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Laboratory surveillance of *Escherichia coli* bacteraemia in England, Wales and Northern Ireland: 2017

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These analyses are based on data relating to diagnosis of blood stream infections by *Escherichia coli* between 2009 and 2017. Data for England were extracted from the Public Health England (PHE) voluntary surveillance database the Second Generation Surveillance System (SGSS) on the 2 April 2018. Data for Wales and Northern Ireland were extracted separately (DataStore on 6 February 2018 and CoSurv on 14 March 2018, 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 2017 rates, which were based on 2016 population estimates as population estimates for 2017 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.

Key points

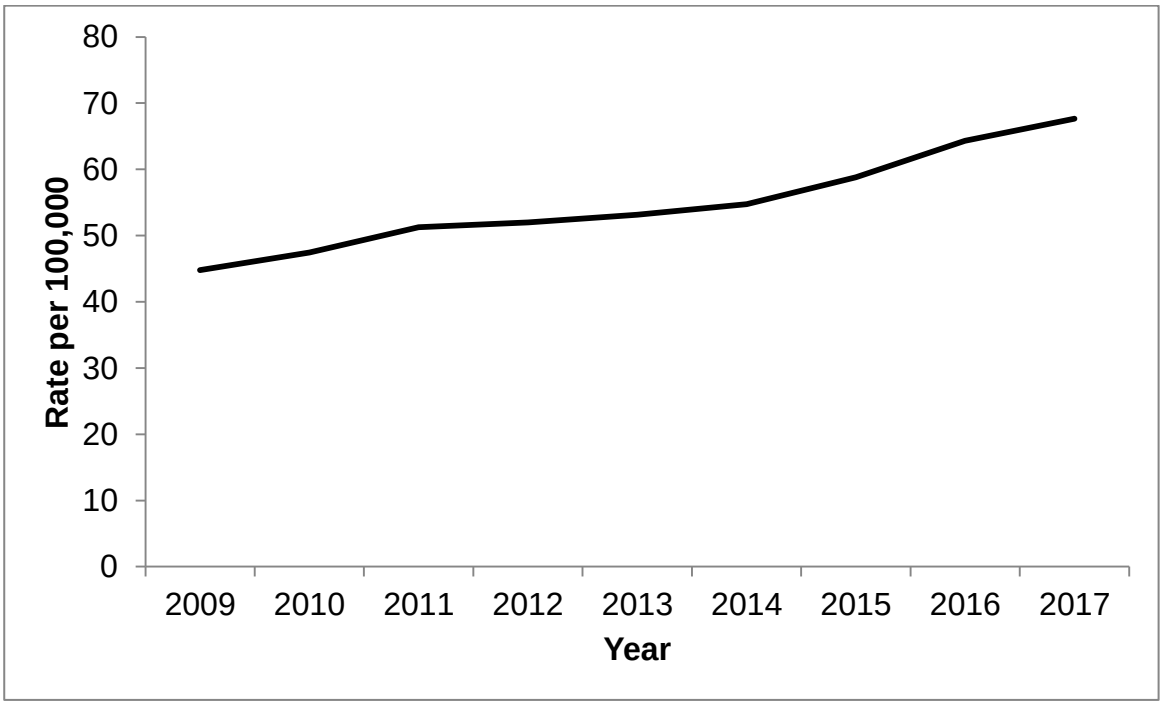
- England, Wales and Northern Ireland had an observed rate of voluntarily reported *E.coli* of 67.7/100,000 in 2017 an increase of 5.0% from 2016
- in England, Wales and Northern Ireland there has been a rate increase of 21.4% since 2013
- all countries have had an observed increase between 2013 and 2017 (England 21.7%, Wales 15.7% and Northern Ireland 25.8%)
- in 2017 the North East (94.1/100,000) and South East (69.9/100,000) region had the highest rates of *E.coli* bacteraemia, Yorkshire & the Humber (57.6/100,000) and London (57.9/100,000) had the lowest
- the highest rates of *E.coli* bacteraemia were observed in individuals aged 75 and over (411.6/100,000) followed by individuals aged 65 to 74 (134.1/100,000) and individuals aged less than one year (88.7/100,000)
- 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 women (n=21,083) than men (n=19,574)
- resistance to pairwise combinations of drug combinations ranged from 2.10% (gentamicin and piperacillin/tazobactam) to 13.32% (ciprofloxacin and co-amoxiclav)
- the proportion of isolates resistant to a combination of ciprofloxacin, gentamicin, third generation cephalosporins and meropenem was 0.02%
- ascertainment between English mandatory and voluntary surveillance was approximately 88.1%, an increase from 86.4% in 2016

Trends

In England, Wales and Northern Ireland the rate of *E.coli* bacteraemia increased to 67.7/100,000 in 2017 from 64.3/100,000 (a 5.0% increase) in 2016. This observed rate is the highest that has been reported over the nine 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 the majority of the reports are derived) transition to SGSS, which is credited for the improvement of lab based voluntary surveillance.

Figure 1. *E. coli* bacteraemias per 100,000 population (England, Wales and Northern Ireland): 2009-2017



Geographic distribution

The combined rate for England, Wales and Northern Ireland was 67.6/100,000. This is an increase of 21.4% since 2013. Individually, all countries have had an observed increase over the same period (England 21.7%, Wales 15.7% and Northern Ireland 25.8%).

There are noticeable differences in the trends within each of the constituent countries. Within England, post the introduction of SGSS, there has had relatively large but steady increases since 2014 (13.0%). There was a second consecutive increase in the rate of bacteraemia reported in Wales after an observed decrease in 2015. Northern Ireland, despite an observed reduction in 2016, rebounded with a large increase (15.8%) in 2017 (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 small geographical areas are consolidated into Public Health Centres (PHCs n=9). All PHCs reported higher rates in 2017 compared to 2013. The highest rates observed throughout this period have been from the North East and this continued in 2017 (94.1/100,000) the South East reported the second highest rate of *E.coli* bacteraemia (69.9/100,000). In contrast, during 2014 the South East reported the lowest rate of bacteraemia of any of the PHCs (47.3/100,000). Conversely, in 2017, Yorkshire & the Humber reported the lowest rate of bacteraemia (57.6/100,000), similarly it was observed that London also had a relatively low rate of *E.coli* bacteraemia (57.9/100,000) (figure 2).

While the rate for England continues to increase there have been some promising signs of reductions at a regional level. In 2016 all PHCs had an observed increase when compared with 2015. In 2017 however, three PHCs namely the North West (-2.2%) Yorkshire & the Humber (-0.9%) and the West midlands (-0.7%) all reported a reduction in the rate of *E.coli* bacteraemia when compared to 2016.

Figure 2. Geographical distribution of pathogen *E. coli* bacteraemia per 100,000 population (England, Wales and Northern Ireland): 2017

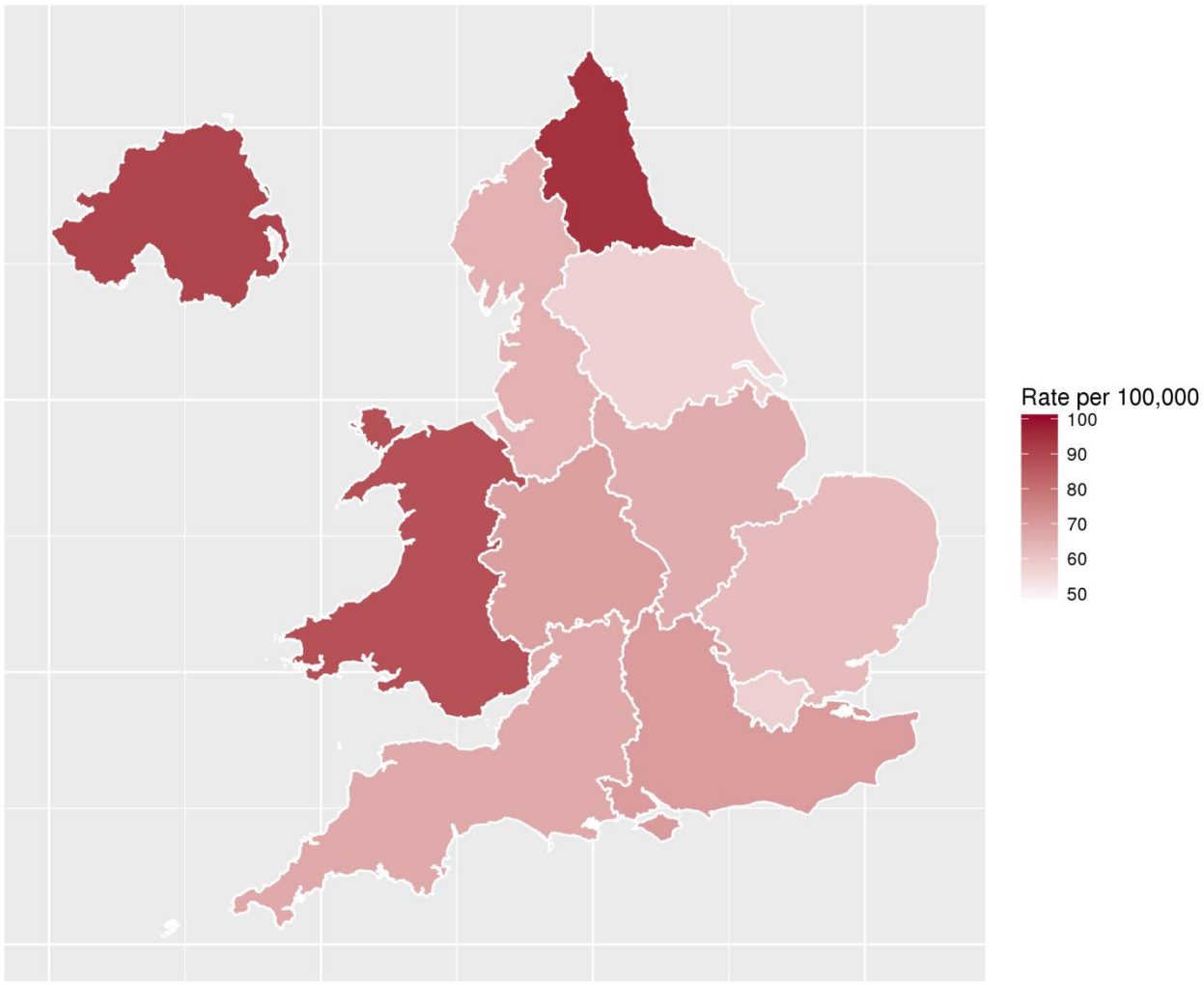


Table 1. *E.coli* bacteraemia per 100,000 population by region (England, Wales and Northern Ireland): 2013 to 2017

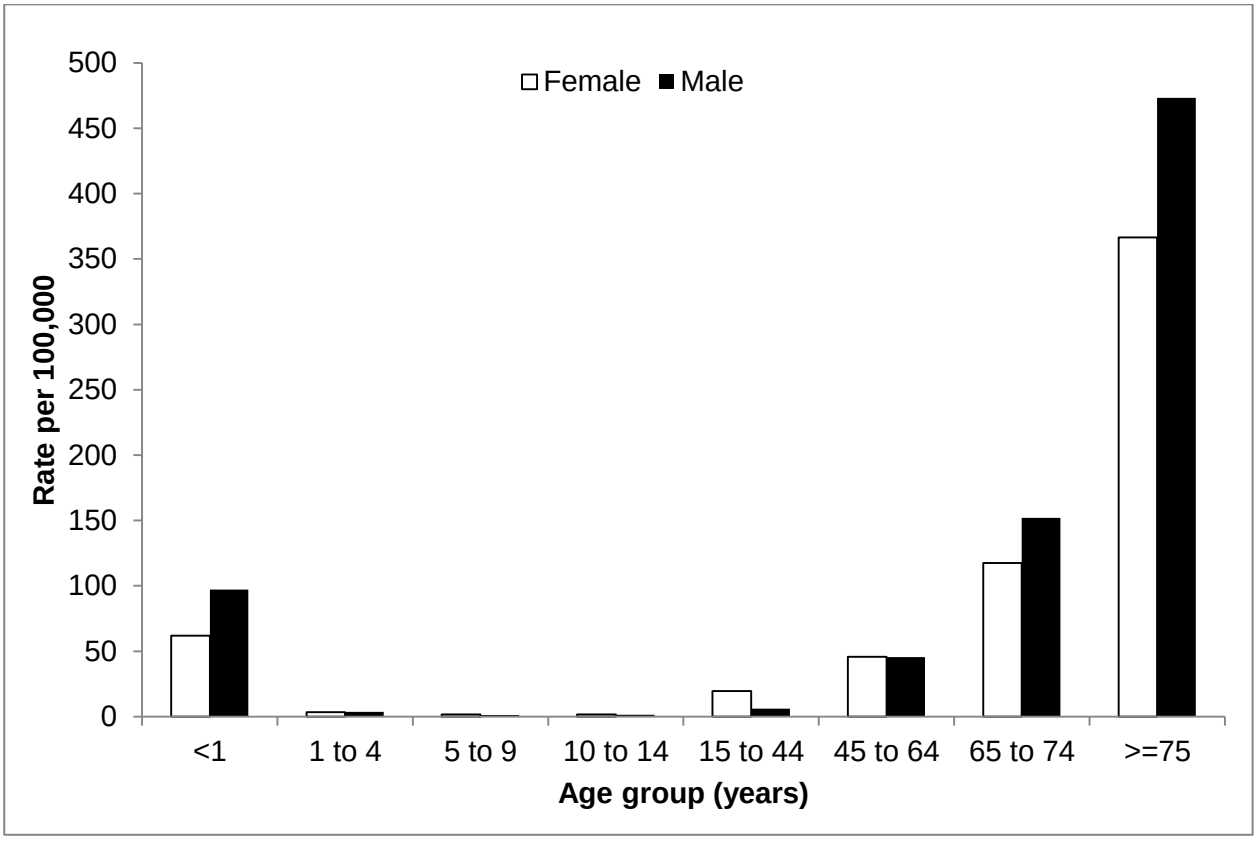
		Rate per 100,000				
Region	**PHE Centre**	**2013**	**2014**	**2015**	**2016**	**2017**
North of England	North East	66.1	66.0	75.2	85.9	94.1
	Yorkshire & Humber	45.0	45.1	55.0	58.1	57.6
	North West	60.9	60.1	61.8	66.3	64.9
Midlands and East of England	West Midlands	55.7	60.2	65.5	69.6	69.1
	East Midlands	53.0	56.5	63.7	64.8	66.2
	East of England	50.9	52.2	51.4	58.8	62.6
London	London	47.6	47.3	49.6	54.9	57.9
South of England	South West	47.4	53.8	56.0	64.4	66.9
	South East	46.5	44.7	52.7	61.5	69.9
England		51.5	52.6	57.2	63.0	65.7
Northern Ireland		66.9	72.4	77.3	76.9	90.2
Wales		73.9	81.4	77.1	79.6	87.6
England Wales and Northern Ireland		**53.1**	**54.7**	**58.8**	**64.3**	**67.6**

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 namely individuals aged 65 to 74 (134.1/100,000) and more prominently in the age group 75 and over (411.6/100,000) (figure 3) [4]. *E.coli* bacteraemia also has a high rate in the very young i.e. individuals aged less than one year (88.7/100,000).

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). Within the oldest age group this is largely due to population differences between the sexes. Overall, there were slightly more *E.coli* bacteraemia reports in woman (n=21,083) than men (n = 19,574).

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



Antimicrobial resistance: England and Northern Ireland

In the three year period leading up to and including 2017 the majority of key antimicrobial agents had a year on year increases in the proportion of isolates being reported as resistant. This included increases in ceftazidime (1.87%), cefotaxime (1.73%), cefpodoxime (1.35%), ceftriaxone (1.28%), ciprofloxacin (1.17%) and gentamicin (0.56% 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 percent 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. In 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. We are currently investigating how these labs conduct sensitivity testing.

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 2.10% (gentamicin and piperacillin/tazobactam) to 13.32% (ciprofloxacin and co-amoxiclav) (table 3). Over the three year period since 2015 many pairwise combinations have experienced fluctuations in proportions of isolates reporting dual resistance but have otherwise remained stable. Some combinations have had consecutive increases including ciprofloxacin & 3rd gen cephalosporin (1.66%), gentamicin & co-amoxiclav (0.56%) and gentamicin & 3rd gen cephalosporin (0.38%) when 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 3.77% to 4.21%. The proportion of isolates reported as resistant to a combination of piperacillin/tazobactam, co-amoxiclav and ciprofloxacin was 3.66% in 2017, this was similar to levels reported in 2016 and a slight decrease (-0.32%) compared to 2015. Similarly, the proportion reporting resistance to a combination of piperacillin/tazobactam, co-amoxiclav and gentamicin, was similar across all three years (2.13-2.24%).

Of the isolates tested against a combination of ciprofloxacin, gentamicin, 3rd generation cephalosporins and meropenem only 0.02% were resistant to all four drugs; this is the same proportion as reported in 2015 and 2016. 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 2017

	2015			2016			2017		
Antimicrobial agent	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**
Gentamicin	90.11	0.52	9.37	89.66	0.50	9.83	89.40	0.67	9.93
Ciprofloxacin	81.67	0.60	17.73	81.33	0.61	18.06	80.26	0.84	18.90
Ceftazidime	89.30	1.53	9.17	89.03	1.52	9.46	87.60	1.36	11.04
Cefotaxime	89.02	0.75	10.23	88.95	0.55	10.50	87.42	0.63	11.96
Ceftriaxone	88.19	0.22	11.59	87.86	0.12	12.03	86.90	0.23	12.87
Cefpodoxime	88.18	0.10	11.72	87.56	0.20	12.24	86.80	0.12	13.07
Meropenem	99.92	0.03	0.05	99.93	0.03	0.04	99.92	0.03	0.05
Piperacillin\Tazobactam	88.75	2.09	9.17	88.63	2.39	8.99	84.86	5.91	9.23
Co-amoxiclav	55.81	0.71	43.48	57.99	0.53	41.48	55.49	0.38	44.13

*__S__ = susceptible; __I__ = intermediate (reduced susceptibility); __R__ = resistant

Table 3. Multi-drug antimicrobial testing and resistance summary* for *E. coli* bacteraemia (England): 2015 to 2017

	2015			2016			2017		
Antimicrobial agent	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**	**S (%)**	**I (%)**	**R (%)**
Gentamicin and Ciprofloxacin	93.18	0.29	6.53	92.89	0.28	6.83	92.80	0.37	6.84
Gentamicin and 3rd Gen Cephalosporin†	95.46	0.32	4.22	95.29	0.35	4.36	95.07	0.33	4.60
Gentamicin and Piperacillin/Tazobactam	97.16	0.62	2.22	97.15	0.73	2.12	96.70	1.20	2.10
Gentamicin and Co-amoxiclav	92.23	0.34	7.43	92.11	0.34	7.55	91.59	0.40	8.01
Ciprofloxacin and 3rd Gen Cephalosporin†	91.88	0.94	7.18	91.38	0.87	7.75	90.43	0.74	8.84
Ciprofloxacin and Piperacillin/Tazobactam	95.03	1.01	3.96	95.10	1.19	3.71	94.47	1.88	3.65
Ciprofloxacin and Co-amoxiclav	87.16	0.47	12.37	87.18	0.48	12.34	85.99	0.69	13.32
3rd Gen Cephalosporin† and Piperacillin/Tazobactam	95.83	1.08	3.08	95.82	1.20	2.98	95.46	1.33	3.22
Piperacillin/Tazobactam and Co-amoxiclav	88.54	2.09	9.37	88.51	2.45	9.04	84.55	6.04	9.41
Ciprofloxacin, Gentamicin and 3rd Gen Cephalosporins†	95.97	0.26	3.77	95.79	0.29	3.92	95.53	0.26	4.21
Piperacillin/Tazobactam, Co-amoxiclav and Gentamicin	97.17	0.59	2.24	97.14	0.72	2.13	96.68	1.19	2.13
Piperacillin/Tazobactam, Co-amoxiclav and Ciprofloxacin	95.05	0.97	3.98	95.14	1.18	3.67	94.42	1.92	3.66
Ciprofloxacin, Gentamicin, 3rd Gen Cephalosporins† and Meropenem	99.97	0.01	0.02	99.97	0.01	0.02	99.97	0.00	0.02

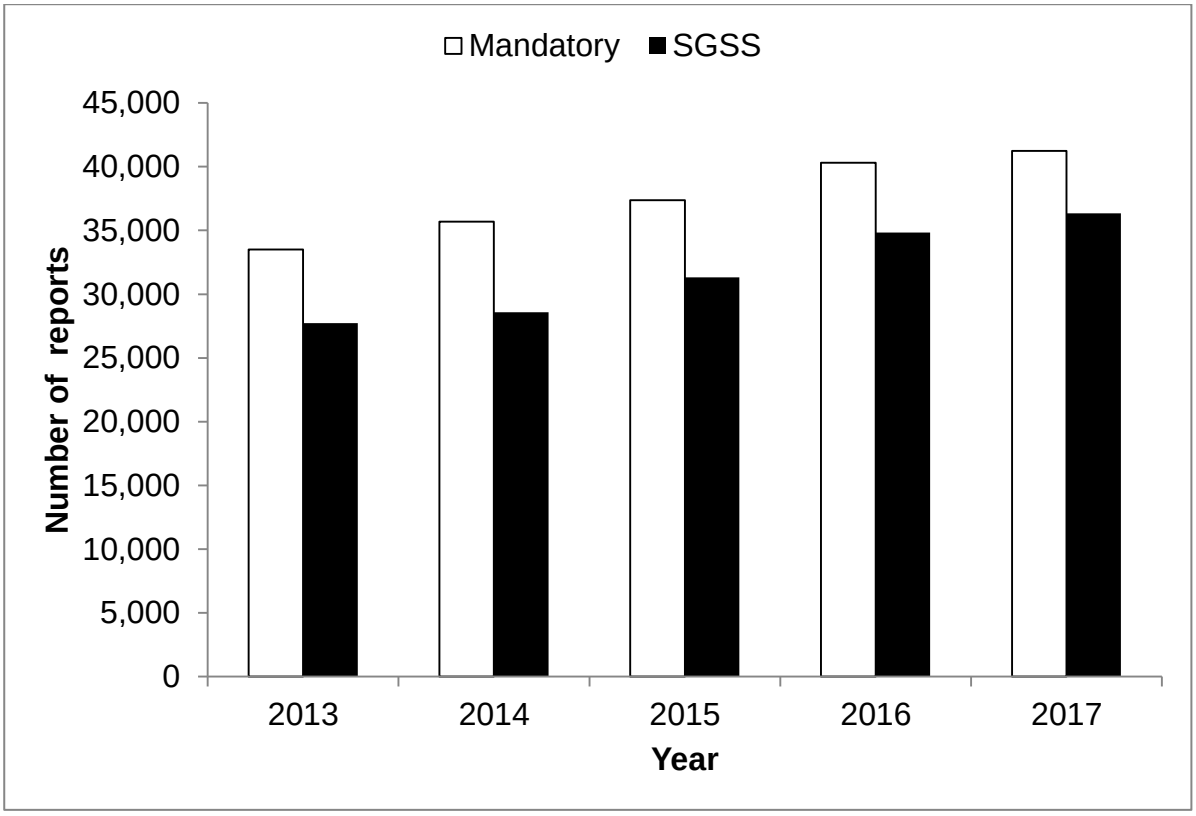
*__S__ = susceptible; __I__ = intermediate (reduced susceptibility); __R__ = resistant † Any of Cefotaxime, Ceftazidime, Ceftriaxone, or Cefpodoxime

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 2017 the agreement stood at 88.1% between the two systems, which is an increase on the level observed in the 2016 report (86.4%). The proportional agreement between the two systems has increased year on years since 2014 (figure 4).

As previously mentioned 2014 marked the introduction of SGSS. The greater increase in voluntary reports since this introduction is a reflection of 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 2017



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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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