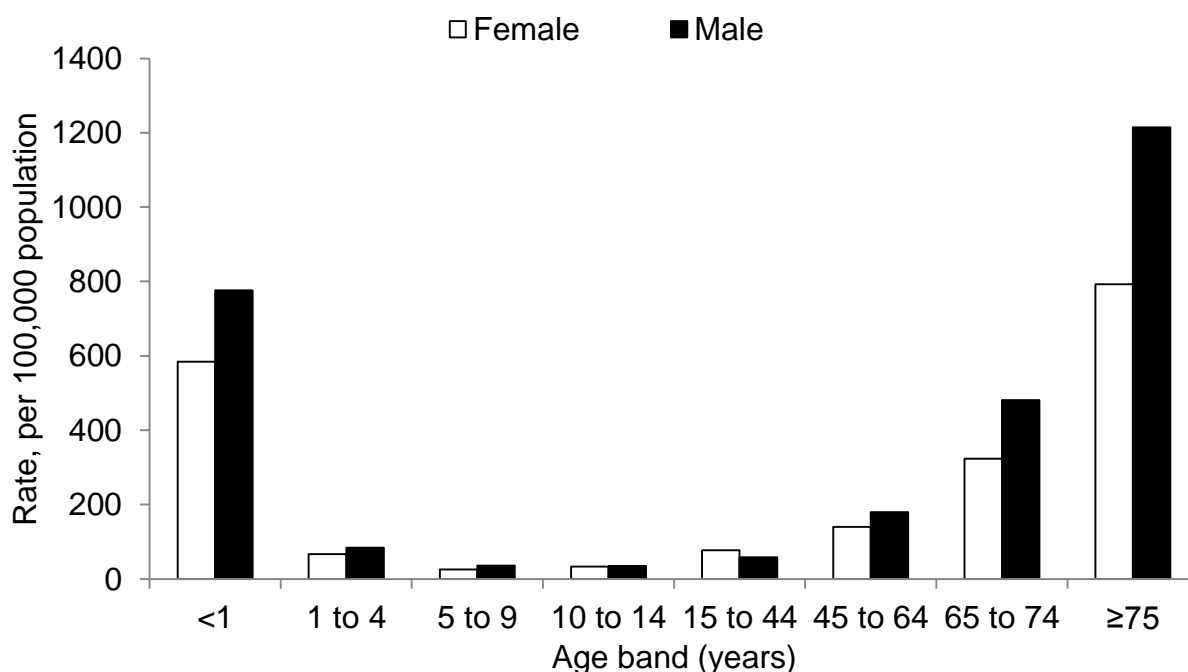
Age- and sex-specific rates of monomicrobial bloodstream infections followed the same pattern being highest in those aged 75 years and over (1,214.3 males; 792.4 females per 100,000 population) and those aged less than 1 year (776.1 males; 584.6 females per 100,000 population) (figure 3b).

Figure 3. Polymicrobial, and Monomicrobial episode rate by age and sex (England and Northern Ireland): 2016

(a) Rate per 100,000 of patients with a polymicrobial bloodstream infection



(b) Rate per 100,000 of patients with a monomicrobial bloodstream infection



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