Annual Epidemiological Commentary: Mandatory MRSA, MSSA and \textit{E. coli} bacteraemia and \textit{C. difficile} infection data, 2014/15

9 July 2015
About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. It does this through world-class science, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. PHE is an operationally autonomous executive agency of the Department of Health.

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Executive summary

The rate of MRSA bacteremia cases dropped by 7.1% in 2014/15 compared to the previous financial year (1.5 vs. 1.6 per 100,000 population). However, counts and rates of \textit{C. difficile} infections and both MSSA and \textit{E. coli} bacteremias have significantly increased in 2014/15 compared to 2013/14: 6.0% in \textit{C. difficile} infection rate from 24.8 per 100,000 population in 2013/14 to 26.3 per 100,000 population in 2014/15, 5.8% in MSSA bacteremia rate from 17.2 per 100,000 population in 2013/14 to 18.2 per 100,000 population in 2014/15 and 4.1% in \textit{E. coli} bacteremia rate from 63.6 per 100,000 population in 2013/14 to 66.2 per 100,000 population in 2014/15 (all \(p<0.05\)).

The observed increases in \textit{Clostridium difficile} infection are currently under investigation and Public Health England (PHE) is working closely with the NHS and the wider health service to look for any underlying reasons. In particular, the proportion of infections that detected in the community that maybe associated with recent hospital stays.

Observed increases in MSSA and \textit{E. coli} bacteremia numbers have been apparent for some time and is in fact why PHE, the Department of Health and the NHS initiated more in-depth surveillance on these infections. PHE are currently working with the Advisory Committee on Antimicrobial Resistance and Healthcare Associated Infection (ARHAI) to identify suitable healthcare interventions to reduce these infections.

A common pattern across all four mandatory surveillance data collections in 2014/15 was the high percentage (between 60% and 80%) of infection cases which would not traditionally have been defined as hospital-onset (ie non-inpatients at an acute Trust or inpatients with a bacteremia occurring <2 days after hospital admission/with a \textit{C. difficile} infection arising <3 days after admission to an acute Trust). Even among inpatients at an acute Trust, the percentage considered as hospital-onset has decreased over time for all four data collections. Using time to onset between date of admission and date of specimen for acute Trust inpatients is a pragmatic but relatively crude gauge for ascertaining where an infection may have been acquired, it does not take into account healthcare interactions within the community and recent prior hospital admissions. However, with the increasing proportion of ostensibly community acquired infections both control and surveillance measures will need to support this setting if reductions in infections are to continue.

Non-mandatory fields collected by PHE, such as the source/primary focus of bacteremia, are sometimes infrequently completed but can provide important epidemiological data. These additional data are vital if we are to identify novel areas where we can direct and implement new interventions to continue to tackle these
important healthcare associated infections (eg the shift in MRSA bacteraemia towards skin and soft tissue sources, rather than intravenous lines).
Introduction

History of the mandatory surveillance scheme

Mandatory MRSA and MSSA bacteraemia surveillance scheme

A long running voluntary surveillance scheme of laboratory reported cases of bacteraemia showed increasing incidence of MRSA infections in England, Wales and Northern Ireland in the 1990s. This generated both media and public interest. In response, the Department of Health (DH) in England introduced a mandatory surveillance scheme for *S. aureus* bacteraemias in April 2001.

Public Health England (PHE) has been managing, on behalf of DH, the surveillance of *Staphylococcus aureus* bacteraemia in England since its initiation. Data were submitted quarterly by each NHS acute Trust and contained aggregate data on the total number of blood culture sets taken, the total number of positive blood cultures, the total number of blood cultures positive for *S. aureus* and the proportion of all *S. aureus* positive blood cultures which were MRSA-positive (1).

While the mandatory surveillance scheme of the aggregate number of *S. aureus* bacteraemias and the proportion which were MRSA positive provided robust data, this lacked relevant epidemiological data which could have provided information on potential intervention targets, and their subsequent assessment. Therefore, in October 2005 the mandatory surveillance scheme for MRSA bacteraemias was enhanced to collect patient-level data (2).

Enhanced surveillance involves collecting patient details for each MRSA bacteraemia episode such as NHS number, hospital number, date of birth, and sex, as well as information concerning the patient's location, date of admission, consultant specialty, and care details at the time the blood sample was taken. Trusts have access to a web-based surveillance system, where these details on each MRSA bacteraemia episode can be entered.

Additionally, all NHS organisations reporting positive cases of MRSA bacteraemia from the 1 April 2013, are required to complete a Post Infection Review (PIR). As a result, MRSA bacteraemia data is no longer apportioned and is now published on the basis of relevant PIR assignment. This process was commenced to support the delivery of zero tolerance on MRSA bacteraemia, as set out by NHS England in the Planning Guidance *Everyone counts: Planning for Patients 2013/14* (3). A PIR is undertaken on all MRSA bacteraemias with the purpose of identifying how a case occurred, to identify actions by local healthcare teams which will prevent a reoccurrence and to identify the organisation
best placed to ensure improvements are made (this is known as “assigning” a case to an organisation). Between 1 April 2013 and 31 March 2014 this was limited to either the NHS acute Trust who reported the case or the Clinical Commissioning Group with responsibility for commissioning care for the patient; however, on 1 April 2014 an additional category was included in the PIR process allowing for assignment to a Third Party. This provision was made to acknowledge the increasingly complex nature of MRSA bacteraemias being reported. Assignment to a “Third Party” occurs through the arbitration process for MRSA bacteraemias and has been available for any cases with an MRSA positive blood culture post 1 April 2014. Further information on the assignment process including third party assignment can be found in the detailed PIR guidance (4) and an example of “Third Party” assignment can be found in the Appendix.

In January 2011 the enhanced patient-level mandatory surveillance scheme was extended to include patient-level surveillance of MSSA bacteraemia due to both the high national total of MSSA bacteraemias, which was higher than in 2001, and the observation that the strides in reducing MRSA bacteraemias had not also been seen among MSSA. It was noted that at a more local level, some organisations had reported reductions in MSSA bacteraemias and including MSSA bacteraemia in the enhanced surveillance scheme may provide details on how these reductions had been achieved, in order to replicate it elsewhere (5).

**Mandatory surveillance of Clostridium difficile**

Surveillance of *C. difficile* laboratory faecal samples in England and Wales was introduced in 1990 as part of the Public Health Laboratory Service’s voluntary monitoring of infectious diseases (6). Between 1990 and 2004 there was a rise in the number of *C. difficile* infections, from less than 3,000 in 1990 to more than 45,000 in 2004 (7). Rates of *C. difficile* infections also rose over this time period in all age groups ≥40 years old (7). Due to the increasing incidence of *C. difficile* infections, the mandatory reporting of *C. difficile* infection in people aged ≥65 years was introduced in England in January 2004, this was a quarterly aggregate data return reported by NHS acute Trusts comprising data on the number of toxin-positive *C. difficile* faecal samples. Due to the continued rise of *C. difficile* infections among the population aged ≥65 years, the *C. difficile* mandatory surveillance scheme was enhanced in April 2007, to be patient-level and to cover all *C. difficile* infections in patients aged 2 years and over (8). Reports are submitted using the same web-enabled system that is used to collect enhanced MRSA (and later MSSA) bacteraemia data. The surveillance includes the collection of patient details for each *C. difficile* episode such as NHS number, hospital number, date of birth, and sex, as well as information concerning the patient's location, date of admission, and care details at the time the faecal sample was taken.
Mandatory surveillance of *Escherichia coli* bacteraemia

*E. coli* has been the predominant cause of bacteraemia in England, Wales and Northern Ireland, overtaking those caused by *S. aureus* in 2003 (9, 10). Following a year-on-year increase in Gram-negative bacteraemia, as reported to PHE via the voluntary surveillance system (44% increase among *E. coli* bacteraemia alone between 2003 and 2011, from 16,542 to 29,777 voluntary reports), and a recommendation from the Advisory Committee on Antimicrobial Resistance and Healthcare Associated Infections (ARHAI) to commence *E. coli* bacteraemia surveillance (11), the DH mandated NHS acute Trusts to report episodes of *E. coli* bacteraemia to PHE through the established enhanced mandatory surveillance Data Capture System (DCS) from June 2011 (12).

Hyperlinks

All hyperlinks included in the PDF of the Annual Epidemiological Commentary can be identified by being in bold turquoise text (*example type face*).
Supplementary Annual Epidemiological Commentaries for MRSA, MSSA and *E. coli* bacteraemias and *C. difficile* infections, data up to 2014/15

Data included in the 2014/15 Annual Epidemiological Commentary (AEC)

Counts and rates of MRSA, MSSA and *E. coli* bacteraemias and *C. difficile* infections included in this report are those with dates of positive specimens between 1 April 2007 and 31 March 2015. This report includes data, extracted from the Healthcare Associated Infections (HCAI) data capture system (DCS) on 20 April 2015\(^1\), from 155 NHS acute Trusts, 211 Clinical Commissioning Groups (CCGs), 29 Specialised Commissioning Hubs and mapped to 25 Area Teams. Data is published in line with organisational arrangements as at 31 March 2015. Data by acute Trust and CCG are presented on an annual and quarterly basis. Epidemiological commentaries are presented on an annual basis. Data tables included in the Annual Epidemiological Commentary can also be found in OpenDocument Spreadsheet (.ods) format on the Annual Epidemiological Commentary web page.

This is the second annual publication of MRSA bacteraemia data by assignment, allocated through the MRSA Post Infection Review (PIR) process, from FY 2013/14 onwards. Trust apportioned MRSA up to and including FY 2014/15 has been included in this report for historical context.

This publication forms part of the range of Official Statistics outputs routinely published by PHE. Epidemiological analyses included in this report are on an annual (financial year) basis. Further epidemiological analyses by quarter can be found in our quarterly epidemiological commentaries.

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The following data tables are included in the current annual publication:

**MRSA bacteraemia**

**Results by PIR assignment**

Table 1: Quarterly counts of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia by PIR assignment (April 2013 to March 2015)

- Table 1a: Quarterly counts of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia from April 2013 to March 2015 – Trust assigned cases
- Table 1b: Quarterly counts of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia from April 2013 to March 2015 – Clinical Commissioning Group assigned cases

Table 2: Financial year counts and rates of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia by PIR assignment (2013/14 to 2014/15)

- Table 2a: Annual counts and rates of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia, 2013/14 to 2014/15 – Trust assigned cases
- Table 2b: Annual counts and rates of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia, 2013/14 to 2014/15 – Clinical Commissioning Group assigned cases

**Results by acute Trust**

Table 3: Quarterly counts of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia by NHS acute Trust (April 2007 to March 2015)

- Table 3a: Quarterly counts of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia from April 2007 to March 2015 – All reported cases
- Table 3b: Quarterly counts of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia from April 2008 to March 2015 – Trust apportioned cases only

Table 4: Financial year counts and rates of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia by NHS acute Trust (2007/08 to 2014/15)

- Table 4a: Annual counts and rates of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia from 2007/08 to 2014/15 – All reported cases
Table 4b: Annual counts and rates of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia from 2008/09 to 2014/15 – Trust apportioned cases only

Results by CCG

Table 5: Quarterly counts of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemias by Clinical Commissioning Group (April 2009 to March 2015)

Table 6: Financial year counts and rates of Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia by Clinical Commissioning Group (2009/10 to 2014/15)

*C. difficile* infections

Results by acute Trust: patients aged 2 years and over

Table 7: Quarterly counts of *C. difficile* infection by NHS acute Trust (April 2007 to March 2015)

Table 7a: Quarterly counts of *C. difficile* infection (patients aged 2 years and over) from April 2007 to March 2015 – All reported cases

Table 7b: Quarterly counts of *C. difficile* infection (patients aged 2 years and over) from April 2007 to March 2015 – Trust apportioned cases only

Table 8: Financial year counts and rates of *C. difficile* infection by NHS acute Trust (2007/08 – 2014/15)

Table 8a: Annual counts and rates of *C. difficile* infection (patients aged 2 years and over) from 2007/08 to 2014/15 – All reported cases

Table 8b: Annual counts and rates of *C. difficile* infection (patients aged 2 years and over) from 2007/08 to 2014/15 – Trust apportioned cases only

Results by CCG: patients aged 2 years and over

Table 9: Quarterly counts of *C. difficile* infection by Clinical Commissioning Group (April 2009 to March 2015)

Table 10: Financial year counts and rates of *C. difficile* infection by Clinical Commissioning Group (2009/10 to 2014/15)
MSSA bacteraemia

Results by acute Trust

Table 11: Quarterly counts of Meticillin Susceptible *Staphylococcus aureus* (MSSA) bacteraemia by NHS acute Trust (January 2011 to March 2015)

  - Table 11a. Quarterly counts of Meticillin Susceptible *Staphylococcus aureus* (MSSA) bacteraemia from January 2011 to March 2015 – All reported cases
  - Table 11b: Quarterly counts of Meticillin Susceptible *Staphylococcus aureus* (MSSA) bacteraemia from January 2011 to March 2015 – Trust apportioned cases only

Table 12: Financial year counts and rates of Meticillin Susceptible *Staphylococcus aureus* (MSSA) bacteraemia (2011/12 to 2014/15)

  - Table 12a: Annual counts and rates of Meticillin Susceptible *Staphylococcus aureus* (MSSA) bacteraemia from 2011/12 to 2014/15 – All reported cases
  - Table 12b: Annual counts and rates of Meticillin Susceptible *Staphylococcus aureus* (MSSA) bacteraemia from 2011/12 to 2014/15 – Trust apportioned cases only

Results by CCG

Table 13: Quarterly counts of Meticillin Susceptible *Staphylococcus aureus* (MSSA) bacteraemia by Clinical Commissioning Group (January 2011 to March 2015)

Table 14: Financial year counts and rates of Meticillin Susceptible *Staphylococcus aureus* (MSSA) bacteraemia by Clinical Commissioning Group (2011/12 to 2014/15)

*E. coli* bacteraemia

Results by NHS acute Trust

Table 15: Quarterly counts of *E. coli* bacteraemia by NHS acute Trust (July 2011 to March 2015)

Table 16: Financial year counts and rates of *E. coli* bacteraemia by NHS acute Trust (2012/13 to 2014/15)
Results by CCG

Table 17: Quarterly counts of *E. coli* bacteraemias by Clinical Commissioning Group (July 2011 to March 2015)

Table 18: Financial year counts and rates of *E. coli* bacteraemia by Clinical Commissioning Group (2012/13 to 2014/15)

Commentary

In addition, this document contains annual, national and regional level (NHS England Area Team) epidemiological commentaries for MRSA, MSSA and *E. coli* bacteraemias and *C. difficile* infections. For Area Team analyses in this report, CCGs and their attributed cases are linked to the Area Teams they are part of. However, CCGs and Area Teams only came into existence on 1 April 2013, analyses looking at time trends are using retrospective attribution of cases to CCGs and Area Teams. These may become less accurate the older the data are and, therefore, these have only been performed back to and including FY 2009/10 reports. The temporal data before 2013/14 contained in this report with regards CCGs and Area Teams have only been provided as an indication of the trend over time for a given CCG/Area Team and thus, should be treated with caution. In addition, Specialist Commissioning hubs are not mapped to Area Teams for the purpose of this report, and so any cases attributed to one of the 29 Clinical Commissioning Hubs have been excluded from the regional analyses.

Mandatory surveillance data series included in this report start from FY 2007/08, or the earliest full quarter of data collection.

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2 Area Teams can also be mapped via NHS acute Trusts, based upon the Area Team within which an NHS Trust is located, which is how the Area Team included in Tables 1-18 (to which this document is a supplementary commentary) are derived.
Epidemiological analyses of *Staphylococcus aureus* bacteraemia

A total of 10,628 *S. aureus* bacteraemias were reported to Public Health England in 2014/15 through both the meticillin resistant *S. aureus* (MRSA) bacteraemia and meticillin susceptible *S. aureus* (MSSA) bacteraemia mandatory surveillance schemes. This represents a 4.7% increase on the *S. aureus* bacteraemias reported in 2013/14 (n=10,152) and 7.5% overall increase since 2011/12 (n=9,883 *S. aureus* bacteraemia reports).

Since 2011/12, the percentage of annual *S. aureus* bacteraemia reports associated with MRSA has decreased from 11.3% (n=1,116 of 9,883) to 7.5% (n=801/10,628) in 2014/15.

The following sections will describe the epidemiology of the MRSA and MSSA in England separately.

**Meticillin Resistant *Staphylococcus aureus* (MRSA) bacteraemia**

**Total reports**

A total of 801 cases of MRSA bacteraemia were reported by English NHS acute Trusts between 1 April 2014 and 31 March 2015 (FY 2014/15). This represents a reduction of 7.1% in the number of cases in FY 2013/14 when 862 cases were reported, and an overall reduction of 82.0% from the number of cases reported in FY 2007/08 (4,451 cases). Figure S1a shows that the associated national incidence rate decreased from 8.7 to 1.6 cases per 100,000 population over this time period.

Although the number of MRSA bacteraemia reports and their associated rates continue to decline year-on-year (Table S1a), this decline has slowed over time (22.0% reduction in number of infections between FY 2009/10 and FY 2010/11, 17.2% between FY 2011/12 and FY 2012/13, 6.7% between FY 2012/13 and FY 2013/14 and 7.1% between FY 2013/14 and 2014/15).

**Trust assigned reports**

Since 1 April 2013, MRSA bacteraemia has been reported by the assignment outcome of the PIR process. Between 1 April 2013 and 31 March 2014, this separated cases into two groups either Trust or CCG assigned. From 1 April 2014, an additional category was added to the PIR process (assignment to a “Third Party”), taking into consideration the increasingly complex nature of MRSA bacteraemias being reported. Prior to April
2013 MRSA cases were reported grouped by the Trust apportionment algorithm; categorising cases by their time of onset in relation to patient admission and the location of the patient. This evolving metric makes analysis of temporal trends difficult as the time series is broken by the change to definitions. Therefore, for historical context, MRSA reports have been Trust apportioned using the old algorithm and included in this report for FY 2008/09 to FY 2014/15.

Of the 801 cases in FY 2014/15, 320 MRSA bacteraemias were assigned to an acute Trust (0.9 per 100,000 bed days) and 384 were assigned to a CCG (0.71 per 100,000 population) while the remaining 97 MRSA bacteraemias were assigned to a Third Party (Table S1b), equivalent to 0.2 per 100,000 population.

When data are considered in terms of the previously utilised Trust apportionment algorithm there were 287 Trust apportioned MRSA bacteraemias in FY 2014/15. This is slightly lower than those found to be Trust assigned cases; however, this difference reflects the change in reporting methodology rather than any change in infection rates.

The rate of Trust apportioned cases per 100,000 bed days has been included in Figure S1b from FY 2008/09 to FY 2014/15 for historical context. We have not provided the Trust assigned rates over time in a figure (only in Table S1b) as the time series has been disrupted; the additional categorisation of Third Party assignment for all cases with a specimen date from 1 April 2014 onwards, means that the Trust assigned data for 2013/14 are not truly comparable to the Trust assigned data for 2014/15, as further declines in Trust assigned cases may be an artefact of the change in methodology rather than a true decline.
Figure S1: Trends in rates of MRSA bacteraemia

Fig. S1a. All reported cases rate (2007/08 to 2014/15)*

Fig. S1b. Trust apportioned rates (2008/09 to 2014/15)*

Figure S1b: presents Trust apportioned data from FY 2008/09 to FY 2014/15, provided for historical context. Trust assigned rates have not been presented graphically for 2013/14 and 2014/15 due to changes in the methodology, meaning that there is a twice disrupted time series. Data for Trust assigned rates can be found in Table S1b and shall not be presented graphically until there are several data points available.

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15. In addition, the 2014/15 bed-day total is of an aggregate of quarter one-quarter three of 2014/15 and quarter 4 of 2013/14, as at the time this analysis was performed, quarter 4 2014/15 data had not been published.

Age and sex distribution

For all age-gender analyses, those cases with a missing or unknown gender were removed from the analyses. For 2007/08 there were 52 such reports (1.2% of 4,451 reported MRSA bacteraemias) and in 2014/15, there were 19 of 801 (2.4%) reports denoted as “Unknown” gender.

Figure S2 shows the rates per 100,000 population by age and sex for MRSA bacteraemias for England in (a) 2007/08 and (b) 2014/15. In both males and females the highest rates are among those aged ≥85 years (2007/08: 149.2 per and 44.5 per 100,000 population respectively, 2014/15: 24.6 and 7.8 per 100,000 population).

Rates of MRSA bacteraemia are generally higher among men than women among all age groups. The rate of MRSA in men aged 65-74 years and 75-84 years were more than twice the rate among women of the same age in 2007/08 (29.2 vs. 12.3 per 100,000 population, rate ratio 2.4 (95% CI: 2.1-2.8) and 73.5 vs. 26.4 per 100,000 population, rate ratio 2.8 (95% CI: 2.5-3.1), respectively) and more than 3-fold higher.
among those aged ≥85 years of age (149.2 vs. 44.5 per 100,000 population respectively, rate ratio: 3.3 (95% CI: 2.9-3.8)).

In 2014/15, the rates of MRSA bacteraemia have declined in both men and women of all ages and also have resulted in reduced rate ratios between men and women aged between 0 and 74 years of age. However, the rate ratios among men and women aged ≥75 years have remained broadly similar; with rates of MRSA bacteraemia 3-fold higher among men than women aged 75-84 years (9.1 vs. 3.1 per 100,000 respectively, rate ratio 3.0 (95% CI: 2.1-4.1) and ≥85 years (24.6 vs. 7.8 per 100,000 population respectively, rate ratio 3.1 (95% CI: 2.3-4.3)), see Table S2a and Table S2b.

**Time to onset**

The time to onset among inpatients, was defined as the difference between the date of admission and the date the first positive specimen was taken; therefore, this analysis only includes inpatients, day patients and patients in emergency assessment (henceforth collectively referred to as inpatients) where a date of admission was available. In addition, the date of specimen must have been on or after the date of admission and the specimen had to have been taken during an admission to an acute Trust.

In 2007/08 the median number of days to the onset of MRSA bacteraemia among inpatients was 7 (IQR: 0-21) days. This has been in decline since 2007/08, and between 2010/11 and 2013/14 the median number of days between date of admission and date of specimen was 2 days. In 2014/15, the median number of days between date of admission and date of specimen among inpatients at NHS acute Trusts was 1 (IQR:0-13).

Figure S3 shows the distribution of time to onset of MRSA bacteraemia. As with the declining median over time, the percentage of MRSA bacteraemias among inpatients diagnosed within 2 days of admission has increased over time. In 2007/08 only one-third of infections were diagnosed in <2 days post-admission. However, by 2014/15 the distribution had changed substantially, with half (50.7%) of MRSA bacteraemias among inpatients diagnosed within 2 days of the date of hospital admission, representing an increase of 52.8%. Of further note, there has only been a slight percentage decrease among MRSA bacteraemias diagnosed between 2 and 6 days after the date of admission (5.8%) between 2007/08 and 2014/15 but a much greater decline has been observed among MRSA bacteraemias diagnosed ≥7 days post admission (32.3% between 2007/08 and 2014/15).
Table S1a: Meticillin Resistant *Staphylococcus aureus* bacteraemia counts and rates by financial year, England: 2007/08 – 2014/15

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported case rate (per 100,000 population)</th>
<th>Total bed-days</th>
<th>Trust apportioned cases</th>
<th>Trust apportioned rate (per 100,000 bed days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007/08</td>
<td>51,381,093</td>
<td>4,451</td>
<td>8.7</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>2008/09</td>
<td>51,815,853</td>
<td>2,935</td>
<td>5.7</td>
<td>37,700,812</td>
<td>1,606</td>
<td>4.3</td>
</tr>
<tr>
<td>2009/10</td>
<td>52,196,381</td>
<td>1,898</td>
<td>3.6</td>
<td>37,326,212</td>
<td>1,004</td>
<td>2.7</td>
</tr>
<tr>
<td>2010/11</td>
<td>52,642,452</td>
<td>1,481</td>
<td>2.8</td>
<td>35,091,035</td>
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<td>2.0</td>
</tr>
<tr>
<td>2011/12</td>
<td>53,107,169</td>
<td>1,116</td>
<td>2.1</td>
<td>34,667,952</td>
<td>473</td>
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<td>2012/13</td>
<td>53,493,729</td>
<td>924</td>
<td>1.7</td>
<td>34,439,455</td>
<td>398</td>
<td>1.2</td>
</tr>
<tr>
<td>2013/14</td>
<td>53,865,817</td>
<td>862</td>
<td>1.6</td>
<td>34,311,181</td>
<td>364</td>
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<tr>
<td>2014/15*</td>
<td>53,865,817</td>
<td>801</td>
<td>1.5</td>
<td>34,520,684</td>
<td>287</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Table S1b: Meticillin Resistant *Staphylococcus aureus* bacteraemia by PIR assignment, 2013/14 - 2014/15

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Mid-year population estimate</th>
<th>CCG assigned cases</th>
<th>CCG assigned case rate (per 100,000 population)</th>
<th>Third Party assigned cases</th>
<th>Third Party assigned case rate (per 100,000 population)</th>
<th>Total bed-days</th>
<th>Trust assigned cases</th>
<th>Trust assigned rate (per 100,000 bed days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013/14</td>
<td>53,865,817</td>
<td>450</td>
<td>0.8</td>
<td>N/A</td>
<td>N/A</td>
<td>34,311,181</td>
<td>412</td>
<td>1.2</td>
</tr>
<tr>
<td>2014/15*</td>
<td>53,865,817</td>
<td>384</td>
<td>0.7</td>
<td>97</td>
<td>0.2</td>
<td>34,520,684</td>
<td>320</td>
<td>0.9</td>
</tr>
</tbody>
</table>

Table S1a and b * FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15. In addition, the 2014/15 bed-day total is of an aggregate of quarter one-quarter three of 2014/15 and quarter 4 of 2013/14, as at the time this analysis was performed, quarter 4 2014/15 data had not been published.
Figure S2: Age- and sex-specific MRSA bacteraemia rates per 100,000 population, England
S2a. 2007/08

Table S2: MRSA bacteraemia counts and rates by age group and gender
S2a. 2007/08

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported case rate (per 100,000 population)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>&lt;1</td>
<td>329,378</td>
<td>313,225</td>
<td>31</td>
</tr>
<tr>
<td>1 to 14</td>
<td>4,356,789</td>
<td>4,154,593</td>
<td>22</td>
</tr>
<tr>
<td>15 to 44</td>
<td>10,697,911</td>
<td>10,692,826</td>
<td>252</td>
</tr>
<tr>
<td>45 to 64</td>
<td>6,285,546</td>
<td>6,425,657</td>
<td>594</td>
</tr>
<tr>
<td>65 to 74</td>
<td>1,995,820</td>
<td>2,190,847</td>
<td>583</td>
</tr>
<tr>
<td>75-84</td>
<td>1,202,023</td>
<td>1,653,644</td>
<td>884</td>
</tr>
<tr>
<td>85+</td>
<td>333,066</td>
<td>749,768</td>
<td>497</td>
</tr>
</tbody>
</table>

S2b. 2014/15*

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported case rate (per 100,000 population)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>&lt;1</td>
<td>347,291</td>
<td>329,240</td>
<td>4</td>
</tr>
<tr>
<td>1 to 14</td>
<td>4,557,238</td>
<td>4,344,673</td>
<td>9</td>
</tr>
<tr>
<td>15 to 44</td>
<td>10,731,434</td>
<td>10,653,480</td>
<td>58</td>
</tr>
<tr>
<td>45 to 64</td>
<td>6,712,115</td>
<td>6,885,167</td>
<td>90</td>
</tr>
<tr>
<td>65 to 74</td>
<td>2,418,603</td>
<td>2,604,970</td>
<td>92</td>
</tr>
<tr>
<td>75 to 84</td>
<td>1,348,062</td>
<td>1,695,677</td>
<td>122</td>
</tr>
<tr>
<td>85+</td>
<td>419,226</td>
<td>818,641</td>
<td>103</td>
</tr>
</tbody>
</table>

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.
Source of MRSA bacteraemia

The source of bacteraemia is a non-mandatory field and the percentage completion is variable. In 2007/08, 54.2% of all MRSA bacteraemias reported to the mandatory surveillance scheme had this field completed, while in 2014/15 only 31.6% of the infections reported included this additional data, see Table S3.

Over the eight financial years of data included in this report, there have been two main known sources of bacteraemia: skin/soft tissue infection (SSTI) and catheters/indwelling lines. These two sources of bacteraemia have accounted for approximately 30-40% of all MRSA bacteraemias with a reported source between 2007/08 and 2014/15. However, in 2014/15, a further source of MRSA bacteraemia accounted for a greater percentage of known sources than catheters/indwelling lines; pneumonia (15.4%).

In 2007/08, 25.6% of all MRSA bacteraemias with a reported source of infection were associated with catheters/indwelling lines; however, between 2007/08 and 2014/15 there has been a 53.6% reduction in the percentage of MRSA bacteraemias associated with these sources, accounting for only 11.9% of all MRSA bacteraemias with an attributed source of infection in 2014/15. In contrast, skin and soft tissue infection (SSTI) -associated MRSA bacteraemias have increased by nearly 30%, from 16.4% of MRSA bacteraemias with an associated source of infection in 2007/08 to 20.9% in 2014/15. Pneumonia accounted for 15.4% of MRSA bacteraemias with a known source of infection in 2014/15, increasing by 132% from 6.6% in 2007/08. In addition, the percentage of “other” reported sources of MRSA bacteraemia have fluctuated over time, from 29.2% in 2007/08 to a peak of 37.1% in 2011/12, decreasing to 25.3% in 2014/15. This category includes endocarditis, osteomyelitis, septic arthritis, surgical site infections, prosthetic joint infections, urinary tract infections (UTIs), ventilator-associated pneumonia and those infections attributed to other causes than the list provided in the surveillance scheme. Of these additional sources of infection septic arthritis, endocarditis and osteomyelitis have made up an increasing percentage of MRSA bacteraemias from 2007/08 to 2014/15.

Due to the 2 to 3 fold difference in rates of MRSA bacteraemia between men and women aged ≥75 years, source of bacteraemia for older men and women were investigated. A significant difference in the sources of bacteraemia was found among older men and women for 2014/15; including a greater percentage of MRSA bacteraemias among older men with a
reported source of pneumonia (23.0% vs. 14.6%) or UTI (11.5% vs. 0.0%) than among older women.

**Figure S3:** Time to onset among inpatients with MRSA bacteraemia, 2007/08 – 2014/15

![Figure S3: Data from inpatients (defined as inpatients, day patients and patients in emergency assessment) from an NHS acute Trust only where the location when the positive specimen was taken was in an acute Trust, where the date of specimen was on or after the date of admission.](image)

**Table S3:** Distribution of reported sources of MRSA bacteraemia, 2007/08 - 2014/15

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Catheters &amp; Lines N (%)*</th>
<th>SSSI N (%)*</th>
<th>Pneumonia N (%)*</th>
<th>Other N (%)*</th>
<th>Unknown N (%)*</th>
<th>Total N (%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007/08</td>
<td>617 (25.6)</td>
<td>395 (16.4)</td>
<td>160 (6.6)</td>
<td>705 (29.2)</td>
<td>537 (22.2)</td>
<td>2,414 (100)</td>
</tr>
<tr>
<td>2008/09</td>
<td>346 (22.5)</td>
<td>276 (17.9)</td>
<td>113 (7.3)</td>
<td>552 (35.8)</td>
<td>254 (16.5)</td>
<td>1,541 (100)</td>
</tr>
<tr>
<td>2009/10</td>
<td>178 (19.5)</td>
<td>191 (20.9)</td>
<td>63 (6.9)</td>
<td>328 (35.8)</td>
<td>155 (16.9)</td>
<td>915 (100)</td>
</tr>
<tr>
<td>2010/11</td>
<td>118 (17.5)</td>
<td>146 (21.6)</td>
<td>47 (7.0)</td>
<td>251 (37.1)</td>
<td>114 (16.9)</td>
<td>676 (100)</td>
</tr>
<tr>
<td>2011/12</td>
<td>71 (14.7)</td>
<td>98 (20.3)</td>
<td>41 (8.5)</td>
<td>177 (36.7)</td>
<td>95 (19.7)</td>
<td>482 (100)</td>
</tr>
<tr>
<td>2012/13</td>
<td>72 (18.3)</td>
<td>74 (18.8)</td>
<td>34 (8.6)</td>
<td>128 (32.5)</td>
<td>86 (21.8)</td>
<td>394 (100)</td>
</tr>
<tr>
<td>2013/14</td>
<td>39 (13.3)</td>
<td>57 (19.4)</td>
<td>33 (11.2)</td>
<td>100 (34.0)</td>
<td>65 (22.1)</td>
<td>294 (100)</td>
</tr>
<tr>
<td>2014/15</td>
<td>30 (11.9)</td>
<td>53 (20.9)</td>
<td>39 (15.4)</td>
<td>64 (25.3)</td>
<td>67 (26.5)</td>
<td>253 (100)</td>
</tr>
</tbody>
</table>

**Table S3:** *Percentages are row percentages.

“Catheters and lines” includes the following options from the mandatory surveillance system question options for source of bacteraemia dialysis lines, central venous catheter (CVC) associated, peripheral venous catheter (PVC) associated and intravenous (IV) lines.

“Other” includes the following options for the mandatory surveillance system question options for source of bacteraemia: endocarditis, osteomyelitis, other, prosthetic joint, surgical site infection (SSI), septic arthritis, urinary tract infection (UTI) and ventilator-associated pneumonia.
Geographic distribution of MRSA bacteraemias

Some variation in the rates of MRSA bacteraemia was noted between regions in 2014/15 with a range from 0.8 per 100,000 in South Yorkshire and Bassetlaw Area Team (AT) to 2.5 per 100,000 in Bristol, North Somerset, Somerset and South Gloucestershire AT (see Figure S4). There were six ATs with an MRSA rate ≥1.7 per 100,000 population (Arden, Herefordshire and Worcestershire AT, Bath, Gloucestershire, Swindon and Wiltshire AT, Bristol, North Somerset, Somerset and South Gloucestershire AT, Durham, Darlington and Tees AT, London AT, Merseyside AT, Shropshire and Staffordshire AT) but only four with a rate ≤1.0 per 100,000 population (Derbyshire and Nottinghamshire AT, Devon, Cornwall and Isles Of Scilly AT and South Yorkshire, Bassetlaw AT and Wessex AT).

Table S4 shows the region-specific rates of MRSA bacteraemia for 2009/10 to 2014/15. The AT with the lowest reported MRSA bacteraemia rate in 2009/10 was Arden, Herefordshire and Worcestershire AT (1.9 per 100,000 population) and the highest in West Yorkshire AT (5.2 per 100,000 population). As with the national picture, rates of MRSA bacteraemia for all ATs have declined between 2009/10 and 2014/15. However, 11 ATs have seen an increase in 2014/15 from 2013/14, of note are the three ATs with an increase of at least 50% (Shropshire and Staffordshire AT, Durham, Darlington and Tees AT and Arden, Herefordshire and Worcestershire AT).

The AT with the greatest percentage decline between 2013/14 and 2014/15 was the Kent and Medway AT, who nearly halved their rate of MRSA bacteraemia from 2.0 per 100,000 in 2013/14 to 1.1 per 100,000 in 2014/15. The AT with the greatest percentage decrease in their MRSA bacteraemia rate between 2009/10 and 2014/15 was Derbyshire and Nottinghamshire AT with a 78.7% decrease from 4.5 to 1.0 per 100,000 population. This was one of five ATs who had no increase in their MRSA rate between 2009/10 and 2014/15. The other four were Greater Manchester AT, Surrey and Sussex AT, Wessex AT and West Yorkshire AT.
Figure S4: MRSA bacteraemia rates per 100,000 population by NHS England Area Team*, 2014/15*

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.

Figure S4: Please see Table S4 for key between Area Team codes and Area Team names.
<table>
<thead>
<tr>
<th>Code</th>
<th>NHS Commissioning Board Area Team (AT)</th>
<th>2009/10</th>
<th>2010/11</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>2014/15*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q44</td>
<td>Cheshire, Warrington and Wirral Area Team</td>
<td>4.2</td>
<td>3.2</td>
<td>2.9</td>
<td>1.8</td>
<td>2.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Q45</td>
<td>Durham, Darlington and Tees Area Team</td>
<td>2.9</td>
<td>2.4</td>
<td>1.1</td>
<td>1.9</td>
<td>1.0</td>
<td>2.1</td>
</tr>
<tr>
<td>Q46</td>
<td>Greater Manchester Area Team</td>
<td>4.6</td>
<td>3.5</td>
<td>2.4</td>
<td>2.3</td>
<td>1.9</td>
<td>1.5</td>
</tr>
<tr>
<td>Q47</td>
<td>Lancashire Area Team</td>
<td>3.3</td>
<td>2.8</td>
<td>1.9</td>
<td>1.3</td>
<td>1.6</td>
<td>1.4</td>
</tr>
<tr>
<td>Q48</td>
<td>Merseyside Area Team</td>
<td>5.1</td>
<td>3.8</td>
<td>2.6</td>
<td>3.4</td>
<td>2.0</td>
<td>1.8</td>
</tr>
<tr>
<td>Q49</td>
<td>Cumbria, Northumberland, Tyne and Wear Area Team</td>
<td>3.4</td>
<td>2.5</td>
<td>1.5</td>
<td>2.0</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Q50</td>
<td>North Yorkshire and Humber Area Team</td>
<td>4.2</td>
<td>3.7</td>
<td>2.2</td>
<td>1.7</td>
<td>2.2</td>
<td>1.4</td>
</tr>
<tr>
<td>Q51</td>
<td>South Yorkshire and Bassetlaw Area Team</td>
<td>2.6</td>
<td>1.5</td>
<td>2.3</td>
<td>1.1</td>
<td>1.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Q52</td>
<td>West Yorkshire Area Team</td>
<td>5.2</td>
<td>4.3</td>
<td>2.8</td>
<td>2.8</td>
<td>2.1</td>
<td>1.6</td>
</tr>
<tr>
<td>Q53</td>
<td>Arden, Herefordshire and Worcestershire Area Team</td>
<td>1.9</td>
<td>2.9</td>
<td>1.1</td>
<td>1.8</td>
<td>1.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Q54</td>
<td>Birmingham and the Black Country Area Team</td>
<td>2.9</td>
<td>2.5</td>
<td>2.0</td>
<td>1.6</td>
<td>1.1</td>
<td>1.5</td>
</tr>
<tr>
<td>Q55</td>
<td>Derbyshire and Nottinghamshire Area Team</td>
<td>4.5</td>
<td>2.0</td>
<td>1.6</td>
<td>1.2</td>
<td>1.1</td>
<td>1.0</td>
</tr>
<tr>
<td>Q56</td>
<td>East Anglia Area Team</td>
<td>3.6</td>
<td>2.1</td>
<td>2.3</td>
<td>1.3</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Q57</td>
<td>Essex Area Team</td>
<td>2.5</td>
<td>1.7</td>
<td>1.2</td>
<td>1.7</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td>Q58</td>
<td>Hertfordshire and The South Midlands Area Team</td>
<td>2.3</td>
<td>2.2</td>
<td>1.5</td>
<td>1.0</td>
<td>1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>Q59</td>
<td>Leicestershire and Lincolnshire Area Team</td>
<td>2.6</td>
<td>2.8</td>
<td>2.1</td>
<td>0.8</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td>Q60</td>
<td>Shropshire and Staffordshire Area Team</td>
<td>3.9</td>
<td>3.3</td>
<td>2.0</td>
<td>1.1</td>
<td>0.9</td>
<td>2.1</td>
</tr>
<tr>
<td>Q64</td>
<td>Bath, Gloucestershire, Swindon and Wiltshire Area Team</td>
<td>3.6</td>
<td>2.1</td>
<td>1.6</td>
<td>1.8</td>
<td>1.5</td>
<td>1.8</td>
</tr>
</tbody>
</table>
Table S4: 1 MRSA bacteraemia in 2014/15 was attributed to a Specialised Commissioning hub, these do not map to Area Teams and so this case has been excluded from the regional analyses. East Anglia Area Team appears to have no change between 2013/14 and 2014/15; however, this is down to the rounding of the data to 1 decimal place. East Anglia Area Team has experienced a 3.4% increase in their MRSA bacteraemia rate over this time period.

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.

Discussion: MRSA bacteraemia reports in England

The number and annual incidence rate of MRSA bacteraemia have continued to fall, at a national level, across the NHS in England in 2014/15. In recent years, particularly from 2011/12, this decline has started to slow, with the difference between 2012/13 and 2013/14, as well as between 2013/14 and 2014/15 about 7%. The current financial year (2014/15) is the third consecutive year with fewer than 1,000 MRSA bacteraemia reports.

The NHS operates a zero tolerance policy for MRSA bacteraemias, and as such, to further identify where the local learning from occurrences would be best placed to action, all MRSA bacteraemias have been subject to a Post Infection Review (PIR) since 1st April 2013. On 1st April 2014, an additional category of “Third Party” assignment was included as a potential outcome of the PIR in order to better deal with the complex nature of MRSA bacteraemia reports. This report contains the first full financial year including the new PIR outcome, with 320 (40.0%) MRSA bacteraemias in 2014/15 assigned to an acute Trust, 384 (47.9%) assigned to a CCG and 97 (12.1%) assigned to a Third Party.

The proportion of MRSA bacteraemias, among acute Trust inpatients, which were detected within 2 days of hospital admission, has also increased over time from a third in 2007/08 to half in 2014/15. This is reflected in the
changing distribution of the source of bacteraemia over time, with a reduction in the percentage of catheter/line associated infections and an increase in the percentage of SSTI associated infections, accounting for one-fifth of all MRSA bacteraemias in 2014/15. In addition, in 2014/15, the percentage of MRSA bacteraemias with pneumonia as the reported source exceeded catheter/line associated infections for the first time. However, it is worth noting that the percentage of MRSA bacteraemias with source data provided was low; 31.6% in 2014/15 down from 54.2% in 2007/08. These data need to be viewed with caution, a high degree of missing data can lead to biased estimates, particularly if there is a reason for the non-completion of the cases with missing data or if there are actual differences in the cases for which we have these data and the cases for which this data is missing. It is worth noting that of the 139 NHS Trusts who reported an MRSA bacteraemia in 2014/15, 56 (40.3%) did not complete the source of bacteraemia field for any of their cases and only 29 (20.9%) of NHS Trusts, always completed this data field.

The majority of MRSA bacteraemias occurred in those ≥65 years old; 66.3% of all infections in men and 57.9% of all infections in women in 2014/15 were seen in this age group. Amongst older ages, the rate of MRSA bacteraemia is higher in men than women. In 2014/15, the highest rate of MRSA bacteraemia was observed in men aged ≥85 years, 24.6 per 100,000 population, which is 3 times the rate seen in women of the same age (7.8 per 100,000 population). There were significant differences in the reported sources of bacteraemias between older men and women; with a greater percentage associated with pneumonia (23.0% vs. 14.6%) and UTIs (11.5% vs. 0.0%). Further investigation is required but would be helped by greater completion of the data set in order to identify potential causes and highlight areas for interventions.

All Area Teams (ATs) experienced a decline in their rates of MRSA bacteraemia between 2007/08 and 2014/15; however, regional variations were apparent in 2014/15. Although there was a decline in more than half of Area Teams between 2012/13 and 2013/14, 11 ATs experienced increases; however, the two ATs with the greatest percentage increase between 2013/14 and 2014/15 (Durham, Darlington and Tees AT and Shropshire and Staffordshire AT, which both reported more than double the rate of 2013/14 in 2014/15) had some of the lowest rates in 2013/14 (≤1.0 per 100,000 population). As the number and rate in AT across the country are so low, small changes can equate to large percentage increase or decreases. However, two of the 11 Area Teams with observed increases between 2013/14 and 2014/15 also experienced increases between 2012/13 and 2013/14 (Hertfordshire and The South Midlands Area Team and
Leicestershire and Lincolnshire Area Team). Continued monitoring will be required to ascertain whether this is the start of a continued increase of infections in these areas and further investigation may be required to ascertain the causes of this.

**Meticillin Susceptible *Staphylococcus aureus* (MSSA) bacteraemia**

**Total reports**

A total of 9,827 cases of MSSA bacteraemia were reported across the NHS in England between 1 April 2014 and 31 March 2015 (2014/15). This represents an increase of 5.8% on the number of cases reported in 2013/14 when 9,290 cases were reported, and an increase of 12.1% on the number of cases reported in 2011/12 (8,767 cases). Table S5, Figure S5a shows that the associated national rate also increased from 16.5 to 18.2 cases per 100,000 population over this period.

**Trust apportioned reports**

A total of 2,795 Trust apportioned cases were reported across the NHS in 2014/15. This represents a 3.7% increase compared to the number of Trust apportioned cases in 2013/14 (n=2,696) and is the first increase in Trust apportioned MSSA bacteraemias since its inclusion in the mandatory surveillance scheme. Similarly, the rate of Trust apportioned MSSA bacteraemia has also increased between 2013/14 and 2014/15 from 7.9 per 100,000 bed days to 8.1 per 100,000 bed days, respectively Table S5 and Figure S5b.
Figure S5: Trends in rates of MSSA bacteraemia (2011/12 to 2014/15)*

Fig. S5a. All reported cases rates

Fig. S5b. Trust apportioned rates

Table S5: Meticillin Susceptible *Staphylococcus aureus* bacteraemia counts and rates by financial year, England: 2011/12 – 2014/15

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported rate (per 100,000 population)</th>
<th>Total bed days</th>
<th>Trust apportioned cases</th>
<th>Trust apportioned rate (per 100,000 bed days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011/12</td>
<td>53,107,169</td>
<td>8,767</td>
<td>16.5</td>
<td>34,667,952</td>
<td>2,854</td>
<td>8.2</td>
</tr>
<tr>
<td>2012/13</td>
<td>53,493,729</td>
<td>8,812</td>
<td>16.5</td>
<td>34,439,455</td>
<td>2,700</td>
<td>7.8</td>
</tr>
<tr>
<td>2013/14</td>
<td>53,865,817</td>
<td>9,290</td>
<td>17.2</td>
<td>34,311,181</td>
<td>2,696</td>
<td>7.9</td>
</tr>
<tr>
<td>2014/15*</td>
<td>53,865,817</td>
<td>9,827</td>
<td>18.2</td>
<td>34,520,684</td>
<td>2,795</td>
<td>8.1</td>
</tr>
</tbody>
</table>

Table S5: * FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15. In addition, the 2014/15 bed-day total is of an aggregate of quarter one-quarter three of 2014/15 and quarter 4 of 2013/14, as at the time this analysis was performed, quarter 4 2014/15 data had not been published.

Age and sex distribution of MSSA bacteraemias

For all age-gender analyses, those cases with a missing or unknown gender were removed from the analyses. For 2011/12 there were 265 such reports (3.0% of 8,767 reported MSSA bacteraemias) and in 2014/15, there were 217 of 9,927 (2.2%) reports denoted as “Unknown” gender.
Figure S6 shows the rates for MSSA per 100,000 population by age and gender for (a) 2011/12 and (b) 2014/15. The highest rates in both financial years are among those ≥85 years old for both men and women (2011/12: males ≥85 years 136.2 per 100,000 population, females ≥85 years 66.0 per 100,000 population. 2013/14: males ≥85 years 158.6 per 100,000 population, females ≥85 years 69.6 per 100,000 population). In addition, high rates were seen among infants under 1 year and males aged 75 to 84 years old (see Table S6a and Table S6b).

The rates of MSSA bacteraemia have increased in males and females aged ≥1 year between 2011/12 and 2014/15, except for a slight decrease among females aged 45 to 64 years. The greatest percentage increase in any age and gender group was seen among females aged 15-44 years old, with a 36.0% increase from a rate of 4.5 per 100,000 population in 2011/12 to 6.1 per 100,000 population in 2014/15, (see Table S6a and Table S6b).

Like MRSA, rates of MSSA bacteraemia among men tend to be higher than among women. Among older age groups (≥45 years) the rate among men is approximately double that among women for 2011/12 to 2014/15, while the rates are most similar in those aged <1 year old (2011/12 rate ratio <1 year: 1.3 (95% CI: 1.0-1.5) vs. 2014/15: rate ratio <1 year: 1.1 (95% CI: 0.9-1.4)).

Figure S6: Age- and sex- specific MSSA bacteraemia rates per 100,000 population, England
Fig. S6a. 2011/12
Fig. S6b. 2014/15*

Figure 6b: * FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.
Table S6: MSSA counts and rates by age group and gender
S6a. 2011/12

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported case rate (per 100,000 population)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>&lt;1</td>
<td>347,892</td>
<td>331,210</td>
<td>251</td>
</tr>
<tr>
<td>1 to 14</td>
<td>4,456,591</td>
<td>4,250,599</td>
<td>283</td>
</tr>
<tr>
<td>15 to 44</td>
<td>10,785,390</td>
<td>10,725,373</td>
<td>849</td>
</tr>
<tr>
<td>45 to 64</td>
<td>6,661,870</td>
<td>6,818,577</td>
<td>1,409</td>
</tr>
<tr>
<td>65 to 74</td>
<td>2,206,191</td>
<td>2,385,980</td>
<td>947</td>
</tr>
<tr>
<td>75 to 84</td>
<td>1,285,319</td>
<td>1,658,859</td>
<td>964</td>
</tr>
<tr>
<td>85+</td>
<td>389,909</td>
<td>803,409</td>
<td>531</td>
</tr>
</tbody>
</table>

S6b. 2014/15*

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported case rate (per 100,000 population)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>&lt;1</td>
<td>347,291</td>
<td>329,240</td>
<td>206</td>
</tr>
<tr>
<td>1 to 14</td>
<td>4,557,238</td>
<td>4,344,673</td>
<td>297</td>
</tr>
<tr>
<td>15 to 44</td>
<td>10,731,434</td>
<td>10,653,480</td>
<td>958</td>
</tr>
<tr>
<td>45 to 64</td>
<td>6,712,115</td>
<td>6,885,167</td>
<td>1,552</td>
</tr>
<tr>
<td>65 to 74</td>
<td>2,418,603</td>
<td>2,604,970</td>
<td>1,088</td>
</tr>
<tr>
<td>75 to 84</td>
<td>1,348,062</td>
<td>1,695,677</td>
<td>1,225</td>
</tr>
<tr>
<td>85+</td>
<td>419,226</td>
<td>818,641</td>
<td>665</td>
</tr>
</tbody>
</table>

Table S6b: * FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.

Time to onset of MSSA bacteraemias

In 2011/12 and 2012/13 the median number of days to the onset of MSSA bacteraemia among inpatients at NHS acute Trusts, whose date of specimen was on or after the date of admission was 1 (IQR:0-6) days. For both 2013/14 and 2014/15 the median number of days between date of admission and date of specimen has been 0 (IQR: 0-5) days.

Figure S7 shows the distribution of time to onset of MSSA bacteraemia. For the four financial years that MSSA has been part of the mandatory surveillance scheme, the majority of infections have been detected within 2 days of hospital admission and the number of cases detected within 2 days of hospital admission has increased slightly from 4,373 cases (60.5%) in 2011/12 to 4,730 (62.9%) in 2014/15.
Figure S7: Data from inpatients (defined as inpatients, day patients and patients in emergency assessment) from an NHS acute Trust only where the location when the positive specimen was taken was in an acute Trust, where the date of specimen was on or after the date of admission.

Source of MSSA bacteraemia

The source of bacteraemia is a non-mandatory field and the percentage completion is variable. In 2011/12, 37.7% of all MSSA bacteraemias reported to the mandatory surveillance scheme had this field completed, while in 2014/15 this had reduced to 34.4% of infection reports.

Like MRSA bacteraemia, over the four financial years of data for MSSA bacteraemias included in this report, there have been two main known sources of bacteraemia; SSTI and catheters/indwelling lines. These two sources of bacteraemia have accounted for approximately 35% of all MSSA bacteraemias with an attributed source between 2011/12 and 2014/15.

As seen with MRSA, there has been a reduction in the percentage of MSSA bacteraemias associated with catheters and indwelling lines from 17.1% of all MSSA bacteraemias with a reported source of infection in 2011/12 to 13.2% in 2014/15, representing a 23.1% reduction. There have been slight increases in the percentage of MSSA bacteraemias associated with SSTIs, unknown sources and other sources. SSTIs account for roughly one-fifth of all MSSA bacteraemias (20.3% in 2011/12 and 20.7% in 2014/15). Within the “other” sources of MSSA bacteraemia reported, large percent increases
have been seen in endocarditis (51.1% increase) and pneumonia (51.3% increase) associated MSSA bacteraemias, although they each still account for a low percentage of MSSA bacteraemias with an attributed source overall (5.4% and 9.0%, respectively).

**Table S7: Distribution of reported sources of MSSA bacteraemia, 2011/12 to 2014/15**

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Catheters &amp; Lines N (%)*</th>
<th>SSTI N (%)*</th>
<th>Other N (%)*</th>
<th>Unknown N (%)*</th>
<th>Total N (%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011/12</td>
<td>565 (17.1)</td>
<td>670 (20.3)</td>
<td>1,290 (39.0)</td>
<td>780 (23.6)</td>
<td>3,305 (100)</td>
</tr>
<tr>
<td>2012/13</td>
<td>492 (15.1)</td>
<td>699 (21.4)</td>
<td>1,320 (40.4)</td>
<td>755 (23.1)</td>
<td>3,266 (100)</td>
</tr>
<tr>
<td>2013/14</td>
<td>435 (13.4)</td>
<td>684 (21.1)</td>
<td>1,342 (41.5)</td>
<td>775 (23.9)</td>
<td>3,236 (100)</td>
</tr>
<tr>
<td>2014/15</td>
<td>445 (13.2)</td>
<td>701 (20.7)</td>
<td>1,387 (41.0)</td>
<td>850 (25.1)</td>
<td>3,383 (100)</td>
</tr>
</tbody>
</table>

**Table S7:** Percentages are row percentages.
“Catheters and lines” includes the following options from the mandatory surveillance system question options for source of bacteraemia dialysis lines, CVC associated, PVC associated and IV lines.
“Other” includes the following options for the mandatory surveillance system question options for source of bacteraemia: endocarditis, osteomyelitis, other, pneumonia, prosthetic joint, SSI, septic arthritis, UTI and ventilator-associated pneumonia.

Differences in the source of bacteraemia between male and female infection reports was investigated for the oldest (≥75 years) and youngest (<1 year) age groups. Unlike MRSA, no significant differences were identified for either age group.

**Geographic distribution of MSSA bacteraemias**

Similar to MRSA bacteraemia rates, there is regional variation in MSSA bacteraemia rates for 2014/15 with a range from 14.9 per 100,000 in Essex AT and East Anglia AT to 28.6 per 100,000 in Merseyside AT (see Figure S8). There were 10 AT with an MSSA rate ≥18.9 per 100,000 population (Cheshire, Warrington and Wirral AT, Durham, Darlington and Tees AT, Lancashire AT, Merseyside AT, Cumbria, Northumberland, Tyne and Wear AT, North Yorkshire and Humber AT, South Yorkshire and Bassetlaw AT, Derbyshire and Nottinghamshire AT, Shropshire and Staffordshire AT and Devon Cornwall and Isles of Scilly AT) and four with ≤15.6 per 100,000 population (East Anglia AT, Essex AT, Leicestershire and Lincolnshire AT and London AT).

**Table S8** shows the region-specific rates of MSSA bacteraemia for 2011/12 to 2014/15. The AT with the lowest reported MSSA bacteraemia rate in 2011/12 was Thames Valley (13.3 per 100,000 population) and the highest was Merseyside (23.9 per 100,000 population).
Nationally, England has had a 10.5% increase in the rate of MSSA bacteraemias between 2011/12 and 2014/15. The majority of ATs have also experienced an increase in their MSSA bacteraemias rates over the same time period, however, four ATs have seen an overall decline in their MSSA bacteraemia rates (South Yorkshire and Bassetlaw AT, West Yorkshire AT, Birmingham and the Black Country AT and Leicestershire and Lincolnshire AT), although this was not sustained throughout the four financial years.

Figure S8: MSSA bacteraemia rates per 100,000 population by NHS England Area Team, 2014/15*

Figure S8:◊ Please see Table S8 for key between Area Team codes and Area Team names.

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.
Table S8: Region-specific rates of MSSA bacteraemia in England, 2011/12 to 2014/15, per 100,000 population

<table>
<thead>
<tr>
<th>Code</th>
<th>NHS Commissioning Board Area Team (AT)</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>2014/15*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q44</td>
<td>Cheshire, Warrington and Wirral Area Team</td>
<td>17.7</td>
<td>19.1</td>
<td>18.3</td>
<td>20.7</td>
</tr>
<tr>
<td>Q45</td>
<td>Durham, Darlington and Tees Area Team</td>
<td>15.7</td>
<td>16.0</td>
<td>20.2</td>
<td>19.9</td>
</tr>
<tr>
<td>Q46</td>
<td>Greater Manchester Area Team</td>
<td>16.3</td>
<td>18.3</td>
<td>19.3</td>
<td>17.3</td>
</tr>
<tr>
<td>Q47</td>
<td>Lancashire Area Team</td>
<td>18.3</td>
<td>21.2</td>
<td>20.7</td>
<td>23.2</td>
</tr>
<tr>
<td>Q48</td>
<td>Merseyside Area Team</td>
<td>23.9</td>
<td>21.4</td>
<td>24.2</td>
<td>28.6</td>
</tr>
<tr>
<td>Q49</td>
<td>Cumbria, Northumberland, Tyne and Wear Area Team</td>
<td>17.8</td>
<td>18.4</td>
<td>19.9</td>
<td>19.5</td>
</tr>
<tr>
<td>Q50</td>
<td>North Yorkshire and Humber Area Team</td>
<td>19.5</td>
<td>19.8</td>
<td>22.1</td>
<td>23.1</td>
</tr>
<tr>
<td>Q51</td>
<td>South Yorkshire and Bassetlaw Area Team</td>
<td>23.1</td>
<td>20.5</td>
<td>21.3</td>
<td>19.6</td>
</tr>
<tr>
<td>Q52</td>
<td>West Yorkshire Area Team</td>
<td>20.3</td>
<td>18.0</td>
<td>18.2</td>
<td>18.8</td>
</tr>
<tr>
<td>Q53</td>
<td>Arden, Herefordshire and Worcestershire Area Team</td>
<td>15.3</td>
<td>15.8</td>
<td>16.7</td>
<td>16.2</td>
</tr>
<tr>
<td>Q54</td>
<td>Birmingham and the Black Country Area Team</td>
<td>18.6</td>
<td>17.1</td>
<td>18.3</td>
<td>18.4</td>
</tr>
<tr>
<td>Q55</td>
<td>Derbyshire and Nottinghamshire Area Team</td>
<td>19.9</td>
<td>20.4</td>
<td>20.2</td>
<td>23.3</td>
</tr>
<tr>
<td>Q56</td>
<td>East Anglia Area Team</td>
<td>14.0</td>
<td>13.0</td>
<td>14.5</td>
<td>14.9</td>
</tr>
<tr>
<td>Q57</td>
<td>Essex Area Team</td>
<td>14.1</td>
<td>13.3</td>
<td>12.9</td>
<td>14.9</td>
</tr>
<tr>
<td>Q58</td>
<td>Hertfordshire and The South Midlands Area Team</td>
<td>14.3</td>
<td>14.5</td>
<td>13.5</td>
<td>16.3</td>
</tr>
<tr>
<td>Q59</td>
<td>Leicestershire and Lincolnshire Area Team</td>
<td>17.2</td>
<td>14.7</td>
<td>13.4</td>
<td>15.5</td>
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<tr>
<td>Q60</td>
<td>Shropshire and Staffordshire Area Team</td>
<td>15.5</td>
<td>18.2</td>
<td>17.9</td>
<td>19.4</td>
</tr>
<tr>
<td>Q64</td>
<td>Bath, Gloucestershire, Swindon and Wiltshire Area Team</td>
<td>14.8</td>
<td>15.3</td>
<td>17.2</td>
<td>17.2</td>
</tr>
<tr>
<td>Q65</td>
<td>Bristol, North Somerset, Somerset and South Gloucestershire Area Team</td>
<td>16.8</td>
<td>14.3</td>
<td>15.5</td>
<td>18.5</td>
</tr>
<tr>
<td>Q66</td>
<td>Devon, Cornwall and Isles Of Scilly Area Team</td>
<td>19.7</td>
<td>17.4</td>
<td>20.9</td>
<td>23.0</td>
</tr>
<tr>
<td>Q67</td>
<td>Kent and Medway Area Team</td>
<td>14.0</td>
<td>16.0</td>
<td>16.0</td>
<td>18.3</td>
</tr>
<tr>
<td>Q68</td>
<td>Surrey and Sussex Area Team</td>
<td>13.8</td>
<td>14.0</td>
<td>15.2</td>
<td>17.0</td>
</tr>
<tr>
<td>Q69</td>
<td>Thames Valley Area Team</td>
<td>13.3</td>
<td>13.1</td>
<td>15.3</td>
<td>18.7</td>
</tr>
<tr>
<td>Q70</td>
<td>Wessex Area Team</td>
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<td>15.6</td>
<td>16.7</td>
<td>18.1</td>
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<tr>
<td>Q71</td>
<td>London Area Team</td>
<td>14.7</td>
<td>15.5</td>
<td>15.7</td>
<td>15.2</td>
</tr>
</tbody>
</table>

Table S8: In 2012/13 1 MSSA bacteraemia was mapped to a Specialised Commissioning hub; in 2013/14 there were 5 cases mapped to a Specialised Commissioning hub and in 2014/15 there were 6 cases mapped to a CCG hub. These reports were excluded from the regional analyses as Specialised Commissioning hubs are national-level organisations.

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.
Discussion: MSSA bacteraemia reports in England

Since the initiation of the mandatory surveillance of MSSA bacteraemias in England, we have seen an increase in the number of reports, with an overall 12.1% increase between 2011/12 and 2014/15. The year-on-year increase is itself increasing, between 2011/12 and 2012/13, there was an annual increase of only 0.5%, from 8,767 to 8,812; however, between 2012/13 and 2013/14 there was a 5.4% increase to 9,290 cases, and an increase of 5.8% between 2013/14 and 2014/15. While the majority of MSSA bacteraemias are not Trust apportioned, the number of Trust apportioned MSSA bacteraemias has decreased by 2.1% since 2011/12. However, the first annual increase in Trust apportioned MSSA bacteraemias was observed between 2013/14 and 2014/15. Reasons for the increase in the total number of MSSA bacteraemias, particularly among infections not traditionally considered to be hospital-onset, are unknown and will require further investigation in order to best guide interventions.

Approximately half of all MSSA bacteraemias are among those aged ≥65 years; however, the highest rates are seen in the very young (infants <1 year) or the elderly (≥75 years old). The highest rate among both males and females in 2014/15 was in those ≥85 years of age (158.6 and 69.6 per 100,000 population, respectively). Rates are generally higher among men than women, with men aged ≥45 years old experiencing twice the rate of MSSA bacteraemias than women of the same age.

Like MRSA, differences in the source of bacteraemia and time to onset among males and females were investigated, although no significant differences were found; therefore, reasons for the disparity between males and females requires further investigation, as does the high rates seen in the very young (<1 year old).

Since 2011/12, there has been a reduction in the percentage of MSSA bacteraemias associated with catheters/lines from 17.1% to 13.2%. Similarly to MRSA bacteraemias, one-fifth of infections with an attributed source of infection were associated with SSTIs. The percentage of MSSA reports with the source of bacteraemia data completed is low, about 35% in 2014/15. Like MRSA, conclusions based on a field with low completion needs to be viewed with caution. MSSA bacteraemia reports with source of bacteraemia data may not be representative of all bacteraemia reports, this is of particular concern if the cases without source of bacteraemia data were different to those with this data completed. Of the 153 NHS Trusts who reported an MSSA bacteraemia in 2014/15, 55 (40.0%) never completed the source of bacteraemia field, while 18 (11.8%) always completed this field. Better
completion should be encouraged, in order to allow further investigations into observed disparities and trends over time, to make the best use of this surveillance data in identifying targets for interventions.

Regional variations were present across England in 2014/15, with the highest rates of MSSA bacteraemia seen in the North and the South Western tip of the country. The majority of Area Teams experienced an increase in their MSSA bacteraemia rates over time; however, a few have seen reductions between 2013/14 and 2014/15. Reasons for these variations are not known and will require further exploration if the majority of Area Teams experience further increases in their infection rates.

Discussion: S. aureus bacteraemias

Overall, since MSSA bacteraemias were included in the mandatory surveillance scheme the number of S. aureus bacteraemias has increased from 9,883 in 2011/12 to 10,628 in 2014/15. The vast majority of the S. aureus bacteraemias are caused by meticillin susceptible S. aureus, in fact, in 2014/15 92.5% of all S. aureus bacteraemias were MSSA bacteraemias, this is due to the continued year-on-year decline in MRSA bacteraemias and year-on-year increase in MSSA bacteraemias.

There are several differences in the epidemiology of MRSA and MSSA bacteraemias in England, the key one in terms of prevention until recently, was that a greater percentage of MRSA bacteraemias would be traditionally defined as hospital-onset than of MSSA bacteraemias. In 2014/15, 49.3% of inpatient MRSA bacteraemias occurred ≥2 days post-admission compared to 37.1% of MSSA bacteraemias among inpatients. This equates to 64.2% of all MRSA bacteraemias and 71.6% of all MSSA bacteraemias in 2014/15 that would traditionally have been defined as non-hospital-onset.

Historically, interventions to combat MRSA bacteraemias and other HCAI in England have been hospital based. These include the Cleanyourhands campaign (2004-2008) (13, 14), high-impact interventions or ‘care bundles’ as part of the Saving Lives initiative launched by the Department of Health (first introduced in 2005), such as the central venous catheter care bundle(15), and screening of inpatients for MRSA upon admission and decolonisation of those found to have MRSA carriage (16), which have been associated with a reduction in MRSA bacteraemias in England (14, 17). However, they have not been associated with a similar decline in MSSA bacteraemias (14, 17), which is also evidenced by the annual increases of MSSA bacteraemias.
Catheter/indwelling line associated bacteraemias accounted for a lower percentage of MRSA bacteramieas than MSSA bacteraemias with a reported source in 2014/15 (MRSA: 11.9% vs. MSSA: 13.2%). Furthermore, in 2014/15, approximately one in five of both MRSA and MSSA bacteraemias are associated with a skin and soft tissue infection. As a greater percentage of S. aureus bacteraemias are non-hospital onset cases and a reduced number are associated with catheters and indwelling lines, hospital-based interventions may have a reduced impact on the total number of S. aureus bacteraemias going forward. To achieve further reductions in MRSA bacteraemia reports and in order to combat the growing number of MSSA bacteraemia reports, new interventions focussed on the wider health economy will be required. In order to best identify targets for interventions and to design preventative tools, both better ascertainmement of the source of MRSA and MSSA bacteraemias will be required as well as improved understanding of the interactions patients may have had with healthcare facilities prior to the detection of their S. aureus bacteraemia.

In addition to the similarities in reported known source of bacteraemias in 2014/15, the gender distribution of patients with MRSA and MSSA bacteraemias is also similar; however, there are differences in both the age distribution (a greater percentage of MSSA bacteramias occur in children aged 0-14 years than MRSA bacteraemias, especially among those aged <1 year) and in regional variation (only one Area Team is in the five Area Teams with the highest rates of both MRSA and MSSA (Merseyside Area Team)), indicating that future prevention and control mechanisms for MRSA and MSSA bacteraemias may not yet be totally aligned. Research on the next step for both of these infections is required.
Epidemiological analyses of *Escherichia coli* (*E. coli*) bacteraemia

**Total reports**

A total of 35,676 cases of *E. coli* bacteraemia were reported across the NHS between 1 April 2014 and 31 March 2015 (2014/15). This represents an increase of 4.1% on the number of cases in 2013/14 when 34,275 cases were reported and an overall 10.4% increase from 2012/13 (when there were 32,309 cases), which was the first full financial year of mandatory surveillance data on *E. coli* bacteraemias, Table S9. It can be seen in Figure S9 that the associated national rate also increased from 60.4 to 66.2 cases per 100,000 population over this time period.

While there are currently only three full financial years’ worth of data on *E. coli* bacteraemias in England, in Figure S9b the rate of *E. coli* bacteraemias has been put in context, plotted with the all reports rate for total for *S. aureus* bacteraemias in England. Figure S9b starkly shows that the rate of *E. coli* bacteraemia in England is much greater that the rate of MRSA and MSSA bacteraemias combined for 2012/13 to 2014/15. In addition, the percentage increase of the *E. coli* bacteraemia rate between 2012/13 and 2014/15 (9.7%) was greater than that for *S. aureus* bacteraemias (8.4%).

**Table S9: *E. coli* bacteraemia counts and rates by financial year, England: 2012/13 – 2014/15**

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported rate (per 100,000 population)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012/13</td>
<td>53,493,729</td>
<td>32,309</td>
<td>60.4</td>
</tr>
<tr>
<td>2013/14</td>
<td>53,865,817</td>
<td>34,275</td>
<td>63.6</td>
</tr>
<tr>
<td>2014/15*</td>
<td>53,865,817</td>
<td>35,676</td>
<td>66.2</td>
</tr>
</tbody>
</table>

*Table S9: * FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.*
Figure S9: Rates of *E. coli* bacteraemia (2012/13 to 2014/15)

S9a: Rate of *E. coli* bacteraemia

S9b: Rate of *E. coli* bacteraemia in context: with total *S. aureus* bacteraemia

Figure S9: * FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.

Age and sex distribution

For all age-gender analyses, those cases with a missing or unknown gender were removed from the analyses. For 2012/13 there were 815 reports with “Unknown” gender (2.5% of 32,309 reported *E. coli* bacteraemias) and in 2014/15, there were 811 of 35,676 (2.3%) reports denoted as “Unknown” gender.

Figure S10 shows the rates for *E. coli* per 100,000 population by age and gender for (a) 2012/13 and (b) 2014/15. The highest rates in both financial years are among those ≥85 years old for both men and women (2012/13: 722.2 per 100,000 population and 481.8 per 100,000 population, respectively; 2014/15: 809.3 per 100,000 population and 535.6 per 100,000 population, respectively). Similar to MSSA bacteraemias, there was also a high rate among males and females <1 year old and 65 to 84 years old for both 2012/13 and 2014/15, see Table S10. However, unlike both MRSA and MSSA, where the rates of bacteraemias tend to be higher among men than women in all age groups, in both 2012/13 and 2014/15 females aged 1 to 44 years old had a higher rate of *E. coli* bacteraemia than males of the same age. This was most apparent among 15 to 44 year olds; females had three-fold the rate of *E. coli* bacteraemias than males in the same age category.
The rates of *E. coli* bacteraemia have increased in all age and gender groups between 2012/13 and 2014/15, except for 1 to 14 year old females (3.2 per 100,000 to 3.1 per 100,000). The greatest percentage increase in any age-gender group was seen among 1 to 14 year old males, whose rate increased by 29.2% between 2012/13 and 2014/15 (from 1.8 per 100,000 to 2.3 per 100,000, respectively).

**Time to onset**

In 2012/13 and 2013/14 the median number of days to the onset of *E. coli* bacteraemia among inpatients, defined as the difference between the date the positive specimen was taken and the date of admission, was 0 (IQR: 0-3) days, while for 2014/15 the median was 0 (IQR: 0-2) days.

Figure S11 shows the distribution of the time to onset of *E. coli* bacteraemia among inpatients at acute Trusts by financial year. For 2014/15 72.3% of *E. coli* bacteraemias were detected <2 days after hospital admission, 8.8% were detected between 2 and 6 days after hospital admission and 18.9% ≥7 days post-hospital admission. While the distribution of time to onset over time appears to have changed only slightly over the three full financial years for which *E. coli* bacteraemias have been included in the mandatory surveillance scheme, the increase in percentage of bacteraemias detected <2 days among inpatients and corresponding decrease in the percentage detected between 2 and 6 days and ≥7 days, is statistically significant (P<0.001).
**Figure S10: Age- and sex- specific E. coli bacteraemia rates per 100,000 population, England**

**Fig. S10a. 2012/13**

**Fig. S10b. 2014/15*"}

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.

**Table S10: E. coli counts and rates by age group and gender**

**S10a. 2012/13**

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported case rate (per 100,000 population)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>&lt;1</td>
<td>356,779</td>
<td>339,662</td>
<td>306</td>
</tr>
<tr>
<td>1 to 14</td>
<td>4,498,464</td>
<td>4,289,904</td>
<td>81</td>
</tr>
<tr>
<td>15 to 44</td>
<td>10,751,201</td>
<td>10,689,519</td>
<td>712</td>
</tr>
<tr>
<td>45 to 64</td>
<td>6,673,866</td>
<td>6,837,826</td>
<td>2,944</td>
</tr>
<tr>
<td>65 to 74</td>
<td>2,331,158</td>
<td>2,513,332</td>
<td>3,520</td>
</tr>
<tr>
<td>75 to 84</td>
<td>1,315,285</td>
<td>1,676,227</td>
<td>4,577</td>
</tr>
<tr>
<td>85+</td>
<td>406,695</td>
<td>813,811</td>
<td>2,937</td>
</tr>
</tbody>
</table>

**S10b. 2014/15*”**

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported case rate (per 100,000 population)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>&lt;1</td>
<td>347,291</td>
<td>329,240</td>
<td>339</td>
</tr>
<tr>
<td>1 to 14</td>
<td>4,557,238</td>
<td>4,344,673</td>
<td>106</td>
</tr>
<tr>
<td>15 to 44</td>
<td>10,731,434</td>
<td>10,653,480</td>
<td>706</td>
</tr>
<tr>
<td>45 to 64</td>
<td>6,712,115</td>
<td>6,885,167</td>
<td>3,167</td>
</tr>
<tr>
<td>65 to 74</td>
<td>2,418,603</td>
<td>2,604,970</td>
<td>3,813</td>
</tr>
<tr>
<td>75 to 84</td>
<td>1,348,062</td>
<td>1,695,677</td>
<td>5,218</td>
</tr>
<tr>
<td>85+</td>
<td>419,226</td>
<td>818,641</td>
<td>3,393</td>
</tr>
</tbody>
</table>

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.
Primary focus of bacteraemia

The primary focus (source) of the bacteraemia is a non-mandatory field and the completion is variable. In 2012/13, 85.5% of *E. coli* bacteraemias reported to the mandatory surveillance scheme had this field completed, while in 2014/15 this had declined to 80.4% of infection reports.

The key sources of *E. coli* bacteraemia differ to those associated with both MSSA and MRSA bacteraemias, where SSTIs and catheters/lines play an important role. For *E. coli* bacteraemia the top three known sources of bacteraemia are urinary tract infections (UTIs), gastrointestinal (excluding hepatobiliary) and hepatobiliary infections, see Table S11. While there has been little change in the distribution of most of the sources of bacteraemia between 2012/13 and 2014/15, there has been some change. While the most prevalent source of *E. coli* bacteraemia has been UTI for all three financial years, the percentage has declined over time from 48.9% in 2012/13 to 45.6% in 2014/15, with a corresponding increase in the source of infection reported as unknown, from 20.2% in 2012/13 to 25.2% in 2014/15 (p<0.001).

When the source of bacteraemia is stratified by the different time to onset categories among hospital inpatients (<2 days vs. ≥2 days post-hospital admission), this difference in distributions in more obvious, see Figure S12. Among hospitalised patients whose *E. coli* bacteraemia was detected within 2
days of admission; 48.1% were associated with a UTI versus 36.6% among patients whose *E. coli* bacteraemia was detected ≥2 days post-hospital admission. In contrast, the percentage of *E. coli* bacteraemias detected ≥2 days post-hospital admission associated with gastrointestinal issues and “other” causes is higher than among patients whose *E. coli* bacteraemia was detected <2 days post-hospital admission.

Table S11: Distribution of reported sources of *E. coli* bacteraemia, 2012/13 to 2014/15

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Gastrointestinal (not hepatobiliary) N (%)*</th>
<th>Hepatobiliary N (%)*</th>
<th>UTI N (%)*</th>
<th>Other N (%)*</th>
<th>Unknown N (%)*</th>
<th>Total N (%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012/13</td>
<td>1,782 (6.5)</td>
<td>3,756 (13.6)</td>
<td>13,501 (48.9)</td>
<td>2,986 (10.8)</td>
<td>5,585 (20.2)</td>
<td>27,610 (100)</td>
</tr>
<tr>
<td>2013/14</td>
<td>1,711 (6.0)</td>
<td>3,855 (13.6)</td>
<td>13,390 (47.3)</td>
<td>2,888 (10.2)</td>
<td>6,451 (22.8)</td>
<td>28,295 (100)</td>
</tr>
<tr>
<td>2014/15</td>
<td>1,637 (5.7)</td>
<td>3,807 (13.3)</td>
<td>13,060 (45.6)</td>
<td>2,943 (10.3)</td>
<td>7,219 (25.2)</td>
<td>28,666 (100)</td>
</tr>
</tbody>
</table>

Table S11: *Percentages are row percentages. “Other” includes the following options for the mandatory surveillance system question options for source of bacteraemia: bone & joint, central nervous system, genital tract, IV device, no clinical sign of bacteraemia, respiratory tract, SSTI and other.

Figure S12: Distribution of reported sources of *E. coli* bacteraemia among inpatients, 2014/15

Fig. S12a. Detection of bacteraemia <2 days post-admission

Fig. S12b. Detection of bacteraemia ≥2 days post-admission
Geographic distribution

As with the *Staphylococcus aureus* bacteraemia rates, there was regional variation in *E. coli* bacteraemia rates for 2014/15 with a range from 56.0 per 100,000 population in Bath, Gloucestershire, Swindon and Wiltshire AT to 94.9 per 100,000 population in Merseyside (see Figure S13). There were eight ATs with an *E. coli* bacteraemia rate ≥71.6 per 100,000 population (Durham, Darlington and Tees AT, Lancashire AT, Merseyside AT, Cumbria, Northumberland, Tyne and Wear AT, North Yorkshire and Humber AT, South Yorkshire and Bassetlaw AT and Derbyshire and Nottinghamshire AT) but there were seven with ≤60.0 per 100,000 population (East Anglia AT, Essex Area Team, Hertfordshire and The South Midlands AT, Bath, Gloucestershire, Swindon and Wiltshire AT, Surrey and Sussex AT, Thames Valley AT and London AT).

Table S12 shows the region-specific rates of *E. coli* bacteraemia for 2012/13 to 2014/15. As for 2012/13 and 2013/14, the AT with the lowest reported *E. coli* bacteraemia rate in 2014/15 was Bath, Gloucestershire, Swindon and Wiltshire (56.0 per 100,000 population) and the highest was Merseyside (94.9 per 100,000 population).

Nationally, there has been an increase in the overall rate of *E. coli* bacteraemias between 2012/13 and 2014/15. As such, the majority of ATs have also experienced an increase in their *E. coli* bacteraemias rates over the same time period; however, three have experienced a decrease between 2013/14 and 2014/15 (Greater Manchester AT, Merseyside AT and North Yorkshire and Humber AT) and one AT has seen a decrease between their rate in 2012/13 and 2014/15; Greater Manchester AT, from 66.0 per 100,000 in 2012/13 to 63.8 per 100,000 in 2014/15.
Figure S13: *E. coli* bacteraemia rates per 100,000 population by NHS England Area Team*, 2014/15*

Please see Table S12 for key between Area Team codes and Area Team names.

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.

▲ Data for Q44 (Cheshire, Warrington and Wirral AT) is unavailable as the data for the AT is incomplete. This is because for the period FY 2012/13 to FY 2014/15, Wirral University Teaching Hospital NHS Foundation Trust have only entered data on *E. coli* bacteraemia for April 2013 to February 2014 inclusive. Therefore, the rates of *E. coli* bacteraemia Cheshire, Warrington and Wirral AT will be an underestimate and as such cannot be considered as in line with other ATs in England. In addition, 1 case reported by Wirral University Teaching Hospital NHS Foundation Trust was attributed to a CCG within the East Anglia AT in 2013/14 and so this has also been removed from the above table. Investigations as to why Wirral University Teaching Hospital NHS Foundation Trust have not reported any *E. coli* bacteraemias for both 2012/13 and 2014/15 are currently underway.
### Table S12: Region-specific rates of *E. coli* bacteraemia in England, 2012/13 to 2014/15, per 100,000 population

<table>
<thead>
<tr>
<th>Code</th>
<th>NHS Commissioning Board Area Team (AT)</th>
<th>2012/13</th>
<th>2013/14</th>
<th>2014/15*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q44</td>
<td>Cheshire, Warrington and Wirral Area Team ▲</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Q45</td>
<td>Durham, Darlington and Tees Area Team</td>
<td>77.0</td>
<td>72.6</td>
<td>78.0</td>
</tr>
<tr>
<td>Q46</td>
<td>Greater Manchester Area Team</td>
<td>66.0</td>
<td>66.6</td>
<td>63.8</td>
</tr>
<tr>
<td>Q47</td>
<td>Lancashire Area Team</td>
<td>67.8</td>
<td>70.6</td>
<td>76.7</td>
</tr>
<tr>
<td>Q48</td>
<td>Merseyside Area Team</td>
<td>87.4</td>
<td>97.0</td>
<td>94.9</td>
</tr>
<tr>
<td>Q49</td>
<td>Cumbria, Northumberland, Tyne and Wear Area Team</td>
<td>75.4</td>
<td>74.4</td>
<td>83.8</td>
</tr>
<tr>
<td>Q50</td>
<td>North Yorkshire and Humber Area Team</td>
<td>72.9</td>
<td>78.5</td>
<td>77.8</td>
</tr>
<tr>
<td>Q51</td>
<td>South Yorkshire and Bassetlaw Area Team</td>
<td>79.0</td>
<td>80.2</td>
<td>85.3</td>
</tr>
<tr>
<td>Q52</td>
<td>West Yorkshire Area Team</td>
<td>65.5</td>
<td>65.7</td>
<td>68.6</td>
</tr>
<tr>
<td>Q53</td>
<td>Arden, Herefordshire and Worcestershire Area Team</td>
<td>55.7</td>
<td>57.6</td>
<td>65.1</td>
</tr>
<tr>
<td>Q54</td>
<td>Birmingham and the Black Country Area Team</td>
<td>64.0</td>
<td>66.0</td>
<td>68.1</td>
</tr>
<tr>
<td>Q55</td>
<td>Derbyshire and Nottinghamshire Area Team</td>
<td>80.6</td>
<td>87.2</td>
<td>92.3</td>
</tr>
<tr>
<td>Q56</td>
<td>East Anglia Area Team</td>
<td>50.8</td>
<td>54.3</td>
<td>58.0</td>
</tr>
<tr>
<td>Q57</td>
<td>Essex Area Team</td>
<td>53.7</td>
<td>57.4</td>
<td>58.4</td>
</tr>
<tr>
<td>Q58</td>
<td>Hertfordshire and The South Midlands Area Team</td>
<td>51.1</td>
<td>55.8</td>
<td>59.7</td>
</tr>
<tr>
<td>Q59</td>
<td>Leicestershire and Lincolnshire Area Team</td>
<td>63.6</td>
<td>63.8</td>
<td>66.5</td>
</tr>
<tr>
<td>Q60</td>
<td>Shropshire and Staffordshire Area Team</td>
<td>62.2</td>
<td>69.7</td>
<td>71.5</td>
</tr>
<tr>
<td>Q64</td>
<td>Bath, Gloucestershire, Swindon and Wiltshire Area Team</td>
<td>48.3</td>
<td>47.8</td>
<td>56.0</td>
</tr>
<tr>
<td>Q65</td>
<td>Bristol, North Somerset, Somerset and South Gloucestershire Area Team</td>
<td>55.6</td>
<td>58.9</td>
<td>61.8</td>
</tr>
<tr>
<td>Q66</td>
<td>Devon, Cornwall and Isles Of Scilly Area Team</td>
<td>55.2</td>
<td>60.2</td>
<td>64.4</td>
</tr>
<tr>
<td>Q67</td>
<td>Kent and Medway Area Team</td>
<td>58.5</td>
<td>65.6</td>
<td>68.3</td>
</tr>
<tr>
<td>Q68</td>
<td>Surrey and Sussex Area Team</td>
<td>57.3</td>
<td>59.7</td>
<td>60.0</td>
</tr>
<tr>
<td>Q69</td>
<td>Thames Valley Area Team</td>
<td>50.6</td>
<td>54.1</td>
<td>56.3</td>
</tr>
<tr>
<td>Q70</td>
<td>Wessex Area Team</td>
<td>50.4</td>
<td>53.1</td>
<td>61.3</td>
</tr>
<tr>
<td>Q71</td>
<td>London Area Team</td>
<td>53.2</td>
<td>55.9</td>
<td>57.3</td>
</tr>
</tbody>
</table>

Data for Q44 (Cheshire, Warrington and Wirral AT) is unavailable as the data for the AT is incomplete. This is because for the period FY 2012/13 to FY 2014/15, Wirral University Teaching Hospital NHS Foundation Trust have only entered data on *E. coli* bacteraemia for April 2013 to February 2014 inclusive. Therefore, the rates of *E. coli* bacteraemia Cheshire, Warrington and Wirral AT will be an underestimate and as such cannot be considered as in line with other ATs in England. In addition, 1 case reported by Wirral University Teaching Hospital was attributed to a CCG within the East Anglia AT in 2013/14 and so this has also been removed from the above table. Investigations as to why Wirral University Teaching Hospital NHS Foundation Trust have not reported any *E. coli* bacteraemias for both 2012/13 and 2014/15 are currently underway. Investigations as to why Wirral University Teaching Hospital NHS Foundation Trust have not reported any *E. coli* bacteraemias for both 2012/13 and 2014/15 are currently underway. * E. coli* bacteraemias were excluded from the regional analyses as they were attributed to a CCG hub: 2 in 2012/13, 4 in 2013/14 and 9 in 2014/15.

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.
Discussion

*E. coli* bacteraemias were added to the PHE enhanced mandatory surveillance scheme in June 2011, after a sustained increase in *E. coli* bacteraemia cases was observed through the voluntary surveillance scheme from the early 2000’s. The mandatory scheme sought to increase levels of ascertainment, providing more robust estimates of *E. coli* and to collect additional epidemiological data to guide potential interventions. We have seen a greater number of cases reported to the mandatory surveillance scheme than in the voluntary scheme (circa 20% more cases captured via the mandatory scheme), as well as continued increases of *E. coli* bacteraemia in both surveillance schemes, with a total of 35,676 *E. coli* bacteraemias seen across England in 2014/15, with an associated rate of 66.23 per 100,000 population.

Half of all *E. coli* bacteraemias are seen in patients aged ≥75 years. The highest rates are also observed in older patients (≥85 years), for both men and women; however, there is also a high rate of *E. coli* bacteraemia seen in those <1 year old. Between 2012/13 and 2014/15, men have a higher rate of infection than women in the older age groups (≥65 years); however, unlike the *S. aureus* bacteraemias, women have a higher (up to three-fold) rate of infection than men among 1-44 year olds.

Regional variation was observed in 2014/15; all of the Area Teams with the highest rates of infection were located in the North of England. Between 2012/13 and 2014/15, the majority of Area Teams experienced increases in their rates of *E. coli* bacteraemias, similar to the national picture; however, three experienced decreases between 2013/14 and 2014/15. These data are based on only three years of data and natural fluctuations do occur. Regional rates will need to be monitored over the coming years to see if these variations warrant further examination.

The source of bacteraemia data for *E. coli* bacteraemia is much better completed than that for MRSA and MSSA bacteraemias, 80% versus 32-34%. Overall, approximately half of *E. coli* bacteraemias with a reported source of infection were associated with UTIs, although this differed when stratified by time to onset of bacteraemia.

Currently *E. coli* bacteraemia cases do not undergo Trust apportioning (a suitable cut off point - with respect to the number of days after a hospital admission among inpatients - has yet to be identified, work is; however, underway in order to establish this cut off point), but using time of onset data among hospital inpatients as a proxy for infections that were likely hospital-
onset (ie detection of bacteraemia ≥2 days post-hospital admission among inpatients), the vast majority of *E. coli* bacteraemias would not be defined as hospital-onset. However, due to the high prevalence of *E. coli* bacteraemia, this still equates to large numbers of *E. coli* cases manifesting in the hospital setting, circa 7,500 a year, which could potentially be prevented.
Epidemiological analyses on *Clostridium difficile* infection

**Total reports**

A total of 14,165 cases of *C. difficile* infection were reported across the NHS between April 2014 and March 2015 (2014/15). This represents a 6.0% increase compared to the number of cases reported in 2013/14 when 13,361 cases were reported. This is the first annual increase in *C. difficile* infections since the enhanced mandatory surveillance of *C. difficile* infections was initiated in 2007. The 2014/15 data is not yet at 2012/13 levels and even with the recent increase in 2014/15 there remains a 74.5% overall reduction in the number *C. difficile* infections between 2007/08 and 2014/15 (from 55,498 in 2007/08) (Table S13). It can be seen in Figure S14a that the associated national rate decreased from 108.0 in 2007/08 to 24.8 cases per 100,000 population in 2013/14, with a slight increase in the rate to 26.3 per 100,000 in 2014/15.

Comparing 2013/14 and 2014/15 *C. difficile* infection data in more detail with respect to time period, all four quarters in 2014/15 had a greater number of reported *C. difficile* infections than the corresponding quarters in 2013/14, although April-June 2014 (n=3,440) and October-December 2014 (n=3,366) were within 2% of April-June 2013 (3,386) and October-December 2013 (3,298), respectively. The largest increase was seen between January-March 2014 and January-March 2015, with a greater than 12% increase in the total number of *C. difficile* infections (3,388 vs. 3,006, respectively). Since 2010/11, the January-March quarter has historically had the lowest number of *C. difficile* infections reported in a given financial year; however, in 2014/15, the October-December quarter had a lower number of infections reported, with a rise in *C. difficile* infections in January-March 2015, which has not been observed since 2009/10 (see Table 7b: Quarterly counts of *C. difficile* infection (patients aged 2 years and over) from April 2007 to March 2014 – Trust apportioned cases only, annual data tables).

**Trust apportioned reports**

A total of 5,213 Trust apportioned *C. difficile* infection cases were reported across the NHS in 2014/15. The number of Trust apportioned cases of *C. difficile* infection has been declining in recent years: 84.4% (from 33,442 Trust apportioned cases) since 2007/08. However, like the number of all
reported *C. difficile* infections, there was an increase in Trust apportioned cases between 2013/14 and 2014/15 from 5,033 to 5,213 (3.6%). Of note, the increase in non-Trust apportioned cases was greater, with a 7.5% increase over the same time period from 8,328 non-Trust apportioned *C. difficile* infections in 2013/14 to 8,952 in 2014/15; resulting in a lesser percentage of all reported *C. difficile* infections which were Trust apportioned in 2014/15 than ever before (36.8% in 2014/15).

Like the number of Trust apportioned *C. difficile* infections, the rate of Trust apportioned cases per 100,000 bed days has decreased overall between 2007/08 and 2014/15, from 89.6 per 100,000 bed days in 2007/08 to 15.1 per 100,000 bed days in 2014/15 (Table S13, Figure S14b); however, there has been a 2.9% increase since 2013/14 (14.7 per 100,000 bed days).

Comparing 2013/14 and 2014/15 Trust apportioned *C. difficile* infection data in more detail with respect to time period, unlike the increase in all reported *C. difficile* infections where all four quarters in 2014/15 experienced a greater number of infections than the same quarter in the previous year, there was an 11.0% decrease in the April-June quarter between 2013/14 and 2014/15, though the remaining three quarters did have a greater number of Trust apportioned infections reported than in 2013/14. Of note, the January-March quarter of 2014/15 (Q4), had the most Trust apportioned *C. difficile* infections reported for any quarter in 2014/15 (n=1,358) – this is the first time that this has been observed since the initiation of the Trust apportioning of *C. difficile* infections (Figure 15) (also see Table 7b: Quarterly counts of *C. difficile* infection (patients aged 2 years and over) from April 2007 to March 2014 – Trust apportioned cases only, annual data tables).
Figure S14: Trends in rates of *C. difficile* infection (2007/08 to 2014/15)*
Fig. S14a. All reported cases rates
Fig. S14b. Trust apportioned rates

**Table S13: Clostridium difficile infection counts and rates by financial year, England: 2007/08 – 2014/15**

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported case rate (per 100,000 population)</th>
<th>Total bed-days</th>
<th>Trust apportioned cases</th>
<th>Trust apportioned rate (per 100,000 bed days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007/08</td>
<td>51,381,093</td>
<td>55,498</td>
<td>108.0</td>
<td>37,320,817</td>
<td>33,442</td>
<td>89.6</td>
</tr>
<tr>
<td>2008/09</td>
<td>51,815,853</td>
<td>36,095</td>
<td>69.7</td>
<td>37,700,812</td>
<td>19,927</td>
<td>52.9</td>
</tr>
<tr>
<td>2009/10</td>
<td>52,196,381</td>
<td>25,604</td>
<td>49.1</td>
<td>37,326,212</td>
<td>13,220</td>
<td>35.4</td>
</tr>
<tr>
<td>2010/11</td>
<td>52,642,452</td>
<td>21,707</td>
<td>41.2</td>
<td>35,091,035</td>
<td>10,417</td>
<td>29.7</td>
</tr>
<tr>
<td>2011/12</td>
<td>53,107,169</td>
<td>18,022</td>
<td>33.9</td>
<td>34,667,952</td>
<td>7,689</td>
<td>22.2</td>
</tr>
<tr>
<td>2012/13</td>
<td>53,493,729</td>
<td>14,694</td>
<td>27.5</td>
<td>34,439,455</td>
<td>5,980</td>
<td>17.4</td>
</tr>
<tr>
<td>2013/14</td>
<td>53,865,817</td>
<td>13,361</td>
<td>24.8</td>
<td>34,311,181</td>
<td>5,033</td>
<td>14.7</td>
</tr>
<tr>
<td>2014/15*</td>
<td>53,865,817</td>
<td>14,165</td>
<td>26.3</td>
<td>34,520,684</td>
<td>5,213</td>
<td>15.1</td>
</tr>
</tbody>
</table>

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15. In addition, the 2014/15 bed-day total is of an aggregate of quarter one-quarter three of 2014/15 and quarter 4 of 2013/14, as at the time this analysis was performed, quarter 4 2014/15 data had not been published.
Figure S15: *Clostridium difficile* infection counts by quarter and financial year, England: 2010/11-2014/15*

Data is shown only for 2010/11 to 2014/15 as the number of infections seen in Q1-Q4 2007/08 to 2009/10 inclusive, are so high; therefore, changing the scale of the graph so that the change in quarterly trends in recent years is obscured.

* FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.

Age and sex distribution

For all age-gender analyses, those cases with a missing or unknown gender were removed from the analyses. For 2007/08 there were 667 such reports (1.2% of 55,498 reported *C. difficile* infections (666 “Unknown” and 1 missing)) and in 2014/15, there were 269 of 14,165 (1.9%) reports denoted as “Unknown” gender.

Figure S16 shows the rates of *C. difficile* infections per 100,000 population by age and sex for England in (a) 2007/08 and (b) 2014/15. In both males and females the highest rates are among those aged ≥85 years (2007/08: 1,523.4 per and 1,500.6 per 100,000 population, 2014/15: 294.8 and 294.6 per 100,000 population, respectively).

There has been a large decline in the rates of *C. difficile* infection, among both men and women, between 2007/08 and 2014/15. Both the rates, and the percentage reduction in the rates, of *C. difficile* infection are very similar between men and women, but differ according to age group. The lowest percentage decrease, in both males and females, was among persons aged 2 to 14 years, at approximately 30% between 2007/08 and 2014/15; while,
the greatest percent decrease was observed among persons aged 75 to 84 years and ≥85 years, with an 80% reduction in the rates of *C. difficile* infection among both men and women between 2007/08 and 2014/15, Table S14). Of note, all age groups for both males and females except for those aged 2 to 14 years old experienced an increase in their *C. difficile* infection rates between 2013/14 and 2014/15.

The greater percentage decrease in older adults than among younger age groups has meant that a greater proportion of *C. difficile* infections have been reported among 2-64 year olds in 2014/15 than in 2007/08 (females: 24.3% of all reported *C. difficile* infections vs. 15.8%; males: 25.3% vs. 21.4%), (Table S14).

**Time to onset**

In 2007/08 the median number of days to the onset of *C. difficile* infection among inpatients, defined as the difference between the date the positive specimen was taken and the date of admission, was 11 (IQR: 3-26) days. This has been in decline since 2007/08, and in 2014/15 the median number of days between date of admission and date of specimen was 4 days (IQR: 1-15). The percentage of *C. difficile* infections which would be considered to be hospital-onset (ie ≥3 days post-admission) has decreased from 78.8% in 2007/08 to 57.4% in 2014/15, Figure S17.

**Geographic distribution**

Geographic analyses have been performed based on the 25 NHS England AT. *C. difficile* infection data have been mapped to ATs based on the CCG that the cases were attributed to. *C. difficile* infections associated with Specialised Commissioning Hubs are excluded from the following analyses as they do not map to a specific geography. ONS only provides retrospective data on the population by CCG to 2009; therefore, the following analyses can only have a time series from 2009/10 to 2014/15. Note that the retrospective attribution of cases to a CCG, and therefore an AT, may become less accurate the older the data thus the AT data contained in this report should be treated with caution and used as an indication of the trend over time for a given AT.

Some variation in the rates of *C. difficile* infection was noted between regions in 2014/15 with a range from 20.2 per 100,000 in London AT to 36.9 per 100,000 in Cumbria, Northumberland, Tyne and Wear AT (see Figure S18). There were 10 AT with a *C. difficile* infection rate ≥28.1 per 100,000
population (Greater Manchester AT, Lancashire AT, Merseyside AT, Cumbria, Northumberland, Tyne and Wear AT, South Yorkshire and Bassetlaw AT, Derbyshire and Nottinghamshire AT, East Anglia AT, Shropshire and Staffordshire AT, Bristol, North Somerset, Somerset and South Gloucestershire AT and Devon, Cornwall and Isles Of Scilly Area Team) and five ATs had a rate ≤22.8 per 100,000 population (Essex AT, Hertfordshire and The South Midlands AT, Kent and Medway AT, Thames Valley AT and London AT).

Figure S16: Age- and sex- specific C. difficile infection rates per 100,000 population, England

Fig S16a. 2007/08

Fig S16b. 2014/15*

Figure S16b: * FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.
### Table S14: *C. difficile* infection counts and rates by age group and gender

#### S14a. 2007/08

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported case rate (per 100,000 population)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>2 to 14</td>
<td>4,036,951</td>
<td>3,848,912</td>
<td>178</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 to 44</td>
<td>10,697,911</td>
<td>10,692,826</td>
<td>1,251</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45 to 64</td>
<td>6,285,546</td>
<td>6,425,657</td>
<td>3,479</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65 to 74</td>
<td>1,995,820</td>
<td>2,190,847</td>
<td>4,970</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75 to 84</td>
<td>1,202,023</td>
<td>1,653,644</td>
<td>7,974</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85+</td>
<td>333,066</td>
<td>749,768</td>
<td>5,074</td>
</tr>
</tbody>
</table>

#### S14b. 2014/15*

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Mid-year population estimate</th>
<th>All reported cases</th>
<th>All reported case rate (per 100,000 population)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
<td>Men</td>
</tr>
<tr>
<td>2 to 14</td>
<td>4,197,977</td>
<td>4,002,653</td>
<td>126</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 to 44</td>
<td>10,731,434</td>
<td>10,653,480</td>
<td>402</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45 to 64</td>
<td>6,712,115</td>
<td>6,885,167</td>
<td>910</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65 to 74</td>
<td>2,418,603</td>
<td>2,604,970</td>
<td>1,255</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>75 to 84</td>
<td>1,348,062</td>
<td>1,695,677</td>
<td>1,753</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>85+</td>
<td>419,226</td>
<td>818,641</td>
<td>1,236</td>
</tr>
</tbody>
</table>

*FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.*
Figure S17: Time to onset among inpatients with *C. difficile* infection, 2007/08 – 2014/15

![Graph showing percentage of inpatient episodes by financial year for 7+ days, 3-6 days, and <3 days.](image)

**Figure S17:** Data from inpatients (defined as inpatients, day patients and patients in emergency assessment) from an NHS acute Trust only where the location when the positive specimen was taken was in an acute Trust, where the date of specimen was on or after the date of admission.

**Table S15** shows the region-specific rates of *C. difficile* infection bacteraemia for 2009/10 to 2014/15. The AT with the lowest reported *C. difficile* infection rate in 2009/10 was Kent and Medway (32.9 per 100,000 population) and the highest in Cumbria, Northumberland, Tyne and Wear (75.9 per 100,000 population). As with the national picture, rates of *C. difficile* infection for all ATs have declined between 2009/10 and 2014/15. This percentage decrease has ranged from <30% (Devon, Cornwall and Isles Of Scilly AT, from 42.3 per 100,000 population 2009/10 to 30.0 per 100,000 population 2014/15) to more than 60% (Cheshire, Warrington and Wirral, from 73.8 per 100,000 2009/10 to 27.9 per 100,000 2014/15). However, like the national picture, we have seen many ATs with increased rates in 2014/15; 18 experienced an increase in their regional rate between 2013/14 and 2014/15, four of which experienced an annual increase of more than 20% (Cheshire, Warrington and Wirral AT from 22.9 to 27.9 per 100,000, Lancashire AT from 25.7 to 32.1 per 100,000 population, East Anglia AT from 24.3 to 30.2 per 100,000 population and Essex AT from 15.0 to 20.8 per 100,000 population). Of note, nine of the ATs who experienced an increase in their *C. difficile* infection rates had a greater rate in 2014/15 than in 2012/13 as well as 2013/14. However, it is worth noting that even with an overall increase between 2013/14 and 2014/15 in England, there were eight ATs that experienced either a decrease, or no increase, in their rate of *C. difficile* infection (North...
Yorkshire and Humber AT, West Yorkshire AT, Arden, Herefordshire and Worcestershire AT, Birmingham and the Black Country AT, Bath, Gloucestershire, Swindon and Wiltshire AT, Kent and Medway AT, Thames Valley AT and Leicestershire and Lincolnshire AT).

**Figure S18:** *C. difficile* infection rates per 100,000 population by NHS England Area Team$, 2014/15*

*Figure S18:*$ Please see Table S15 for key between Area Team codes and Area Team names

$ FY 2014/15$ population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.
Table S15: Region-specific rates of *C. difficile* infection in England, 2009/10 to 2014/15, per 100,000 population

<table>
<thead>
<tr>
<th>Code</th>
<th>NHS Commissioning Board Area Team (AT)</th>
<th>2009/10</th>
<th>2010/11</th>
<th>2011/12</th>
<th>2012/13</th>
<th>2013/14</th>
<th>2014/15*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q44</td>
<td>Cheshire, Warrington and Wirral Area Team</td>
<td>73.8</td>
<td>56.3</td>
<td>39.2</td>
<td>27.6</td>
<td>22.9</td>
<td>27.9</td>
</tr>
<tr>
<td>Q45</td>
<td>Durham, Darlington and Tees Area Team</td>
<td>69.9</td>
<td>44.2</td>
<td>38.6</td>
<td>36.5</td>
<td>25.7</td>
<td>27.9</td>
</tr>
<tr>
<td>Q46</td>
<td>Greater Manchester Area Team</td>
<td>67.1</td>
<td>58.4</td>
<td>43.1</td>
<td>35.5</td>
<td>29.4</td>
<td>31.1</td>
</tr>
<tr>
<td>Q47</td>
<td>Lancashire Area Team</td>
<td>59.0</td>
<td>44.9</td>
<td>33.1</td>
<td>28.2</td>
<td>25.7</td>
<td>32.1</td>
</tr>
<tr>
<td>Q48</td>
<td>Merseyside Area Team</td>
<td>74.6</td>
<td>55.6</td>
<td>39.1</td>
<td>34.0</td>
<td>34.5</td>
<td>35.1</td>
</tr>
<tr>
<td>Q49</td>
<td>Cumbria, Northumberland, Tyne and Wear Area Team</td>
<td>75.9</td>
<td>48.8</td>
<td>39.1</td>
<td>35.2</td>
<td>31.2</td>
<td>36.9</td>
</tr>
<tr>
<td>Q50</td>
<td>North Yorkshire and Humber Area Team</td>
<td>39.1</td>
<td>37.4</td>
<td>37.2</td>
<td>26.7</td>
<td>27.5</td>
<td>27.3</td>
</tr>
<tr>
<td>Q51</td>
<td>South Yorkshire and Bassetlaw Area Team</td>
<td>46.1</td>
<td>46.3</td>
<td>40.0</td>
<td>33.6</td>
<td>29.5</td>
<td>31.9</td>
</tr>
<tr>
<td>Q52</td>
<td>West Yorkshire Area Team</td>
<td>51.7</td>
<td>46.3</td>
<td>41.8</td>
<td>34.3</td>
<td>31.0</td>
<td>28.0</td>
</tr>
<tr>
<td>Q53</td>
<td>Arden, Herefordshire and Worcestershire Area Team</td>
<td>48.5</td>
<td>45.8</td>
<td>48.2</td>
<td>35.6</td>
<td>26.3</td>
<td>26.0</td>
</tr>
<tr>
<td>Q54</td>
<td>Birmingham and the Black Country Area Team</td>
<td>60.3</td>
<td>49.4</td>
<td>44.7</td>
<td>26.2</td>
<td>27.3</td>
<td>26.1</td>
</tr>
<tr>
<td>Q55</td>
<td>Derbyshire and Nottinghamshire Area Team</td>
<td>49.0</td>
<td>45.8</td>
<td>31.8</td>
<td>32.8</td>
<td>28.6</td>
<td>31.6</td>
</tr>
<tr>
<td>Q56</td>
<td>East Anglia Area Team</td>
<td>44.9</td>
<td>36.1</td>
<td>26.6</td>
<td>24.2</td>
<td>24.3</td>
<td>30.2</td>
</tr>
<tr>
<td>Q57</td>
<td>Essex Area Team</td>
<td>34.8</td>
<td>24.3</td>
<td>20.6</td>
<td>20.0</td>
<td>15.0</td>
<td>20.8</td>
</tr>
<tr>
<td>Q58</td>
<td>Hertfordshire and The South Midlands Area Team</td>
<td>43.7</td>
<td>32.3</td>
<td>23.6</td>
<td>22.4</td>
<td>22.0</td>
<td>22.8</td>
</tr>
<tr>
<td>Q59</td>
<td>Leicestershire and Lincolnshire Area Team</td>
<td>49.6</td>
<td>39.5</td>
<td>30.3</td>
<td>26.7</td>
<td>24.1</td>
<td>24.1</td>
</tr>
<tr>
<td>Q60</td>
<td>Shropshire and Staffordshire Area Team</td>
<td>53.2</td>
<td>44.9</td>
<td>33.3</td>
<td>29.6</td>
<td>28.5</td>
<td>30.2</td>
</tr>
<tr>
<td>Q64</td>
<td>Bath, Gloucestershire, Swindon and Wiltshire Area Team</td>
<td>50.6</td>
<td>40.4</td>
<td>38.2</td>
<td>33.7</td>
<td>30.6</td>
<td>24.6</td>
</tr>
<tr>
<td>Q65</td>
<td>Bristol, North Somerset, Somerset and South Gloucestershire Area Team</td>
<td>54.9</td>
<td>48.0</td>
<td>39.8</td>
<td>29.9</td>
<td>28.4</td>
<td>32.0</td>
</tr>
<tr>
<td>Q66</td>
<td>Devon, Cornwall and Isles Of Scilly Area Team</td>
<td>42.3</td>
<td>38.6</td>
<td>43.7</td>
<td>27.8</td>
<td>26.6</td>
<td>30.0</td>
</tr>
<tr>
<td>Q67</td>
<td>Kent and Medway Area Team</td>
<td>32.9</td>
<td>35.8</td>
<td>28.0</td>
<td>23.6</td>
<td>22.8</td>
<td>21.4</td>
</tr>
<tr>
<td>Q68</td>
<td>Surrey and Sussex Area Team</td>
<td>48.2</td>
<td>40.1</td>
<td>28.5</td>
<td>27.1</td>
<td>24.3</td>
<td>24.4</td>
</tr>
<tr>
<td>Q69</td>
<td>Thames Valley Area Team</td>
<td>52.5</td>
<td>45.3</td>
<td>40.2</td>
<td>26.3</td>
<td>22.6</td>
<td>20.6</td>
</tr>
<tr>
<td>Q70</td>
<td>Wessex Area Team</td>
<td>40.1</td>
<td>37.4</td>
<td>32.6</td>
<td>23.8</td>
<td>22.1</td>
<td>23.5</td>
</tr>
<tr>
<td>Q71</td>
<td>London Area Team</td>
<td>33.7</td>
<td>31.2</td>
<td>25.7</td>
<td>20.1</td>
<td>17.9</td>
<td>20.2</td>
</tr>
</tbody>
</table>

Table S15: 6 C. difficile infections were excluded from regional analyses as the cases were attributed to a CCG hub, which are not mapped to an Area Team. 1 in 2012/13, 4 in 2013/14 and 1 in 2014/15. * FY 2014/15 population data (used in the rate calculations) had not been published at the time this analysis was performed and so 2013/14 population data were used as a proxy for 2014/15.

Discussion

The total and Trust apportioned counts of C. difficile infection have been decreasing since 2007/08. Dramatic declines were first observed between 2007/08 and 2008/09 (35%) and between 2008/09 and 2009/10 (29%), after the introduction of a government imposed target for a 30% reduction across the NHS in England by 2010/11. However, for the first time since the enhanced surveillance of C. difficile infection in England was introduced we have seen an increase in 2014/15, in both total infections and Trust apportioned infections, compared to the 2013/14 figures.

The majority of C. difficile infections are reported amongst persons ≥75 years old with the highest incidence rates for 2014/15 observed in men and women aged ≥85 years (294.8 and 294.6 per 100,000 population, respectively). The rate of C. difficile infection is slightly higher among women than men in most age groups and overall women do have a higher rate of infection than men (30.1 vs. 21.4 per 100,000 population) and this has not changed over time. Reasons for this disparity are unknown and require further investigation.

The distribution in the time to onset of C. difficile infection has changed over time: a greater percentage of C. difficile infections among acute Trust inpatients have been detected within 3 days of hospital admission over time (~20% in 2007/08 to ~40% in 2014/15). Traditionally defined hospital-onset infections still make up the majority of C. difficile infection reports among inpatients; however, the majority (63.2%, n=8,955/14,165) of all C. difficile infection reports are now among non-inpatients and inpatients not traditionally defined as having a hospital-onset infection (ie diagnosed with C. difficile infection <3 days of admission).

Regional variation was apparent for 2014/15; while all Area Teams have seen a decline in their C. difficile infection rates since 2009/10, all but seven
experienced an increase in their annual incidence rate between 2013/14 and 2014/15, four of which saw an increase of more than 20%.

The number of *C. difficile* infection reports reached their lowest level (13,361 cases) in 2013/14, prior to this the year-on-year declines had slowed substantially with only a 9.1% reduction between 2012/13 and 2013/14 (vs. 18.5% between 2011/12 and 2012/13) and for the first time since the enhanced mandatory surveillance of *C. difficile* began we saw an increase (6.0%) between 2013/14 and 2014/15. This has also been observed in the number of Trust apportioned cases, although a slightly smaller increase was seen in 2014/15 versus 2013/14 (3.6%) then among all reported *C. difficile* infections.

To date, *C. difficile* infection prevention strategies have mostly been hospital-based, such as the Cleanyourhands campaign (13, 14) and a specific *C. difficile* infection care bundle as part of the Saving Lives initiative which included advice on hand hygiene, environmental decontamination, personal protective equipment, isolation or cohort nursing and prudent antibiotic prescribing (18). In addition, Government targets on the number of *C. difficile* infections introduced in October 2007, to be achieved by the end of 2010/11, made controlling *C. difficile* in hospitals a priority and the responsibility of both clinicians and the NHS Trust managers (19). Targets were associated with financial penalties for failure. It has been postulated that these targets and centrally driven improvement programmes from the Department of Health were at least partially responsible for the large reductions in *C. difficile* infections seen in England between 2007/08 and 2010/11 (19).

However, there is evidence that the epidemiology of *C. difficile* infection is changing: the first annual increase in all reports and Trust apportioned *C. difficile* infections, the increasing proportion of infections among the younger population (<65) and the majority of infections not being traditionally defined as hospital-onset. It is too early to say whether the increases seen in 2014/15 will be sustained or why they have occurred, but as a first step to better understand the changing epidemiology of *C. difficile* infection, a more detailed investigation of the demographics of those infected with *C. difficile* in 2014/15 is required, along with increased understanding of the multi-faceted care pathway experienced by patients in order to better define healthcare associated infections.

In April 2014, the financial sanctions regime associated with exceeding pre-set objectives for *C. difficile* infections was changed (20). Prior to 2014/15, NHS acute Trusts could be fined £50,000 per *C. difficile* infection over their pre-set *C. difficile* infection objective. However, from April 2014 NHS acute
Trusts were instead encouraged to identify if a *C. difficile* infection was linked with a lapse in care. Only cases associated with a lapse in care should be considered for inclusion in calculations for financial sanctions. The value of the financial sanctions for each *C. difficile* case in excess of an NHS acute Trust’s pre-set objective was also reduced by 80%, to £10,000. Furthermore, the methodology for setting the objectives was altered. These changes were made because year-on-year declines seen between 2007/08 and 2013/14 had slowed, and for some organisations the level of *C. difficile* infections may have been approaching an irreducible minimum level, where no further improvements in patient care would further reduce the number of *C. difficile* infections. Future Trust level analysis will assess whether recent changes have impacted observed levels of *C. difficile* infection.

There will always be some *C. difficile* infections; *C. difficile* is a ubiquitous organism, it is found everywhere in the environment including soil, and the water supply. (21, 22) and can be carried asymptomatically, with levels of asymptomatic carriage of toxigenic *C. difficile* approximately 15% in long-term care facilities (23) and up to 7% in the general population (24, 25). *C. difficile* infections can and will occur outside of a healthcare environment under the right conditions.

If increases in *C. difficile* infections continue in 2015/16, renewed emphasis on infection prevention and control and associated audit methodologies may be required. In addition, as the proportion of *C. difficile* infections in England not traditionally defined as hospital-onset increases, additional interventions in the community and primary care will need to be identified and actioned to continue to tackle *C. difficile* infections.
Appendix

Glossary

**Gram-negative**  Class of bacteria that do not retain crystal violet stain as used as part of a differential staining technique (called the Gram stain). The Gram stain is used as a way of identifying bacteria and the difference in staining results are due to differences in the bacterial cell wall, which has important implications for antimicrobial usage.

**Gram-positive**  Class of bacteria that do retain crystal violet stain as used as part of a differential staining technique (called the Gram stain). The Gram stain is used as a way of identifying bacteria and the difference in staining results are due to differences in the bacterial cell wall, which has important implications for antimicrobial usage.

**Epidemiology**  Study of the occurrence and distribution of event (mostly health-related) in a population.

**Average**  Scientifically speaking, this is a measure of location. It is a way of describing data and helps to distribute any inequalities in the data across the whole series. There are three main mathematical measures which can be used to calculate an “average” value; the mean, mode and median. Each of these methods has their own strengths and weaknesses.

**Mean**  The arithmetic mean, is often what people think of when they say “average value”. The mean is calculated by summing all of the values in a group \((a_1, a_2, a_3, \ldots, a_n)\) and then dividing by the number of values included in the group \((n)\). Mathematically this is described by the following formula:

\[
\text{mean} = \frac{(a_1 + a_2 + a_3 + \cdots + a_n)}{n}
\]

A real-world example would be if you wanted to calculate the mean amount spent on food shopping over a 4 week period (ie the average amount per week) having spent £51 in week 1, £59 in week 2, £67 in week 3 and £52 in week 4:

\[
\text{mean cost of food per week} = \frac{(\£51 + \£59 + \£67 + \£52)}{4} = \£57.25
\]

**Median**  The median of a group of \(n\) numbers is the number that has just as many numbers in the group greater than it as less than it, ie it is the half-way point if a group of numbers were sorted in value order. For example, the median of the following set of numbers \([1, 2, 3]\) is 2, while the median of the set of numbers \([1, 1, 1, 2, 10, 15, 16, 20, 100, 105, 110]\) is 15.

To calculate the median value, the set of numbers needs to be arranged in numerical order, the median the number that is exactly in the middle. If there
are an even number of values in a set, then the median value is the mean of the two central values.

**Mode**
Is the most common value in a set of data (numbers or text values), for example, in the following set of numbers [1,1,2,10,15,16,20,100,105,110] the mode is 1 as it was included in the set three times, while the other numbers were only included once.

**Inter quartile range or (IQR)**
This is the mid-spread and is a measure of statistical dispersion. The median is considered the half-way mark, this is also known as the 50% percentile. The interquartile range provides the 25th percentile and 75th percentile.

**Rate ratio**
Is the ratio of two rates, or the cut off of the first and third quarters.

**Confidence interval or (CI)**
Based on the likelihood that in most scientific studies, you are unable to determine the actual population mean, but rather a mean of a sample from the population. As only a sample from a population has been taken, a different sample from the same population may provide a different result.

A confidence interval, over an unlimited repetitions of a study, should contain the true value of a parameter (such as the true population mean) no less than its confidence interval. It is usual to calculate the 95% confidence interval.

That means that if we were to draw several independent, random samples from the same population and calculate 95% confidence intervals from each of them, then 95% of such confidence intervals would contain the true population mean. If we took 20 samples from the same population and calculated 95% confidence intervals then 19 of 20 (95%) of these 95% confidence intervals would contain the true population mean while 1 of 20 (5%) will not.

**Bias**
Is the systematic deviation of either results and/or inferences from the real situation.

**Methods**

**Inclusion criteria for reporting to the surveillance system**

**MRSA bacteraemia**

The following positive blood cultures must be reported to PHE, for the mandatory MRSA surveillance:

- All cases of bacteraemia caused by *S. aureus* resistant to meticillin, oxacillin, cefoxitin or flucloxacillin.
MSSA bacteraemia

The following positive blood cultures must be reported to PHE, for the mandatory MSSA surveillance:

- All cases of bacteraemia caused by *S. aureus* which are susceptible to meticillin, oxacillin, cefoxitin, or flucloxacillin ie not subject to MRSA reporting.

*E. coli* bacteraemia

The following *E. coli* positive blood cultures must be reported to PHE:

- All laboratory confirmed cases of *E. coli* bacteraemia

*C. difficile* infection

Any of the following defines a *C. difficile* infection in patients aged 2 years and above and must be reported to the PHE:

1. Diarrhoeal stools (Bristol Stool types 5-7) where the specimen is *C. difficile* toxin positive*.

2. Toxic megacolon or ileostomy where the specimen is *C. difficile* toxin positive*.

3. Pseudomembranous colitis revealed by lower gastro-intestinal endoscopy or Computed Tomography.

4. Colonic histopathology characteristic of *C. difficile* infection (with or without diarrhoea or toxin detection) on a specimen obtained during endoscopy or colectomy.

5. Faecal specimens collected post-mortem where the specimen is *C. difficile* toxin positive or tissue specimens collected post-mortem where pseudomembranous colitis is revealed or colonic histopathology is characteristic of *C. difficile* infection.

Methods of reporting data on the HCAI data capture system (DCS)

The HCAI DCS is a web portal designed by PHE to facilitate the collection of the enhanced data set, which is accessed via NHS net (N3 connection). All NHS acute Trusts have access to the HCAI DCS.

Trusts using the website have access to all the data they have entered, which enables them to assess their burden of these HCAIs. This can be compared to a regional and national aggregate also available to Trusts from the website. Clinical Commissioning Group (CCG) passwords are also issued, allowing them to access data specific to their patients.

Core dataset collected

The data fields defined below are required for each case of MRSA bacteraemia, MSSA bacteraemia, *E. coli* bacteraemia or *C. difficile* infection.

**Mandatory fields**

**NHS number**
Allows cases to be traced and attributed to a CCG (see more details below) and allows identification of duplicates.

**Patient Initial**
Allows identification of duplicate records.

**Patient surname (for calculating soundex)**
Patient surname is not stored, but is used by the system to calculate the soundex automatically; soundex is then retained for de-duplication purposes.

**Specimen date**
Date when specimen was collected. Allows identification of duplicate episodes for the same patient. If date of specimen collection is unknown, date of receipt by testing laboratory can be entered instead. This is one of the fields used to apportion cases to the acute Trust.

**Date specimen type**
Field to indicate if the specimen date provided is the date of specimen collection or date received by the laboratory.
Date of Birth
Allows age at specimen collection to be calculated and tracing to be undertaken. This field also assists in de-duplication procedures

Sex
Patient’s sex. This field also assists in de-duplication procedures

De-duplication of records is the responsibility of the reporting acute Trust and there is a tool which allows for the easy identification of duplicate records for a patient. However, these data may include legitimate multiple entries/records per patient as it is possible for a patient to experience more than one episode. The length of an individual episode of MRSA, MSSA and *E. coli* bacteremia is defined as 14 days, while for *C. difficile* infections an episode is defined as 28 days.

**Non mandatory fields (but provide useful information):**

Patient’s hospital number
Desirable for avoiding duplicate entries.

Lab Number
Desirable for avoiding duplicate entries.

Lab Where Specimen Processed
Records the laboratory where the positive specimen was identified.

Patient location when specimen taken
Records where the patient was located at the time of specimen collection. This is one of the fields used to apportion cases to the acute Trust. If this field is left null the case will be apportioned to the acute Trust if all other criteria are met (see below).

Patient category
Identifies the category of patient within the hospital, such as inpatient/out-patient etc. This is one of the fields used to apportion cases to the acute Trust. If this field is left null the case will be apportioned to the acute Trust if all other criteria are met (see below).

Date of Admission
Records the date the patient was admitted to the hospital for the period of care during which the sample was taken. This field becomes mandatory if inpatient, day patient, or emergency assessment is selected for the field “patient category”. This is one of the fields used to apportion cases to the acute Trust. If this field is left null the case will be apportioned to the acute Trust if all other criteria are met (see below).
**Specialty**
Records the specialty of the consultant the patient was under at the time the specimen was taken.

**Augmented Care**
Records whether a patient was undergoing augmented care (a subset of the specialty under which the patient was being treated) at the time the specimen was taken. Although all patients will have a specialty recorded, not all patients will have an augmented care category recorded.

**Dialysis**
Records whether the patient was undergoing dialysis at the time the specimen was taken and if so which type of dialysis. HES Consultant specialty codes are not specific enough to identify dialysis patients.

**Provenance of Patient (where the patient was admitted from)**
Records where the patient was located prior to this hospital admission, such as home (normal place of residence), other hospitals or abroad.

**Risk Factor Page**
In addition to the main data entry screen a risk factor screen is available where additional important information relating to the epidemiology of these infections. This page is not available for *E. coli* bacteraemia cases, instead all data is entered onto one main page (see below).

**E. coli specific fields**

**Likely primary focus (source) and Factors directly predisposing to this episode**
These collect information on the source of the infection (for example urinary tract, indwelling intravascular device) and factors which may have been associated with the episode to help elucidate the epidemiology of this infection.

**Is this episode likely to be HCAI**
This option allows the microbiologist to make a judgement about whether the episode was a healthcare associated infection; if “yes” is selected a number of options are available for completion. Again this will help elucidate the epidemiology of this infection.

**Deadline for entering data**

All cases reported by the NHS with specimen dates during the previous month must be entered onto the website by the 15 of the following month. The previous month’s data must then be signed off by the Trust’s Chief Executive Officer (CEO) by the 15 of every
month. For example, data concerning specimens collected in October must be entered and signed off by the 15 of November.

CCG Attribution Process

All cases of MRSA, MSSA and *E. coli* bacteraemia and *C. difficile* infection are attributed to a CCG, regardless of their Trust apportioning status or PIR assignment.

PHE’s HCAI DCS does not currently request NHS organisations to record patient CCG details for any of MRSA, MSSA, *E. coli* bacteraemia or *C. difficile* infection cases. To obtain this data an extract, comprising patient NHS number and date of birth are submitted to the Health & Social Care Information Centre (HSCIS), via Demographics Batch Services (DBS), on a daily basis to identify patient GP registration details and patient residential postcode.

Overview of CCG attribution

The CCG for each case is attributed, in the following order:

- If patient’s GP practice code is available (and is based in England), the case will be attributed to the CCG at which the patient’s GP is listed.

- If the patient’s GP practice code is unavailable but the patient is known to reside in England, the case is attributed to the CCG catchment area in which the patient resides.

- If both the patient’s GP practice code and patient post code are unavailable or if a patient has been identified as residing outside England, then the case is attributed to a CCG based upon the postcode of the HQ of the acute Trust that reported the case.

Note that the retrospective attribution of cases to a CCG may become less accurate the older the data are. Therefore, the data contained in this report for time periods prior to 2013/14 should be treated with caution and only used as an indication of the trend over time for a given CCG.

Algorithms for apportioning cases

Please note that the algorithm applied for the apportioning of MSSA bacteraemia (and historically MRSA, until 1 April 2013) versus *C. difficile* infection uses a different number of days between specimen collection and admission to apportion cases; the principle is the same however. All cases of MSSA bacteraemia and *C. difficile* infection are either
Trust apportioned or non-Trust apportioned based on the algorithms below (see also Appendix Figures A1 and A2). *E. coli* bacteraemia are not Trust apportioned.

It is not possible for PHE to change the apportionment of a case, as apportionment is based on the data entered by the acute Trust and the algorithm is applied to the entire dataset not on a case by case basis; a case may only change from one category to another if the relevant case details are incorrect and require amendment by the Trust. In addition to apportioning, all cases are also attributed to a CCG (see above). Thus all Trust apportioned and non-Trust apportioned cases will be attributed to a CCG.

*MSSA bacteraemia (and historically MRSA bacteraemia*)

**Trust apportioned:**

Any NHS patient specimens taken on the third day of admission onwards (eg day 3 when day 1 equals day of admission) at an acute Trust (including cases with unspecified specimen location) for Inpatients, Day-patients, Emergency Assessment, or unspecified patient category.

Records with a missing admission date (where the specimen location is acute Trust or missing and the patient category is Inpatient, Day-patient, Emergency Assessment, or unspecified) are also included.

**Non-Trust apportioned:**

Any NHS patient specimens not apportioned to the above. This will typically include the following groups:

- Any acute Trust specimens taken on either the day of admission or the subsequent day (eg days 1 or 2, where day 1 equals day of admission).

- Any specimens from patients attending an acute Trust who are not Inpatients, Day patients or under Emergency Assessment (ie non admitted patients).

- Any specimens from patients attending an identifiable healthcare location except an acute Trust. This will typically include GP, nursing home, non-acute NHS hospital and private patients.

*MRSA bacteraemias underwent the apportioning algorithm until 31 March 2013. From 1 April 2013 all MRSA bacteraemia cases were subject to the Post Infection Review. Based upon these individual investigations an MRSA case would then be assigned to an acute Trust or CCG. As apportioning is based solely on other data items collected the process can be carried out on current data to allow the time series to be continued.*


C. difficile

Trust apportioned:

Any NHS patient specimens taken on the fourth day of admission onwards (eg day 4 when day 1 equals day of admission) at an acute Trust (including cases with unspecified specimen location) for Inpatients, Day-patients, Emergency Assessment, or unspecified patient category.

Records with a missing admission date (where the specimen location is acute Trust or missing and the patient category is Inpatient, Day-patient, Emergency Assessment, or unspecified) are also included.

Non-Trust apportioned:

Any NHS patient specimens not apportioned to the above. This will typically include the following groups:

- Any acute Trust specimens taken on either the day of admission or the two subsequent days (eg days 1, 2, 3 where day 1 equals day of admission).
- Any specimens from patients attending an acute Trust who are not Inpatient, Day-patient or under Emergency Assessment (eg non admitted patients).
- Any specimens from patients attending an identifiable healthcare location except an acute Trust. This will typically include GP, nursing home, non-acute NHS hospital and private patients.

Assignment of MRSA cases through the Post Infection Review

All NHS organisations reporting positive cases of MRSA bacteraemia from the 1st April 2013, are required to complete a Post Infection Review (PIR). As a result, MRSA bacteraemia data is no longer apportioned and is now published on the basis of relevant PIR assignment.

A PIR is undertaken on all MRSA bacteraemias with the purpose of identifying how a case occurred, to identify actions which will prevent a reoccurrence and to identify the organisation best placed to ensure improvements are made (this is known as “assigning” a case to an organisation).

Between 1st April 2013 and 31st March 2014 this was limited to either the NHS acute Trust who reported the case or the Clinical Commissioning Group with responsibility for commissioning care for the patient; however, on 1st April 2014 an additional category
was included in the PIR process allowing for assignment to a Third Party. This provision was made to acknowledge the increasingly complex nature of MRSA bacteraemias being reported.

**Example of Third Party Assignment**

Assignment to a “Third Party” occurs through the arbitration process for MRSA bacteraemias and has been available for any cases with an MRSA positive blood culture post 1st April 2014. This new category is designed to capture instances where the MRSA case could not legitimately be assigned to either the Trust or the CCG. Therefore, for the purposes of the published data on MRSA cases, these Third Party cases will not be assigned to either the Trust or the CCG. An example of “Third Party” assignment is below.

*Third Party Provider (England) Patient “A”*

**Background**

A CCG in Berkshire commissions specialist services for Patient “A” from a London specialist provider. After a few days, the patient returns to Berkshire Trust and is found to test positive for MRSA bacteraemia. Since the sample was taken on the day of admission, the Post Infection Review is led by the CCG. During the Post Infection Review process it has been established that the patient had received no clinical care in Berkshire in the immediate period prior to admission and that it is most likely that the bacteraemia developed in Trust A. In view of these facts, the CCG feels that the case should not be assigned to them on the Data Capture System.

The matter is, therefore, referred to the arbitration panel led by the Regional Medical Director and the Regional Director of Nursing.

**Outcome**

The arbitration panel agrees with the CCG and recommends that the case is assigned on the Data Capture System to a Third Party. In the interests of patient safety, the CCG in Berkshire (which commissioned the service) should inform the London provider to support clinical learning and minimise the risk of a reoccurrence.

Further examples can be found in the PIR toolkit (4).
Figure A1. Summary of the apportionment process for MSSA (and historically MRSA) bacteraemia cases entered onto the DCS

Until 1 April 2013, MRSA bacteraemia cases also had the above algorithm applied in order to ascertain whether a case was Trust apportioned or non-Trust apportioned. Since 1 April 2013, all MRSA cases are subject to a PIR. Through this a case is then assigned to the organisation best placed to learn and improve from the infection episode. Between 1 April 2013 and 31 March 2014, an MRSA bacteraemia could only be assigned to either an NHS acute Trust (Trust-assigned) or a CCG (CCG-assigned). However, to better reflect the complex MRSA bacteraemia cases being reported to PHE, all MRSA bacteraemias with a specimen date on or after 1 April 2014 could also be assigned to an additional category (a “Third Party”). Such an approach provides acknowledgment of this complexity by allowing MRSA bacteraemias that would have
previously been allocated to either an acute provider or CCG by default (when neither were involved and/or when there were no possible failings in patient care) to be allocated as third party.
Figure A2. Summary of the apportionment process for *C. difficile* infection cases entered onto the DCS

**Analysis of Data**

**Time to onset calculations**

To describe time to onset of an episode (bacteraemia or *C. difficile*) among inpatients, the number of days between the date of admission to an NHS acute Trust and the date of positive specimen were calculated. This was only performed for patients who were admitted to an acute Trust (defined as either an inpatient, day patient or emergency assessment, ie patients who
should have an admission date to an acute Trust) and for those whose specimen was taken on or after the date of admission also at an NHS acute Trust.

The number of days between the date of admission and the date of specimen can then be described in two different ways; by grouping the number of days into meaningful categories or by describing the “average”. Both have been provided in this report. As mentioned in the glossary, there are three metrics which can be used to describe the average value; the mean, median and mode. In this report, the median was used, providing us with the central value of the number of days between date of admission and date of positive specimen. The median was selected rather than the mean, because the latter can provide spurious “average” values if the data are skewed, i.e. if a few inpatients had very long hospital stays before they had a *C. difficile* infection, then the mean value would become much greater as it would be largely influenced by the value of the numbers in the range.

NB. Please note that in the Annual Epidemiological Commentary, 2013/14, inpatients with a date of hospital admission after a positive specimen date were included in the calculation. This has been revised for the 2014/15 publication because episodes where patients were classified as “Inpatient”, “Day patient” or “Emergency Assessment” should not have a specimen date prior to date of admission and so have now been excluded from the time to onset calculations.

### Denominator Data

NHS acute Trust-level population data does not currently exist in England as NHS acute Trusts do not treat patients within defined geographical boundaries. Therefore, a suitable proxy for population is required in order to calculate Trust apportioned/assigned rates. The occupied overnight beds (from the national KH03 dataset) provides the daily average overnight bed occupation for a specific time period; full financial years for 2007/08 to 2009/10 and by quarter for financial years 2010/11 to 2014/15. This dataset is an open access return published by NHS England and provides a measure of clinical activity in each trust, which is used as a proxy measure of the patient population.


Where issues with KH03 data quality were identified suitable adjustments were made to published data. For 2012/13 to 2014/15 these included:

- RYJ (Imperial College Healthcare NHS Trust): data for April-June 2013/14 was >20% higher than both the previous quarter (i.e. January-March 2012/13) and
the same quarter in the previous year (ie April-June 2012/13); therefore, data from Q1 2012/13 was used in place of published KH03 figures for Q1 2013/14.

- RWD (United Lincolnshire Hospitals NHS Trust): data for April-June to October-December 2014/15 were >20% higher than the same quarters in the previous year (April-June to October-December 2013/14); therefore, data for the same quarters in the previous year were used in place of published KH03 figures for April-June to October-December 2014/15.
- RQW (Princess Alexandra Hospital NHS Trust): data for April-June 2014/15 and October-December 2014/15 was missing; therefore, data for same quarter from the previous year (April-June 2013/14) were used for that Trust.
- RYQ (South London Healthcare NHS Trust) demerger: 45% of published KH03 figures for RYQ were added to the KH03 total for RJZ (King’s College Hospital NHS Foundation Trust); 45% of published KH03 figures for RYQ were added to the KH03 total for RJ2 (Lewisham and Greenwich NHS Trust) and 10% of published KH03 figures for RYQ were added to the KH03 total for RN7 (Dartford and Gravesham NHS Trust) for FY 2009/10 and April-June 2010 to July-September 2013.
- RJD (Mid Staffordshire NHS Foundation Trust) demerger: 94% of published KH03 figures for RJD were added to the KH03 total for RJE (University Hospital of North Midlands NHS Trust) and 6% of published KH03 figures for RJD were added to the KH03 total for RL4 (The Royal Wolverhampton NHS Trust).

Details on older modifications are available on request.

KH03 data are published 6-8 weeks after the end of the relevant period, when this report was produced, the final quarter of 2014/15 (ie January-March 2015) had not yet been published (latest KH03 download in April 2015). The KH03 data used in both the Annual Epidemiological Commentary and the Annual Tables for 2014/15 has had this quarter replaced with the same quarter from the previous financial year (ie KH03 data for 2014/15 includes data for April-June 2014, July-September 2014, October-December 2014 and January-March 2014 in place of January-March 2015. This is in line with our standard approach.

CCG rates and national/regional rates are calculated using estimated population statistics from ONS. This is used as the CCG encompasses a wider health population. ONS population data are published as at a point in time (mid-year), however, rates for HCAIs are published for financial years; therefore the ONS mid-year estimate included in the financial year is selected for the denominator (eg for 2007/08, ONS data for mid-2007 is used). Data for the most recently published year may be substituted for the current surveillance year (eg substituting data from calendar year 2013 for financial year 2014/15 as 2014 population data has yet to be published).
Rate calculations

CCG rates

All cases are attributed to a CCG (see above) and using this data we calculate rates per 100,000 population for each CCG. Data at a CCG level can be scaled up to both NHS Commissioning Board Area Teams and a national level; therefore, to calculate rates for CCGs, Area Teams and nationally the following equation is applied:

\[
\text{Calculation of rate (per 100,000 population)} = \left( \frac{\text{Total number of infection reports attributed to a CCG for the given time period}}{\text{ONS mid-year population estimates for a CCG for the time period}} \right) \times 100,000
\]

We utilise the ONS mid-year population estimated data for relevant time periods, for instance, for financial year 2010/11 mandatory surveillance data we have used mid-year 2010 population estimates.

In addition, since 1 April 2013, all MRSA bacteraemia cases have undergone a PIR, resulting in some cases being CCG assigned. Rates for CCG assigned cases for 2013/14 have also been calculated using the following equation:

\[
\text{Rate of CCG assigned MRSA cases (per 100,000 population), FY 2013/14} = \left( \frac{\text{Total number of CCG assigned MRSA cases from a CCG, FY 2013/14}}{\text{ONS mid-year population estimate for 2012}} \right) \times 100,000
\]

Trust rates

We calculate acute Trust rates using Trust apportioned (or Trust assigned cases). The total occupied bed days (KH03) data are used as an indicator of the total activity in each trust during the relevant time period(s).

Since 2010/11 KH03 have been published quarterly, prior to this they were published on a financial year basis. The average daily overnight bed occupancy for all acute Trusts has been multiplied by the number of days in the relevant time period.

The relevant rate per 100,000 bed days was calculated as follows:

\[
\text{Calculation of rate (per 100,000 bed days)} = \left( \frac{\text{Total number of Trust apportioned/assigned infection reports from a Trust for the given time period}}{\text{Average daily bed occupancy x Number of days in the time period}} \right) \times 100,000
\]

Prior to Trust apportioning, all-reports rates were calculated per acute Trust. Therefore, for historical purposes to retain the time series, we also calculate an all-reports rate per acute Trust. “All reported cases” refers to all MRSA, MSSA or E. coli bacteraemias or C. difficile infections that were detected by the acute Trust that processed the specimen. It
is important to note that this does not necessarily imply that the infection was acquired there.

The all reported case rate per 100,000 bed days was calculated as follows:

\[
\text{Calculation of rate (per 100,000 bed days)} = \left( \frac{\text{Total number of infection reports by a Trust for the given time period}}{\text{Average daily bed occupancy} \times \text{Number of days in the time period}} \right) \times 100,000
\]

Healthcare associated infections in Wales, Scotland and Northern Ireland

Surveillance data for \textit{C. difficile} infections and MRSA and MSSA bacteraemias is also performed in Wales, Scotland and Northern Ireland.

Links to the relevant web pages are as follows:


Please note that there are several differences between the English mandatory surveillance systems and the systems run by the devolved administration, including case definitions/protocols for diagnosing the infections, definitions re: inpatient episode vs. Trust apportioned/assigned episodes and the way in which data are presented. Therefore, the data provided in the published reports from Public Health Agency Northern Ireland, Public Health Wales and Health protection Scotland are not directly comparable with those data published by Public Health England, found in this report and annual tables.
References


