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Laboratory surveillance of *Staphylococcus aureus* bloodstream infections in England, Wales and Northern Ireland: 2018

Health Protection Report
Volume 13 Number 29
16 August 2019

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These analyses are based on data regarding positive blood cultures of *Staphylococcus aureus* 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 11 July 2019. Data for Wales and Northern Ireland were extracted separately (DataStore on 30 April and CoSurv on 17 June, 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 positive blood culture laboratory reports were calculated using mid-year resident population estimates for the respective year and geography [1]. 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 [2].

The report includes analyses on the temporal trends, age and sex distribution, and geographical distribution of cases of MRSA and MSSA bloodstream infection in England 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. [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.

Data from six laboratories (two in London, one in the South East, one in the North East, one in the North West and one in Yorkshire and Humber) were excluded from the analyses due to concerns about the quality of data submitted to SGSS.

Key Points

- the overall rate of *S. aureus* bloodstream infection for England, Wales and Northern Ireland increased for the fifth consecutive year to 21.3 reports per 100,000 population
- in 2018, the rate of MRSA bloodstream infection was 1.4 per 100,000 population in England, 2.7 in Wales and 2.9 for Northern Ireland
- in 2018, the rate of MSSA bloodstream infection was 16.3 per 100,000 population in England, 27.5 in Wales and 20.6 for Northern Ireland
- the rate of MRSA bloodstream infection varied across PHECs from 0.6 in the East Midlands to 2.0 per 100,000 population in the South West
- the rate of MSSA bloodstream infection varied across PHECs from 11.3 in London to 23.3 per 100,000 in the North East
- for both MRSA and MSSA bloodstream infection, the rate was higher for older adults (≥ 75 years old and 65-74 years old) and infants (< 1 year)
- the bloodstream infection rate was higher in males in comparison to females across all age groups for MSSA and all age groups except 10-14 years old, for MRSA
- between 2015 and 2017 there has been a year-on-year increase in resistance of MRSA to gentamicin (7% to 15%) and fusidic acid (13% to 22%); between 2017 and 2018 resistance levels remained stable
- resistance to vancomycin, teicoplanin and linezolid has been consistently low in MRSA bloodstream infection isolates (0% to $< 1\%$)
- case ascertainment between voluntary and mandatory schemes continues to improve (88% agreement in 2018 for MRSA)

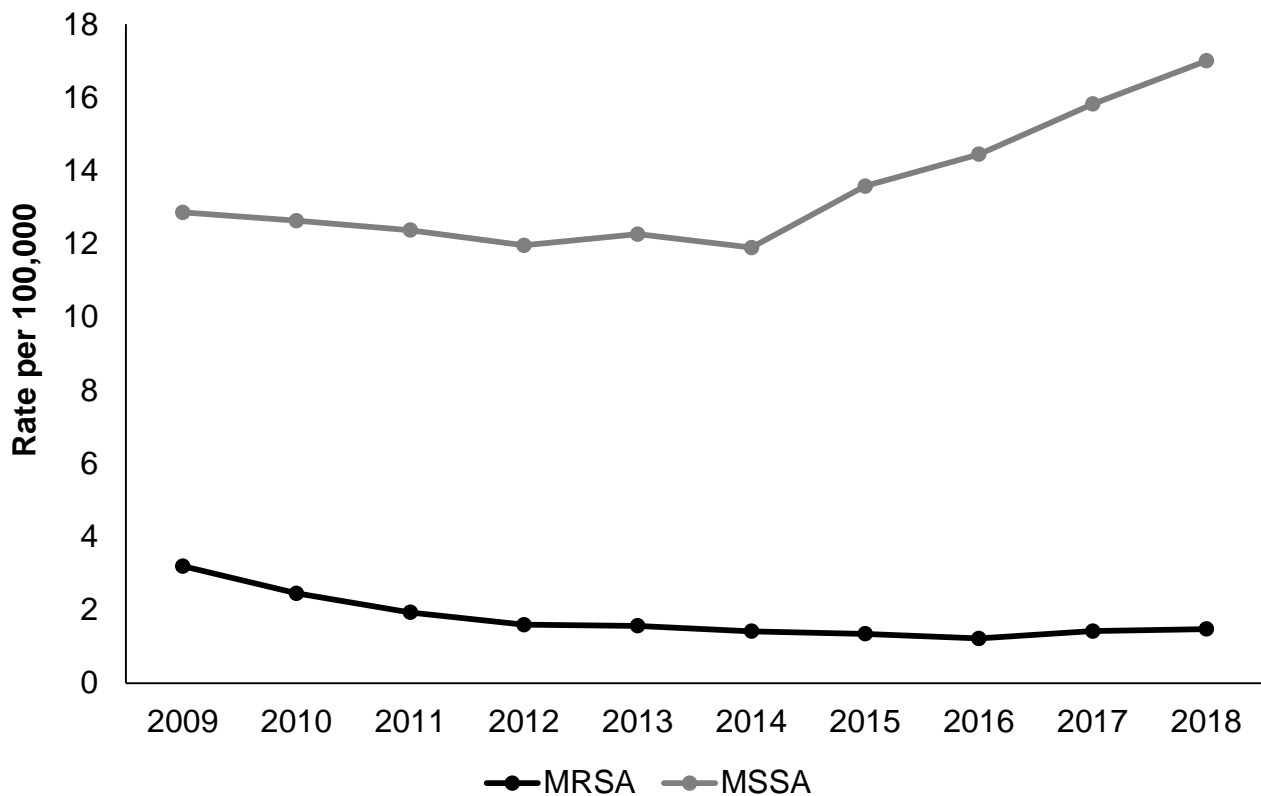
Trends

Figure 1a shows the rate of laboratory-reported MRSA and MSSA in England, Wales and Northern Ireland between 2009 and 2018.

The trends of MRSA and MSSA differ between 2009 and 2018. The rate of MRSA decreased by 53.8% in England, Wales and Northern Ireland from 3.2 reports per 100,000 population in 2009 to 1.5 in 2018. The largest reduction was observed between 2009 and 2012 (50.2%) [3,4]. Since 2012 MRSA bloodstream infection has continued to fluctuate marginally year-on-year but has consistently remained low with a rate between 1.2 and 1.6 reports per 100,000 population.

Between 2009 and 2014 the rate of MSSA was relatively stable. After this point, the trend entered a period characterised by year-on-year increases in which the rate of bloodstream infection increased 42.9% from 11.9 reports per 100,000 population in 2014 to 17.0 in 2018.

Figure 1. Rates of bloodstream infection per 100,000 population (England, Wales and Northern Ireland) caused by MRSA and MSSA: 2009 to 2018

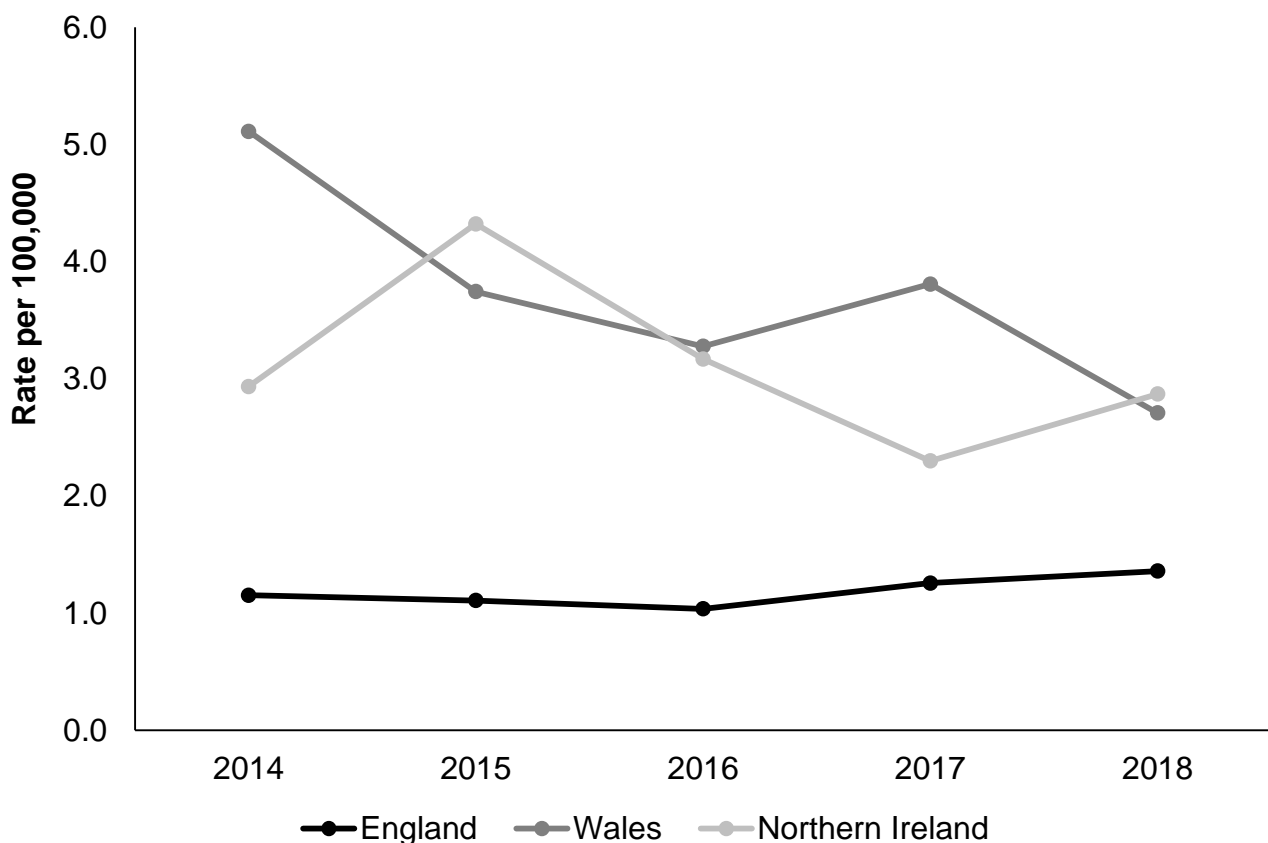


Geographic distribution: MRSA

The combined rate of bloodstream infection due to MRSA in England, Wales and Northern Ireland was 1.5 reports per 100,000 population in 2018. However, generalisations cannot be made between the respective trends of each of the three nations over the last five years.

The trend for England sees a relatively stable rate that continues from 2014 to 2016. This stability is then followed by a period in which the rate increases (34.3%) from 1.0 reports per 100,000 population in 2016 to 1.4 in 2018 (figure 2a). Although England has had two consecutive years of increase in the rate of MRSA bloodstream infection, it continues to have the lowest rate of the three nations. Caution is also required in the interpretation of this data as the Mandatory Surveillance Annual Epidemiological Commentary, which has more comprehensive surveillance of MRSA, has observed a broadly stable rate of MRSA for England since 2013/14 [5]. The increase that is being observed is likely due to recent improvements in the proportion of isolates being captured by voluntary surveillance, which will be covered later in this report (see Ascertainment section).

Figure 2a. Rates of bloodstream infection per 100,000 population caused by MRSA, by nation: 2014 to 2018



Northern Ireland had an observed spike in 2015 with an observed rate of 4.3 reports per 100,000 population. The rate subsequently declined 46.8% to 2.3 reports per 100,000 population in 2017, before a slight increase in 2018. Wales has had, broadly speaking, a declining trend from 5.1 reports per 100,000 population in 2014 to 2.7 in 2018 (47.0% reduction).

At the level of the PHECs, the rate varied from 0.6 per 100,000 population in the East Midlands to 2.0 in the South West (Figure 3a, Table 1a). No PHEC has consistently had the highest or lowest rate of MRSA over the five-year period between 2014 and 2018.

Only two PHECs had an observed decline between 2017 and 2018. The East Midlands declined 32.2%, while the North East had a decline of 21.6%. All other PHECs observed an increase in 2018 compared to 2017, the biggest of which was in Yorkshire and Humber where the rate increased from 1.0 reports per 100,000 population to 1.2 (22.4%). The South West has had the highest rate for the second year in a row and saw a large increase from 1.7 reports per 100,000 to 2.0 (19.6%). London also observed a large increase from 1.2 reports per 100,000 population to 1.4 (18.3%). With improving levels of ascertainment between mandatory and voluntary surveillance reporting, these results should be interpreted with care as increases are, at least in part, likely a reflection of improvements in the coverage of voluntary surveillance.

Figure 3a. Geographical distribution of MRSA bloodstream infection rates per 100,000 population (England, Wales and Northern Ireland): 2018

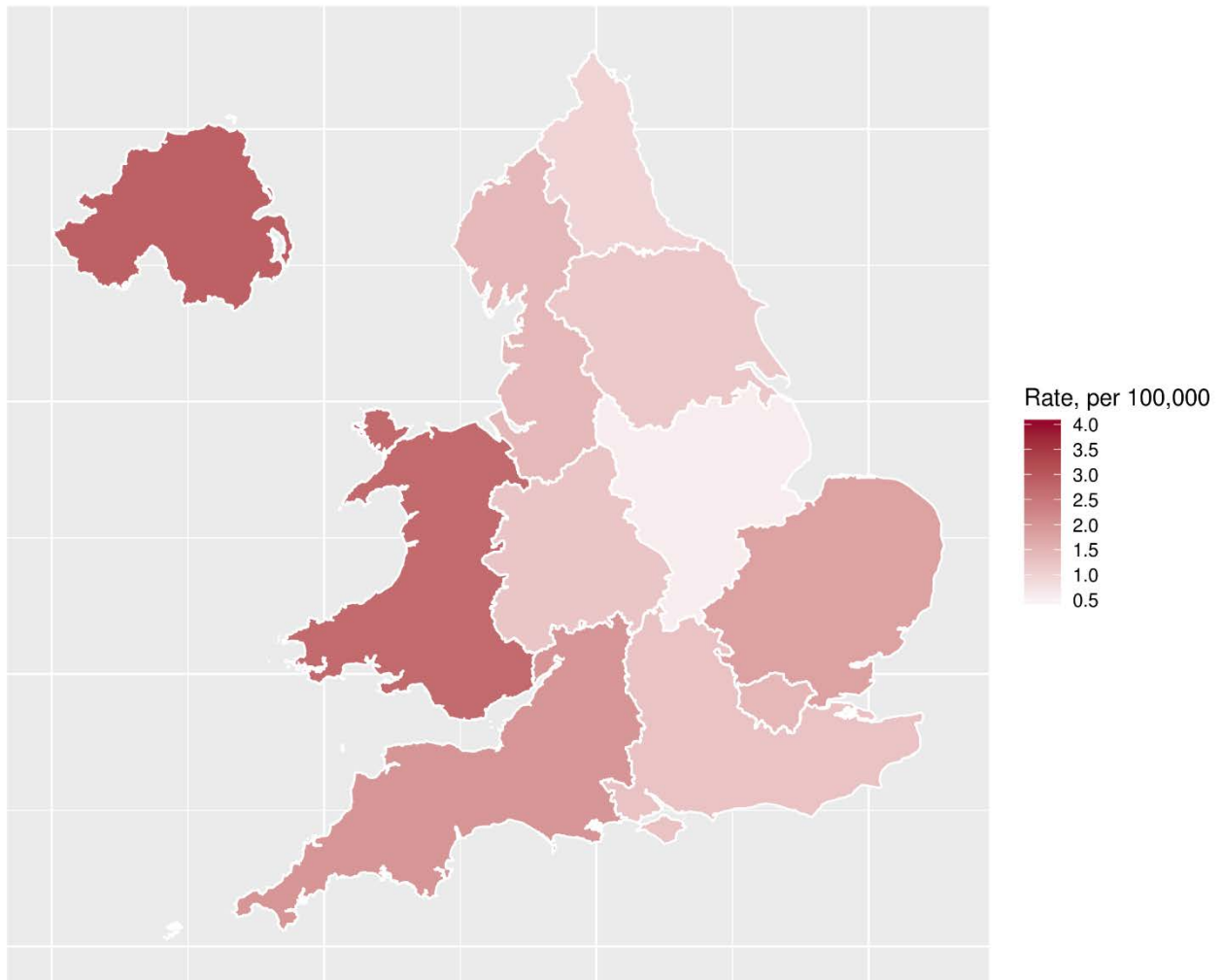


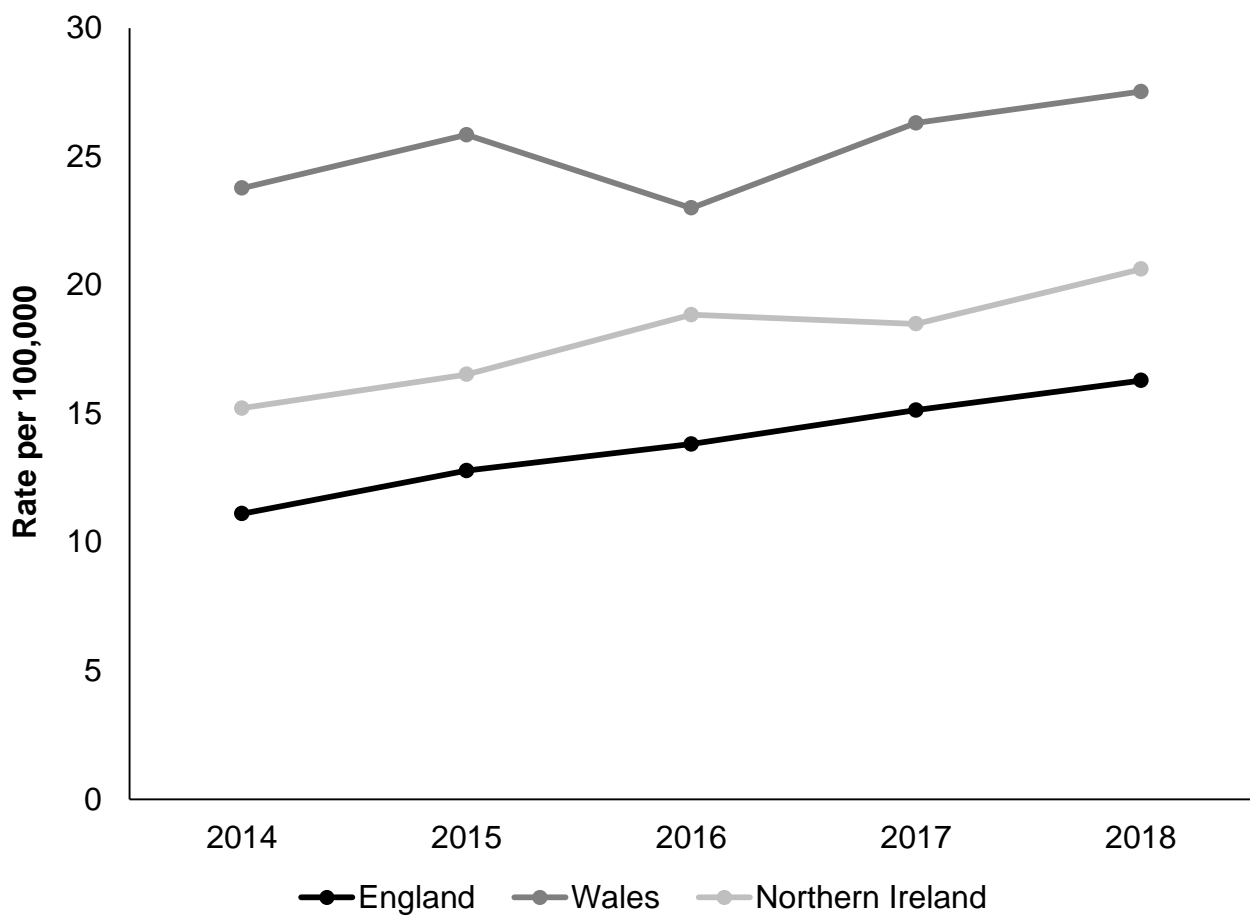
Table 1a: Rate of MRSA bloodstream infection reports per 100,000 population by PHE Centre (England, Wales and Northern Ireland): 2014 to 2018

Region	PHE Centre	Rate, per 100,000				
		2014	2015	2016	2017	2018
Midlands and East of England	West Midlands	1.3	1.7	1.0	1.1	1.2
	East Midlands	1.1	1.1	0.7	0.9	0.6
	East of England	1.8	1.4	1.4	1.6	1.8
North of England	North East	0.7	1.1	1.3	1.2	1.0
	Yorkshire and Humber	0.7	1.0	1.0	1.0	1.2
	North West	1.1	1.1	1.2	1.4	1.4
London	London	1.1	1.0	1.0	1.2	1.4
South of England	South West	1.4	1.1	1.3	1.7	2.0
	South East	1.0	0.8	0.7	1.1	1.3
England		1.2	1.1	1.0	1.3	1.4
Wales		5.1	3.7	3.3	3.8	2.7
Northern Ireland		2.9	4.3	3.2	2.3	2.9
England, Wales and Northern Ireland		1.4	1.3	1.2	1.4	1.5

Geographic distribution: MSSA

England, Wales and Northern Ireland have all had an observed increase in the rate of MSSA bloodstream infection between 2014 and 2018. England observed a steady year-on-year increase from 11.1 reports per 100,000 population in 2014 to 16.3 in 2018 (46.6%). This increase is broadly reflected in mandatory surveillance and was reported in the Mandatory Surveillance Annual Epidemiological Commentary [5]. Wales consistently had the highest observed rate of MSSA throughout the period. Although fluctuations are observed, the rate increases from 23.8 reports per 100,000 population in 2014 to 27.5 in 2018 (15.8%). While the rate in Northern Ireland increased between 2014 and 2018 from 15.2 reports per 100,000 population to 20.6 (35.5%) most of this increase occurred between 2014 and 2016 (figure 2b).

Figure 2b. Rates of bloodstream infection per 100,000 population caused by MSSA, by nation: 2014 to 2018



At the level of the PHECs, there was substantial variation between centres. The rate of MSSA bloodstream infection varied from 11.3 reports per 100,000 population in London to 23.3 in the North East (figure 3b, table 1b). All PHECs have had an observed increase in the rate between 2014 and 2018, varying from a 26.6% increase (South East) to 83.7% (Yorkshire and the Humber). No PHEC has consistently reported the highest of MSSA bloodstream infection overall five years, from 2014 to 2018, although the North East has had consistently high bloodstream infection rates. London has consistently had the lowest rate over the same five-year period.

Figure 3b. Geographical distribution of MSSA bloodstream infection rates per 100,000 population (England, Wales and Northern Ireland): 2018

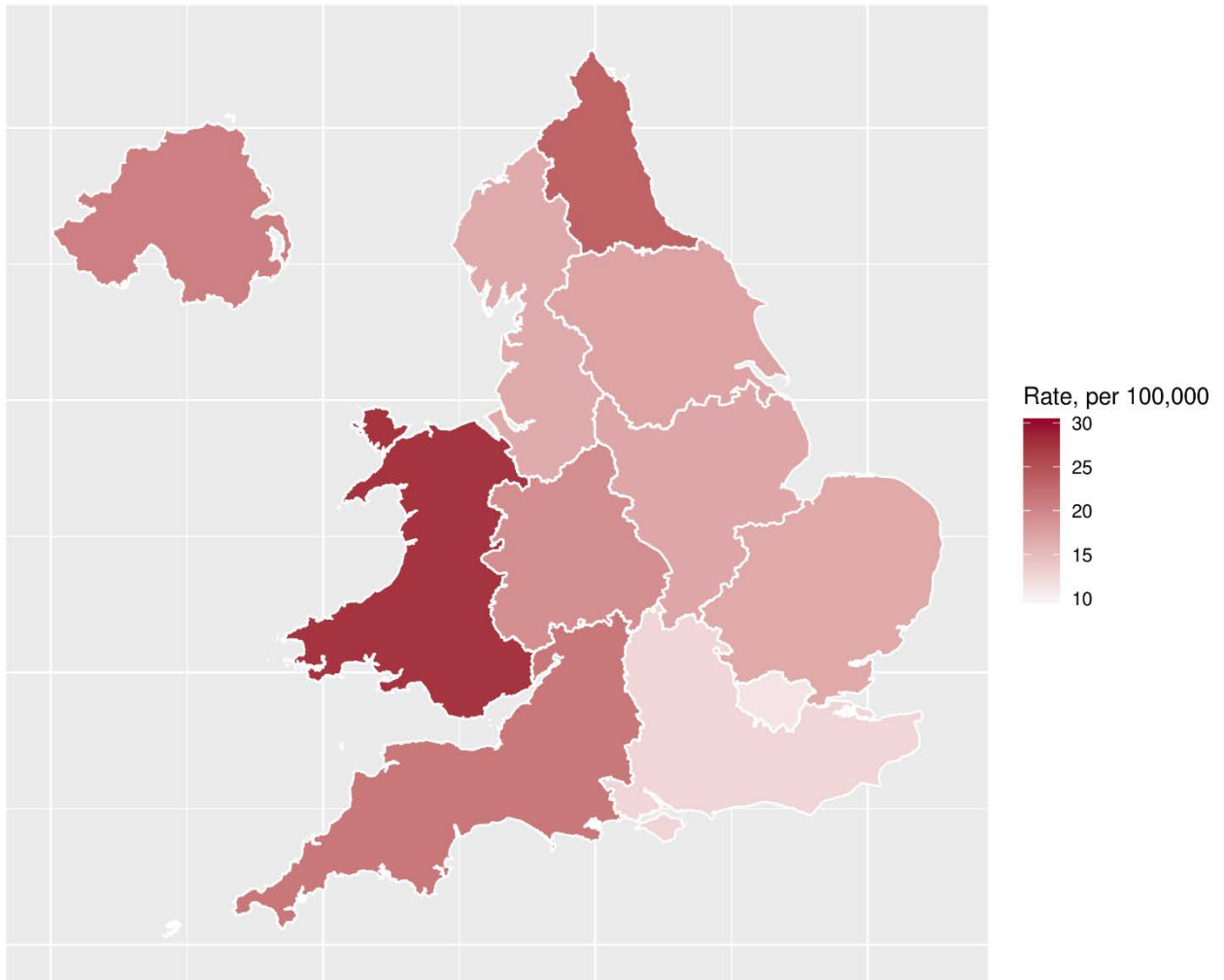


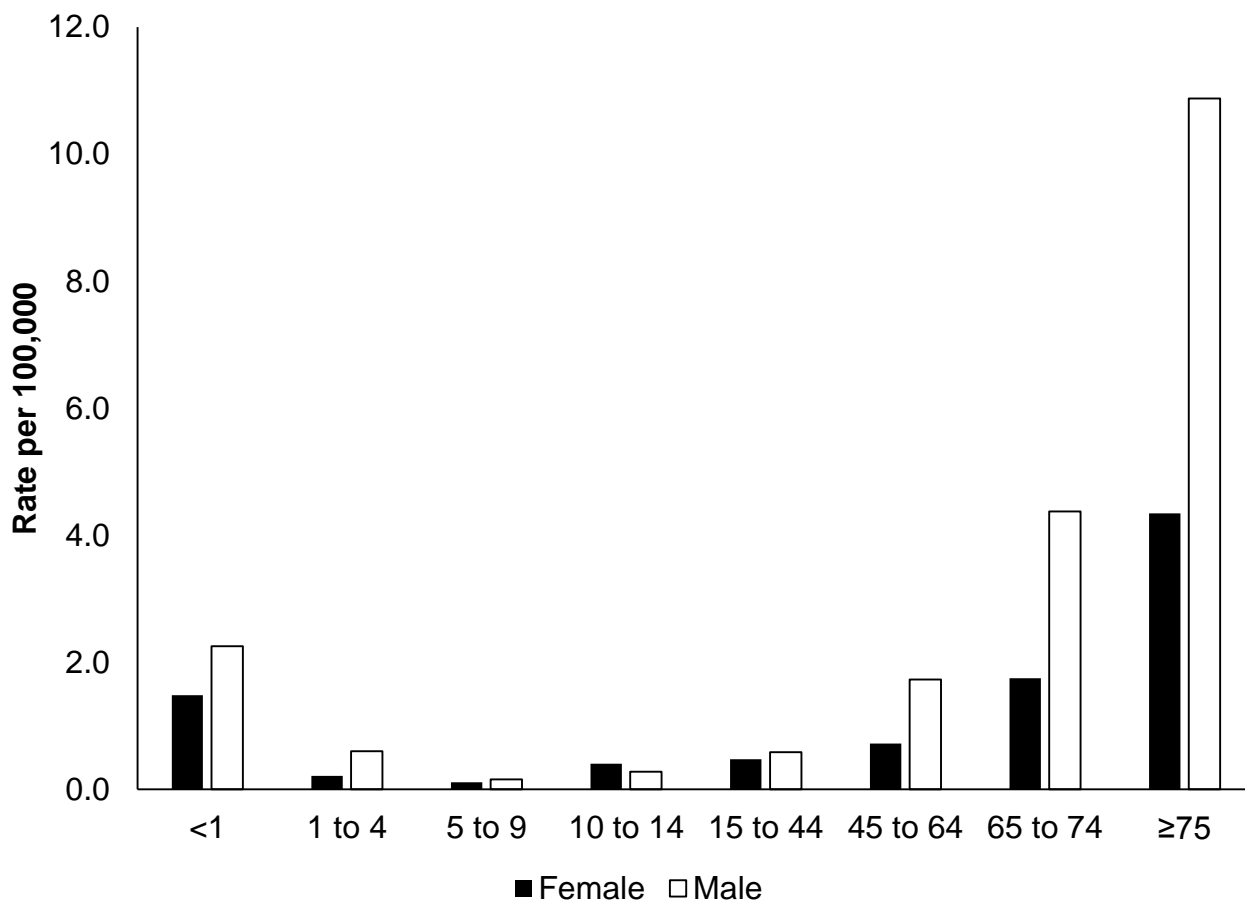
Table 1b: Rate of MSSA bloodstream infection reports per 100,000 population by PHE Centre (England, Wales and Northern Ireland): 2014 to 2018

Region	PHE Centre	Rate per 100,000				
		2014	2015	2016	2017	2018
Midlands and East of England	West Midlands	13.8	15.2	17.5	19.0	19.3
	East Midlands	11.5	15.7	17.1	17.4	16.9
	East of England	12.5	13.9	15.1	16.4	16.7
North of England	North East	13.5	19.8	22.4	20.9	23.3
	Yorkshire and Humber	9.4	14.4	14.5	15.4	17.2
	North West	11.4	12.8	11.1	14.2	16.6
London	London	8.0	7.7	7.5	10.2	11.3
South of England	South West	13.8	15.1	17.8	19.9	21.4
	South East	9.7	9.4	11.7	11.3	12.6
England		11.1	12.8	13.8	15.1	16.3
Wales		23.8	25.8	23.0	26.3	27.5
Northern Ireland		15.2	16.5	18.8	18.5	20.6
England, Wales and Northern Ireland		11.9	13.6	14.4	15.8	17.0

Age and sex distribution: MRSA

Figure 4a depicts MRSA bloodstream infection rates per 100,000 population amongst men and women across different age groups in England, Wales and Northern Ireland in 2018. The bloodstream infection rate was the highest in the elderly (≥ 75 years and 65-74 years) as well as the very young (< 1 year). The rate of bloodstream infection per 100,000 population in the older age groups was markedly higher amongst males in comparison to females (≥ 75 years: 10.9 vs. 4.3, 65-74 years: 4.4 vs. 1.7 and 45-64: 1.7 vs 0.7 per 100,000 population). The observed age and sex distribution is broadly consistent with previous Health Protection Reports and the Mandatory Surveillance Annual Epidemiological Commentary [3,5,6].

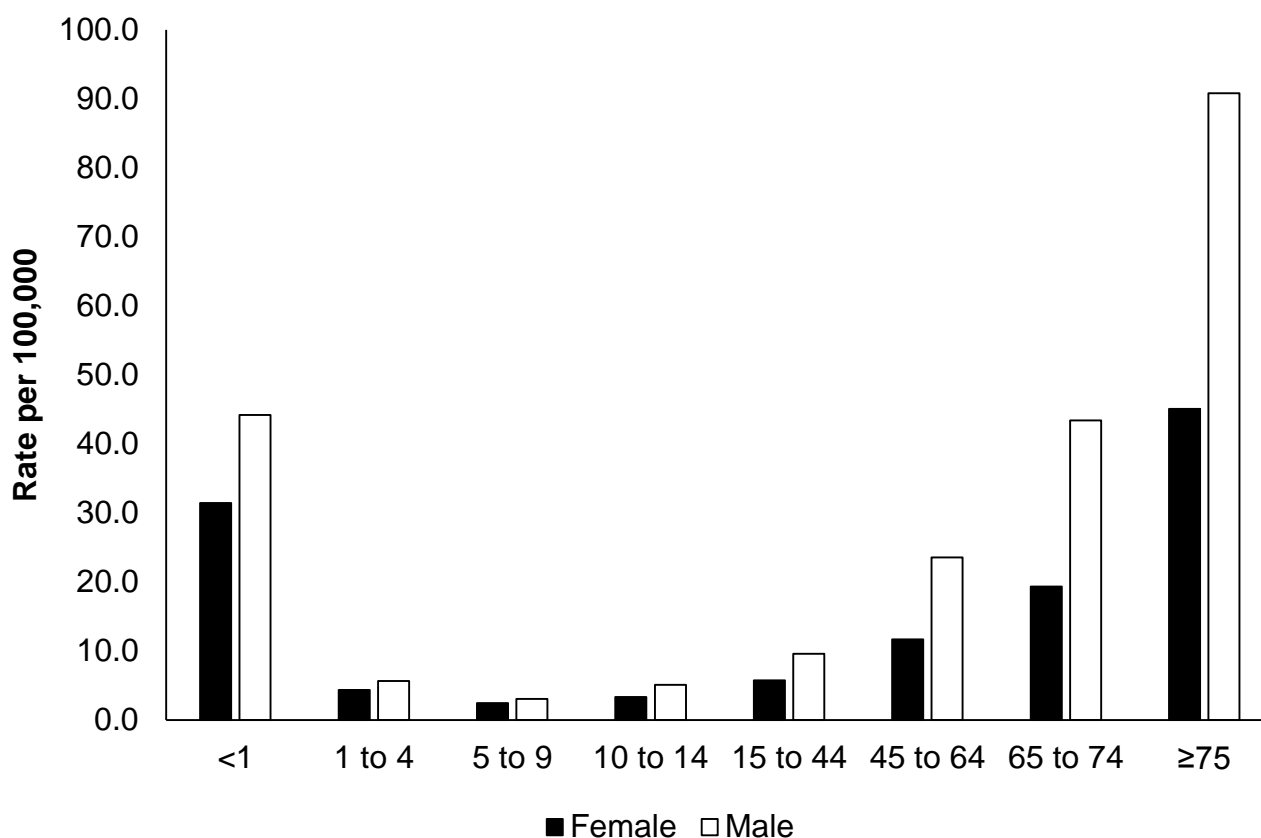
Figure 4a. MRSA bloodstream infection rates per 100,000 population by age and sex (England, Wales and Northern Ireland): 2018



Age and sex distribution: MSSA

Figure 4b shows that the rate of MSSA bloodstream infection had similar distribution patterns across age and sex as MRSA bloodstream infection, with the notable exception of having male rates of MSSA exclusively higher than female rates across all age groups. The bloodstream infection rate was the highest in the elderly as well as the very young (≥ 75 years, 65-74 years and <1 year age groups). The rate of bloodstream infection per 100,000 population in the older age groups was markedly higher amongst males in comparison to females (≥ 75 years: 90.8 vs. 45.0, 65-74 years: 43.4 vs. 19.3 and 45-64: 23.5 vs 11.7 per 100,000 population).

Figure 4b. MSSA bloodstream infection rates per 100,000 population by age and sex (England, Wales and Northern Ireland): 2018



Antimicrobial resistance: England and Northern Ireland

Tables 2a and 2b show trends in susceptibility to key antibiotic agents for MRSA and MSSA between 2015 and 2018 for England and Northern Ireland.

Between 2015 and 2017 there was a sharp increase in the proportion of MRSA blood isolates that are resistant to gentamicin (7% to 15%). Between 2017 and 2018 this remained stable at 15%. Since 2015 there has been a steady increase in the number of isolates being identified as resistant to fusidic acid (16% to 25%). Resistance to rifampicin is relatively low and has remained broadly stable between 2015 and 2018, fluctuating between 2% and 3%. Mupirocin resistance, broadly speaking, is also stable with the proportion of isolates reported as resistant fluctuating between 3% and 5%. Reported resistance rates to vancomycin, teicoplanin and linezolid have remained consistently low between 2015 and 2018 (0% to <1%). Levels of resistance to ciprofloxacin and erythromycin reported have consistently been high over the four-year period and remained so in 2018 at 62% and 51%, respectively.

In MSSA blood isolates, resistance to erythromycin increased between 2015 and 2018 from 14% to 16%. Resistance to gentamicin remained broadly stable over the four-year period, fluctuating between 1% and 2%. Resistance to ciprofloxacin remained stable at around 5%-6%. Rates of resistance to vancomycin, teicoplanin, rifampicin, mupirocin and linezolid have remained consistently low between 2015 and 2018 (0% to 1%). Resistance to fusidic acid, unlike that observed for MRSA, also has remained stable at 13%.

As expected, MRSA in general exhibited higher resistance proportions across more antibiotic classes than MSSA. Effective treatment options for patients infected with MRSA resistant to multiple antimicrobials will be more limited; such individuals will be at higher risk of poor outcomes (e.g. greater length of hospital stay or death), thus highlighting the increasing concern over antimicrobial resistance [7,8].

Table 2a. Antimicrobial susceptibility* for MRSA bloodstream infection (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	89	0	11	90	0	10	85	<1	15	85	<1	15
Ciprofloxacin	29	1	70	32	1	67	32	2	66	37	1	62
Vancomycin	100	0	0	100	0	0	100	<1	0	100	0	0
Teicoplanin	100	0	<1	99	0	1	99	<1	1	100	0	0
Linezolid	100	0	0	100	0	0	100	0	<1	100	0	0
Erythromycin	46	<1	53	44	1	56	45	<1	55	49	0	51
Rifampicin	97	1	2	97	1	3	97	<1	3	97	<1	3
Mupirocin	93	2	5	94	2	4	94	2	4	95	2	3
Fusidic Acid	83	1	16	80	1	20	78	<1	22	74	<1	25

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

Table 2b. Antimicrobial susceptibility* for MSSA bloodstream infection (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	98	<1	1	99	0	1	98	<1	2	98	<1	2
Ciprofloxacin	93	1	6	93	1	6	93	1	6	95	<1	5
Vancomycin	100	<1	0	100	<1	0	100	<1	0	100	<1	0
Teicoplanin	100	<1	<1	100	<1	<1	100	<1	<1	100	<1	<1
Linezolid	100	0	<1	100	0	<1	100	0	<1	100	<1	<1
Erythromycin	86	<1	14	84	<1	15	83	<1	17	83	<1	16
Rifampicin	98	1	1	98	1	1	99	1	1	99	<1	1
Mupirocin	99	<1	1	99	1	1	99	<1	<1	99	1	<1
Fusidic Acid	87	<1	13	87	<1	13	87	<1	13	87	<1	13

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

Ascertainment: Comparison of MRSA and MSSA positive specimens from the voluntary laboratory reporting scheme versus MRSA and MSSA infections from the mandatory surveillance scheme in England

The following data compare MRSA and MSSA bloodstream infections reported to the voluntary laboratory surveillance scheme with those reported to the mandatory surveillance scheme. Data on voluntary bloodstream infection reports were limited to those from England only (Wales and Northern Ireland do not take part in the English mandatory surveillance scheme); data from six laboratories (two in London, one in the South East, one in the North East, one in the North West and one in Yorkshire and Humber) were excluded due to concerns about the quality of data submitted to SGSS.

The number of MRSA bloodstream infection reported under voluntary and mandatory reporting schemes shows a broadly similar trend (figure 5a), although the number that are reported through voluntary surveillance is lower than through the mandatory scheme. The case ascertainment of MRSA bloodstream infection reports to the voluntary scheme fluctuated between 2014 and 2016, though since 2016 there has been far greater ascertainment with mandatory surveillance (87.5% in 2018). This recent increase in ascertainment, while beneficial for voluntary surveillance, has resulted in year-on-year increases to the rate of MRSA bloodstream infection, which inaccurately reflects the trend observed through mandatory surveillance. As a result, caution should be used when trying to draw conclusions from this report and instead it is preferable to consult the Mandatory Surveillance Annual Epidemiological Commentary [5].

The number of MSSA bloodstream infection reports increased in both the mandatory and voluntary surveillance schemes between 2014 and 2018 (figure 5b), albeit numbers reported voluntarily were much lower although ascertainment is steadily improving. Similarly to MRSA, this increasing ascertainment in MSSA makes interpretation of trends over time problematic.

Figure 5a. Ascertainment of MRSA bloodstream infection data for the mandatory and voluntary reporting schemes in England: 2014 to 2018

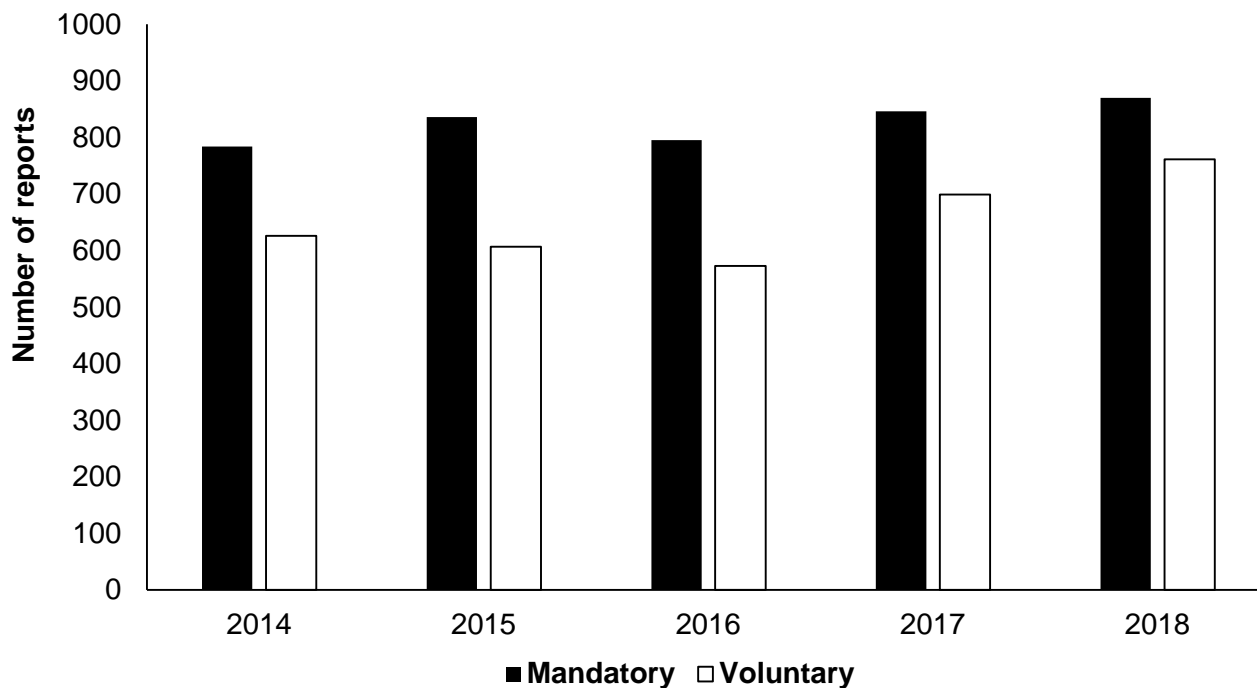
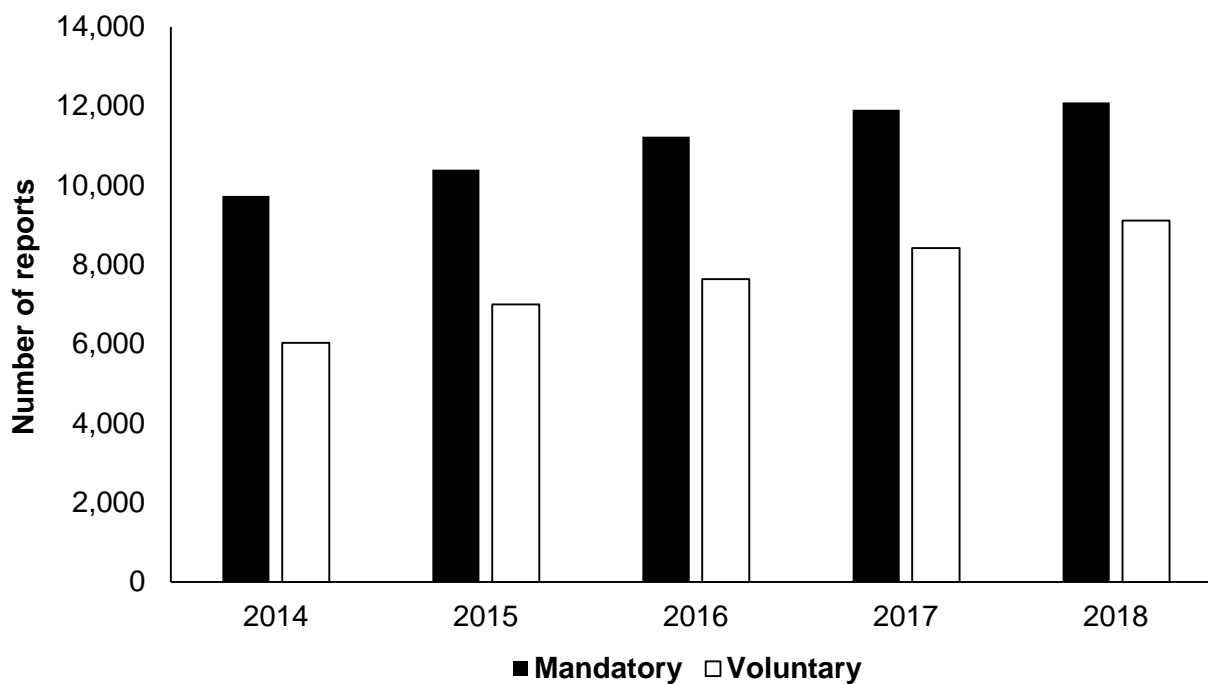


Figure 5b. Ascertainment of MSSA bloodstream infection data for the mandatory and voluntary reporting schemes in England: 2014 to 2018



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, Public Health Wales and Public Health Agency, Northern Ireland and the PHE Reference Unit, in particular, is valued in the preparation of this report. Feedback and specific queries about this report are welcome and can be sent to:

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