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Laboratory surveillance of *Escherichia coli* bacteraemia in England, Wales and Northern Ireland: 2018

Health Protection Report
Volume 13 Number 37
18 October 2019

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These analyses are based on data relating to diagnosis of blood stream infections by *Escherichia coli* between 2009 and 2018. Data for England were extracted from the Public Health England (PHE) voluntary surveillance database the Second-Generation Surveillance System (SGSS) on the 24 August 2019. Data for Wales and Northern Ireland were extracted separately (DataStore on 30 April 2019 and CoSurv on 2 July 2019, respectively).

In England and Northern Ireland, laboratories are requested to submit data individually to SGSS CDR/CoSurv, with reporting based on clinically significant isolates. Data from Wales is collected by extraction from a single laboratory information system, used by all microbiology laboratories, where all positive blood cultures are recorded, including those not thought to be clinically significant.

Rates of bacteraemia laboratory reports were calculated using mid-year resident population estimates for the respective year and geography with the exception of 2018 rates, which were based on 2017 population estimates as population estimates for 2018 were not available at the time of producing this report [1,2]. 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 nine local PHE Centres (PHECs) formed from administrative local authority boundaries [3].

The report includes analyses on the temporal trends, age and sex distribution, and geographical distribution of cases of *E.coli* bacteraemia cases in England, Wales and Northern Ireland. Single-agent antimicrobial susceptibility trends since 2015 are reported for England and Northern Ireland based on SGSS AMR 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 in some instances from data in earlier publications due to the change in surveillance systems and the inclusion of late reports. Similarly, data may differ to reports published by devolved administrations due to differences in data processing.

Key points

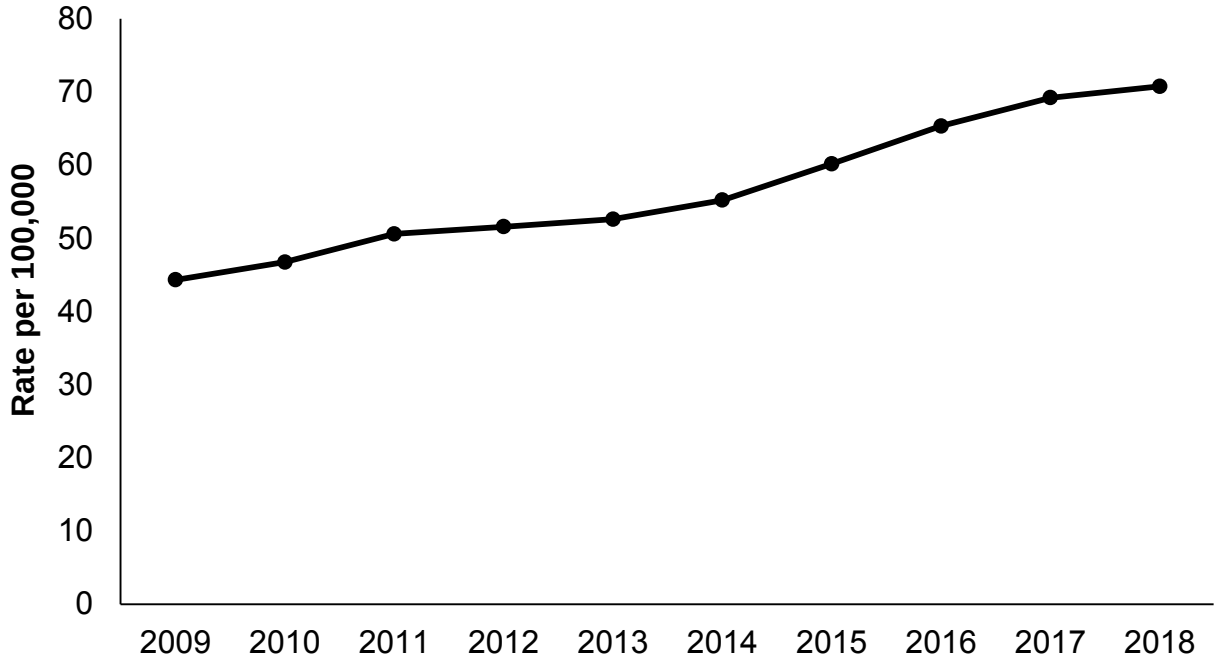
- England, Wales and Northern Ireland had an observed rate of voluntarily reported *E. coli* of 70.7 per 100,000 population in 2018 an increase of 2.2% from 2017
- in 2018, the rate by individual country was; England 69.7, Northern Ireland 88.0 and Wales 79.6 per 100,000 population
- England and Northern Ireland had an observed increase between 2014 and 2018 (England 31.2% and Northern Ireland 20.0%), Wales had an observed decrease (2.2%)
- in 2018, the North East (111.7 per 100,000 population) and the South West (75.6 per 100,000 population) reported the highest rates of *E. coli* bacteraemia, the North East has reported the highest over the last 5 years.
- males had higher rates of *E. coli* bacteraemia in age groups that included individuals aged less than one year, 65 to 74 and 75 & above
- there were more *E. coli* bacteraemia reports for woman (n=22,331) than men (n=20,794)
- resistance to pairwise combinations of antimicrobials ranged from 2.2% (gentamicin and piperacillin/tazobactam) to 13.9% (ciprofloxacin and co-amoxiclav)
- the proportion of isolates resistant to a combination of ciprofloxacin, gentamicin, 3rd generation cephalosporins and meropenem was 0.04%
- ascertainment between English mandatory and voluntary surveillance was approximately 91.7%, an increase from 91.0% in 2017

Trends

In England, Wales and Northern Ireland the rate of *E. coli* bacteraemia increased to 70.7 per 100,000 population in 2018 from 69.2 in 2017 (a 2.2% increase). This observed rate is the highest that has been reported over the ten-year period since 2009 (figure 1).

There has been an increasing trend in *E. coli* bacteraemia since 2009, although some slight changes have occurred most notably between 2011 and 2014, this sub-period was characterised by smaller year-on-year increases than the years both before and after. In contrast, the years that followed 2014 were years identifiable by a more rapidly increasing trend. Caution is required in the interpretation of this data however as It should be noted that 2014 saw many English labs (of which most the reports are derived) transition to SGSS, which is credited for the improvement of lab based voluntary surveillance. A further point is that the increase between 2017 and 2018 was a smaller increase than observed in previous years.

Figure 1. *E. coli* bacteraemia rate per 100,000 population (England, Wales and Northern Ireland): 2009 to 2018



Geographic distribution

In 2018, the combined rate for England, Wales and Northern Ireland was 70.7 per 100,000 population (England 69.7, Northern Ireland 88.0 and Wales 79.6 per 100,000 population). This is an increase of 28.1% since 2014. Individually, England and Northern Ireland had an observed increase between 2014 and 2018 (England 31.2% and Northern Ireland 20.0%), Wales had an observed decrease (2.2%).

Wales and Northern Ireland have consistently had higher rates than England, with England and Northern Ireland broadly showing a similar increasing trend (table 1). It is of note that in England and Northern Ireland, there are links from the different laboratory information systems that report clinically significant isolates to SGSS/CoSurv. Data from Wales are 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. Therefore, the rates in Wales will be relatively higher compared to that in England and Northern Ireland.

Within England, all PHECs reported higher rates in 2018 compared to 2014. The highest rates observed throughout this period have been from the North East and this continued in 2018 (111.7 per 100,000 population). The North East has consistently had the highest rate of *E. coli* over the five-year period. The South West reported the second highest rate of *E. coli* bacteraemia (75.6 per 100,000 population). London is the only centre that has had a relatively low rate of *E. coli* bacteraemia throughout the period, although it has increased 30% from 47.2 per 100,000 population in 2014, to 61.3 in 2018 (figure 2).

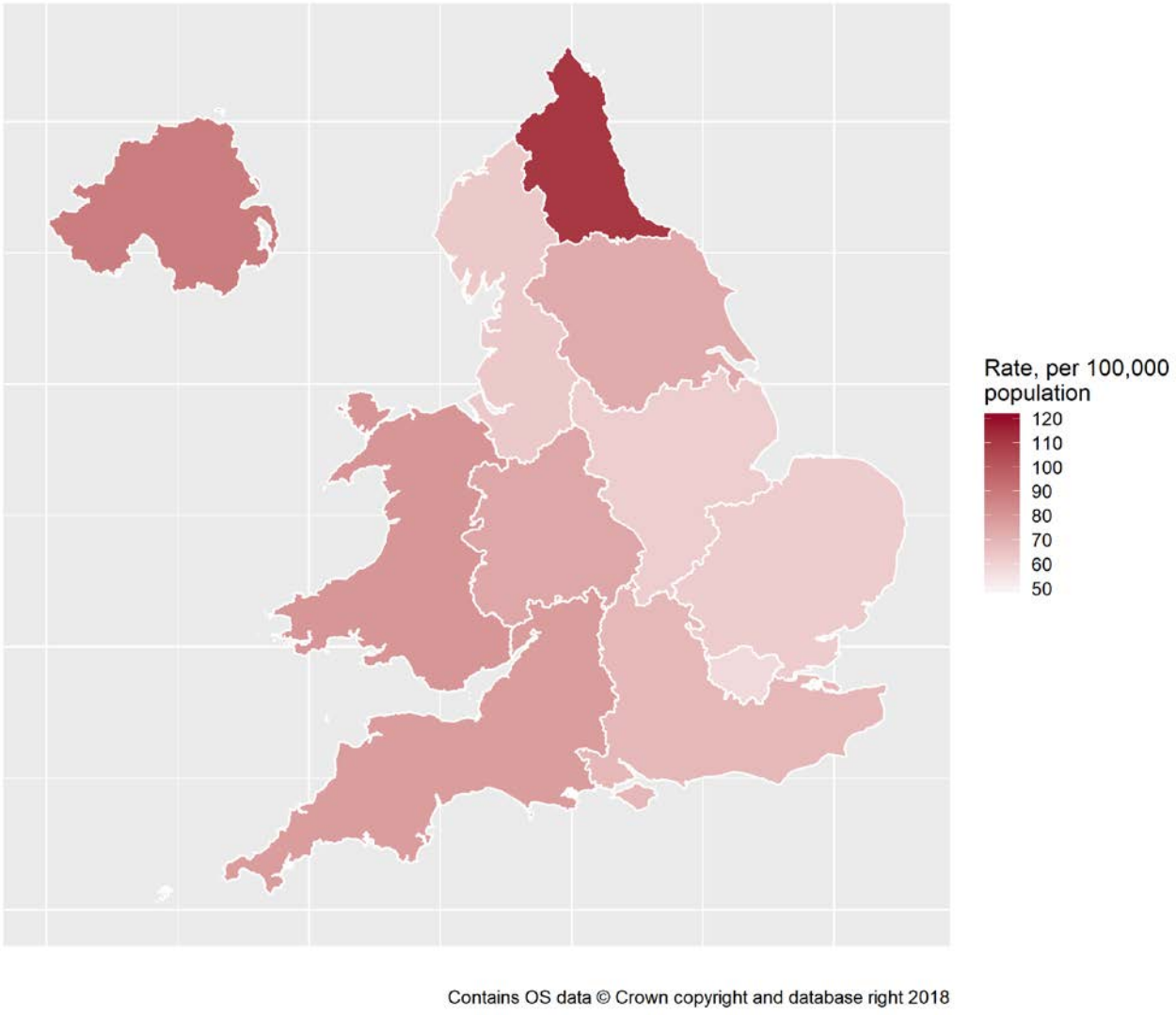
While the rate for England continues to increase, there have been some promising signs of reductions at a PHEC level. In 2018, three PHECs reported a reduction in the rate of *E. coli* bacteraemia when compared to 2017, the East Midlands (-6.6%), the North West (-2.2%) and the South East (-2.2%). At the national level, both Wales and Northern Ireland had an observed decline between 2017 and 2018 (7.7% and 2.2% respectively).

Table 1. *E. coli* bacteraemia per 100,000 population by region (England, Wales and Northern Ireland): 2014 to 2018*

		Rate per 100,000				
Region	**PHE Centre**	**2014**	**2015**	**2016**	**2017**	**2018**
North of England	North East	66.3	78.4	89.7	104.8	111.7
	Yorkshire & Humber	45.6	57.2	60.4	59.3	73.4
	North West	60.4	63.0	66.1	65.2	63.7
Midlands and East of England	West Midlands	60.6	67.4	71.8	70.2	74.6
	East Midlands	55.9	63.3	63.8	66.4	62.0
	East of England	52.8	51.6	58.8	62.9	62.9
London	London	47.2	49.9	54.6	59.0	61.3
South of England	South West	54.1	59.4	68.7	71.2	75.6
	South East	46.6	54.8	62.5	71.9	70.3
England		53.1	58.6	64.1	67.5	69.7
Northern Ireland		73.3	78.4	78.0	90.0	88.0
Wales		81.4	77.1	79.6	86.2	79.6
England Wales and Northern Ireland		**55.2**	**60.2**	**65.3**	**69.2**	**70.7**

*Numbers may differ from previous and different reports

Figure 2. Geographical distribution of *E. coli* bacteraemia per 100,000 population (England, Wales and Northern Ireland): 2018

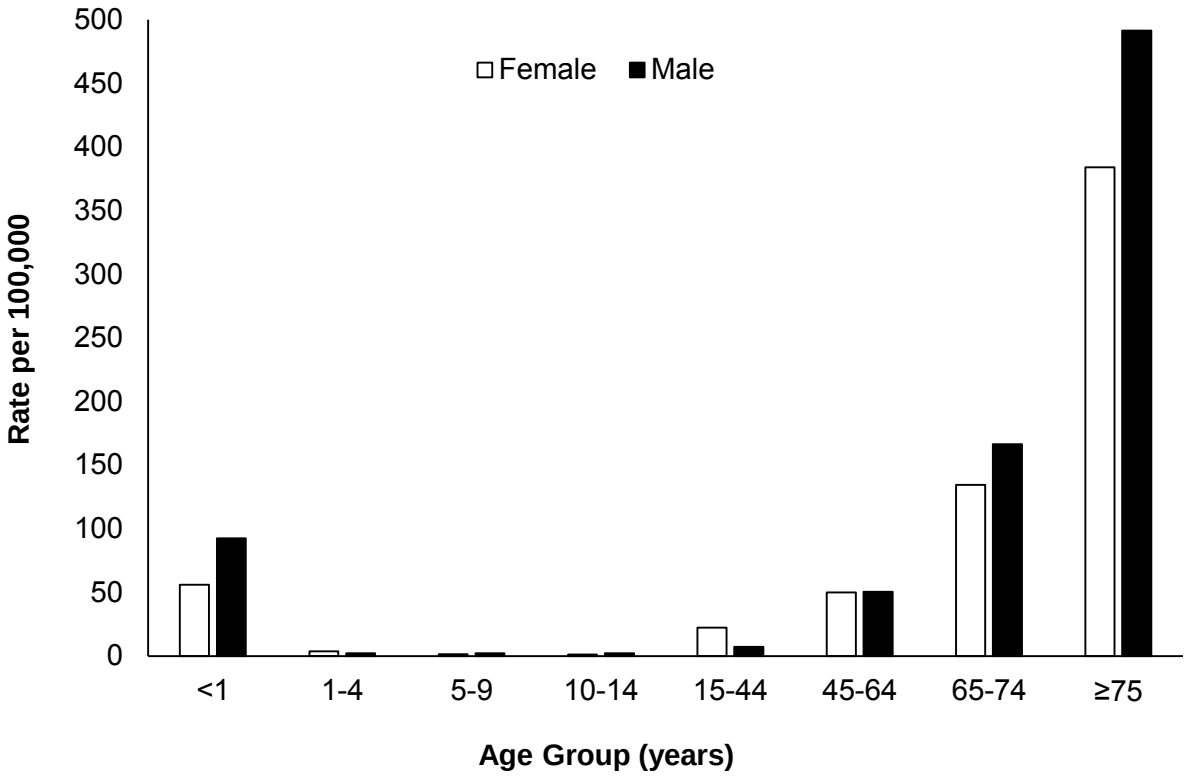


Age and sex distribution

In England, Wales and Northern Ireland, the age distribution of *E. coli* bacteraemia cases continues to primarily affect those individuals of older age groups and the very young, namely individuals aged 75 and over (430.1 per 100,000 population), 65 to 74 (150.0 per 100,000 population) and those aged less than one (76.1 per 100,000 population, figure 3) [4].

This distribution is reflected within both sexes although higher rates were observed in men of the older (65 to 74 and 75 & over) and youngest age group (aged less than one year). Overall, there were slightly more *E. coli* bacteraemia reports in woman (n=22,331) than men (n=20,794) and the distributions shown are largely due to population differences between the sexes

Figure 3. *E. coli* bacteraemia rates per 100,000 population by age and sex (England, Wales and Northern Ireland): 2018



Antimicrobial resistance: England and Northern Ireland

In the four-year period leading up to and including 2018 some key antimicrobial agents had year-on-year increases in the proportion of isolates being reported as resistant. This included increases in ceftazidime (2.8%), cefotaxime (1.9%), ciprofloxacin (1.8%) and gentamicin (0.9% table 2). The increase of resistance to key antimicrobials highlights the increasing concern of antimicrobial resistance for the treatment of *E. coli* bacteraemia. Even though the percentage increases are small it must be kept in perspective of the incidence of *E. coli* bacteraemia. A two per cent increase in resistance to an antibiotic in *E. coli* bacteraemia cases equates to approximately an additional 800 cases, roughly equivalent to the number of MRSA bacteraemia cases in England per year. During 2017, there was a doubling of intermediate sensitivity in isolates tested against piperacillin/tazobactam. After performing a laboratory analysis, it was found that this issue was not evenly spread but concentrated on a minority of laboratories. As of 2018 this proportion has decreased but is still relatively high compared to years before 2017.

Resistance to drug combinations and multidrug resistance continue to be major concerns for *E. coli* bacteraemia [5]. Resistance to pairwise combinations of antimicrobials ranged from 2.2% (gentamicin and piperacillin/tazobactam) to 13.9% (ciprofloxacin and co-amoxiclav) (table 3). Over the four-year period since 2015 many pairwise combinations have experienced fluctuations in the proportion of isolates reporting dual resistance but have otherwise remained stable; some have had consecutive increases including ciprofloxacin & 3rd gen cephalosporin (1.8%), gentamicin & co-amoxiclav (1.3%), gentamicin & 3rd gen cephalosporin (0.8%) and gentamicin & ciprofloxacin (0.7%) compared to 2015.

Multidrug resistance is defined here as resistance to a combination of three or more different antimicrobial classes. The proportion of isolates reported as resistant to ciprofloxacin, gentamicin and 3rd generation cephalosporins has increased year-on-year since 2015 from 3.8% to 4.6%. The proportion of isolates reported as resistant to a combination of piperacillin/tazobactam, co-amoxiclav and ciprofloxacin has remained at 3.7% since 2016, a slight decrease (-0.3%) compared to 2015. The proportion reporting resistance to a combination of piperacillin/tazobactam, co-amoxiclav and gentamicin, was similar across all three years (2.1-2.3%). Of the isolates tested against a combination of ciprofloxacin, gentamicin, 3rd generation cephalosporins and meropenem only 0.04% were resistant to all four drugs; this is similar to the proportion reported in 2015 to 2017. While this proportion is small, patients who fall into this category will have very limited treatment options available.

Table 2. Antimicrobial susceptibility* for *E. coli* bacteraemia (England and Northern Ireland): 2015 to 2018

	2015			2016			2017			2018		
Antimicrobial agent	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**
Gentamicin	89.9	0.5	9.5	89.6	0.5	9.9	89.3	0.7	10.0	89.1	0.5	10.4
Ciprofloxacin	81.5	0.6	17.9	81.2	0.6	18.1	80.2	0.9	18.9	79.3	1.0	19.6
Ceftazidime	89.3	1.5	9.2	88.9	1.6	9.5	87.5	1.4	11.1	86.4	1.6	12.0
Cefotaxime	88.9	0.8	10.3	88.8	0.6	10.5	87.2	0.7	12.1	87.3	0.5	12.2
Meropenem	99.9	<0.1	0.1	99.9	<0.1	<0.1	99.9	<0.1	0.1	99.9	<0.1	0.1
Piperacillin\Tazobactam	88.3	2.1	9.6	88.2	2.4	9.4	84.4	6.0	9.6	87.0	4.0	9.1
Amoxycillin\Clavulanate	57.8	0.7	41.5	59.6	0.5	39.8	56.2	0.4	43.4	55.9	0.2	43.9
Amikacin	97.2	2.3	0.6	96.9	2.3	0.8	95.4	3.6	1.0	96.3	2.8	0.9
Netilmicin	91.8	0.0	8.2	88.0	1.2	10.9	86.0	0.5	13.5	89.0	0.9	10.1
Tobramycin	86.1	1.1	12.8	85.7	1.2	13.1	85.1	1.1	13.8	85.6	0.8	13.5
Ertapenem	99.7	0.1	0.2	99.8	<0.1	0.1	99.8	<0.1	0.2	99.7	<0.1	0.2
Ampicillin/Amoxycillin	35.1	<0.1	64.8	36.5	<0.1	63.5	37.0	0.0	62.9	38.1	<0.1	61.9
Colistin	97.9	<0.1	2.1	98.7	0.1	1.2	98.9	0.0	1.1	97.4	0.1	2.5

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

Table 3. Multi-drug antimicrobial testing and resistance summary for *E. coli* bacteraemia (England): 2015 to 2018

	2015		2016		2017		2018	
Antimicrobial agent	**No. Tested**	**R%**	**No. Tested**	**R%**	**No. Tested**	**R%**	**No. Tested**	**R%**
Gentamicin and Ciprofloxacin	28,946	6.5	33,426	6.8	35,034	6.8	35,563	7.2
Gentamicin and 3rd Generation Cephalosporin	26,247	4.3	29,964	4.4	31,050	4.7	31,141	5.0
Gentamicin and Piperacillin/Tazobactam	29,000	2.2	32,646	2.1	33,699	2.1	35,080	2.2
Gentamicin and Amoxicillin/Clavulanate	29,079	7.3	33,669	7.4	34,953	8.0	35,047	8.6
Ciprofloxacin and 3rd Generation Cephalosporin*	25,872	7.6	29,759	7.9	30,962	8.9	31,128	9.3
Ciprofloxacin and Piperacillin/Tazobactam	28,113	4.0	32,075	3.7	33,303	3.7	34,683	3.7
Ciprofloxacin and Amoxicillin/Clavulanate	28,311	12.2	33,210	12.2	34,402	13.3	34,200	13.9
3rd Generation Cephalosporin* and Piperacillin/Tazobactam	25,549	3.1	28,814	3.0	29,822	3.3	30,591	3.3
Piperacillin/Tazobactam and Amoxicillin/Clavulanate	28,327	9.5	32,314	9.2	33,082	9.6	33,830	9.1
Ciprofloxacin, Gentamicin and 3rd Generation Cephalosporins*	25,761	3.8	29,446	4.0	30,340	4.3	30,316	4.6
Piperacillin/Tazobactam, Amoxicillin/Clavulanate and Gentamicin	28,200	2.3	31,969	2.1	32,361	2.1	32,931	2.2
Piperacillin/Tazobactam, Amoxicillin/Clavulanate and Ciprofloxacin	27,433	4.0	31,458	3.7	31,996	3.7	32,549	3.7
Ciprofloxacin, Gentamicin, 3rd Generation Cephalosporins* and Meropenem	24,872	0.0	28,469	<0.1	29,401	<0.1	29,514	<0.1

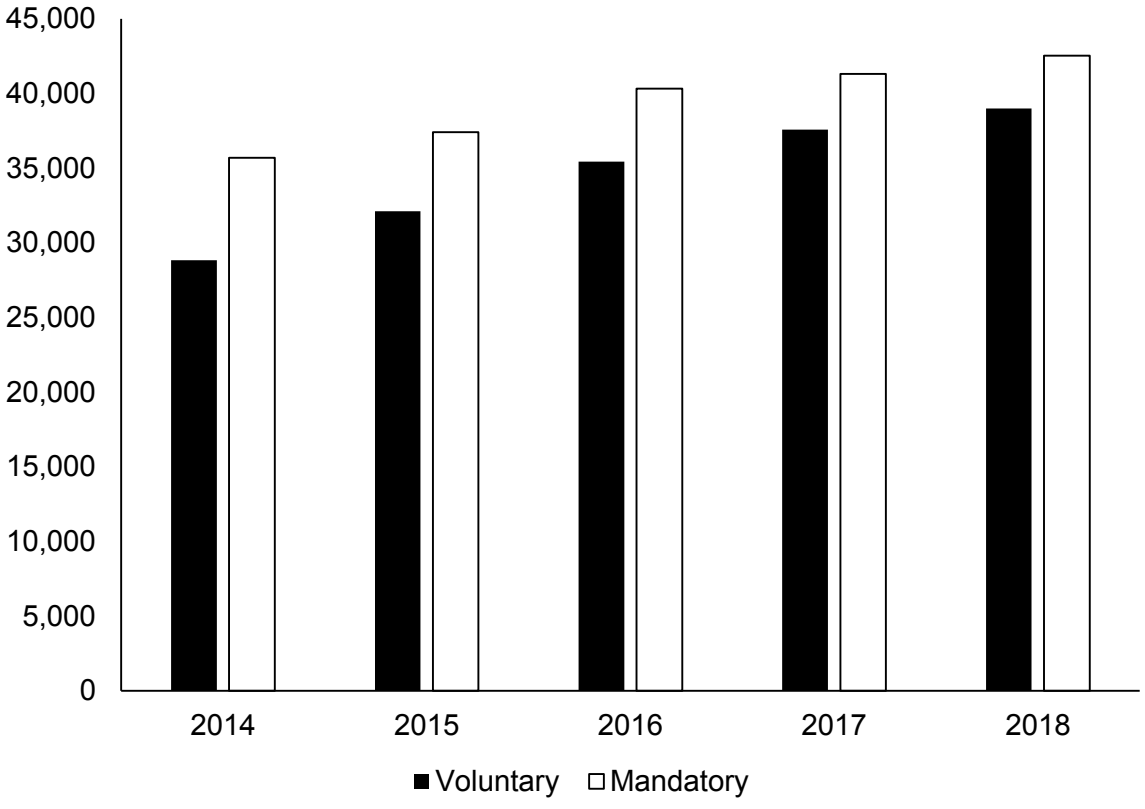
* cefotaxime, ceftazidime

Ascertainment

Within England the surveillance of *E. coli* bacteraemia is captured by two systems, the following data compares *E. coli bacteraemia* reported to the voluntary laboratory surveillance scheme with those reported to the mandatory surveillance scheme [6]. Comparing the two systems shows that mandatory surveillance identifies and captures data on more cases than voluntary surveillance does. Of importance are the amount of records in mandatory surveillance and the amount within voluntary surveillance. If we assume all voluntary records also appear in mandatory surveillance then in 2018 the agreement stood at 91.7% between the two systems, which is an increase on the level observed in the 2017 report (91.0%). The proportional agreement between the two systems has increased annually since 2014 (figure 4).

As previously mentioned, 2014 marked the introduction of SGSS. The greater increase in voluntary reports since this introduction reflects the change of reporting database from its predecessor (LabBase2) to the current SGSS as this increase in voluntary reports is not observed in the mandatory reports.

Figure 4. Ascertainment of *E. coli* bacteraemia data for the mandatory and voluntary reporting schemes in England: 2013 to 2018



Microbiology services

For advice on treatment of antibiotic-resistant infections caused by these opportunistic pathogens, laboratories should contact the Medical Microbiologists at PHE's Bacteriology Reference Department in Colindale (colindalemedmicro@phe.gov.uk). For reference services, including species identification and confirmation of sensitivity testing results, laboratories should contact PHE's Resistance and Healthcare Associated Infections Reference Unit of NIS Laboratories in London.

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 PHE AMRHAI Reference Unit, Public Health Wales and HSC Public Health Agency (Northern 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.

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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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Published: **October 2019**
PHE publications
gateway number: **2019130**

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Sustainable Development Goals