Surveillance of Surgical Site Infections in NHS Hospitals in England
2014/15
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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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Key points

- Data on 620,535 procedures comprising 17 surgical categories and 8,516 inpatient and readmission surgical site infections (SSIs) was collected by 232 NHS hospitals and NHS independent sector treatment centres between April 2010 and March 2015.

- In 2014/15, 138 NHS trusts and eight NHS treatment centres participated in the mandatory orthopaedic SSI surveillance, contributing data on 102,496 procedures. Four eligible NHS trusts did not participate this year.

- The proportion of hospitals undertaking continuous surveillance was highest in reduction of long bone fracture (62%). A moderate decrease in the corresponding proportion was observed for hip and knee prosthesis in 2014/15 (59% and 56% respectively) compared to 2013/14 (62% each).

- Data completion for age, patient sex, date of admission and procedure code was 100% for records submitted in 2014/15 across all surgical categories and ≥99% for duration of surgery and wound class in most surgical categories. For the ASA score (pre-operative health classification by the American Society of Anesthesiologists), data completion varied between surgical categories (65% to 98%) as was the case for body mass index (9% to 82%).

- Between 2008/09 and 2014/15, a significant decrease in the inpatient/readmission SSI incidence occurred for repair of neck of femur, reaching 1% in 2014/15. No overall trends for hip or knee prosthesis were found and the incidence remained low (<1%) in both categories. No evidence of a trend was found for reduction of long bone fracture with an incidence of 1.4% in 2014/15.

- For other categories, a small but significantly increasing trend in SSI was found for patients undergoing spinal surgery with an SSI rate of 1.3% in 2014/15. A large and significantly decreasing trend was found for gastric surgery with an SSI rate of 1.6% in 2014/15.

- Eight NHS trusts were identified as high outliers for the mandatory orthopaedic surveillance in 2014/15 with an incidence of SSI higher than expected. Seven NHS trusts and an additional NHS treatment centre were identified as low outliers. All 16 providers have been contacted and encouraged to review their clinical practices or surveillance methodology.

- *Staphylococcus aureus* accounted for 13% of inpatient SSIs in 2014/15 following a decreasing trend from 2006/7 due to a decrease in methicillin-resistant *S. aureus* (MRSA). In 2006/7 MRSA accounted for 25% of SSIs and decreased markedly since then accounting for 3% in 2014/15. Enterobacteriaceae increased from 2008/9 and accounted for 25% of SSIs in 2014/15.

- In 2014/15, *S. aureus* was the predominant organism in orthopaedic and spinal surgery accounting for ≥36% of cases whereas coagulase-negative staphylococci were predominant in coronary artery bypass graft infections and Enterobacteriaceae in large bowel surgery.
Section 1. Introduction and surveillance methods

1.1 Introduction

This report is a summary of data on surgical site infections (SSIs) collected by NHS hospitals and independent sector NHS treatment centres in England participating in one of 17 surgical categories of surveillance between April 2004 and March 2015. The results include orthopaedic data submitted by hospitals following the mandatory requirement introduced by the Department of Health in April 2004 [1]. The mandate requires all NHS trusts undertaking orthopaedic surgical procedures to carry out a minimum of three months’ surveillance in each financial year in at least one of four categories (hip prosthesis, knee prosthesis, repair of neck of femur or reduction of long bone fracture). Orthopaedic data from participating hospitals are aggregated to trust level for public reporting purposes. Trusts with very small volumes are exempt from the mandatory surveillance but are expected to undertake surveillance in a category that reflects the largest component of their surgical activity.

1.2 Data collection and feedback

Data is collected at hospital level. All hospitals participating in PHE’s national SSI surveillance are required to follow the surveillance protocol outlining the case definitions and follow-up methods [2]. Each hospital collects data prospectively on all eligible patients in a given surgical category over a three-month period. The post-operative follow-up period is set at 30 days for non-implant procedures and one year for prosthetic implant procedures. A set of demographic and operation-related data is collected for each eligible procedure and submitted via a secure web-based application.

Since July 2008, hospitals are required to have systems in place to identify patients who are included in the surveillance and later readmitted to hospital with an SSI. SSIs identified on readmission are assigned to the hospital where the original operation took place. Two other post-discharge surveillance methods were introduced in 2008 but remain optional: a) systematic review of patients attending outpatient clinics or at home by clinical staff trained to apply the case definitions and b) wound healing questionnaires completed by patients 30 days after the operation [2]. Data derived from these optional methods is not currently included in the national benchmarks or used for outlier assessment.

After each completed quarter, participating hospitals can download automated confidential reports accessed securely from the SSI web application for dissemination.
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within their trust. These reports provide the hospitals’ crude SSI incidence and the corresponding national benchmark from the same surgical category. A range of reports are available from the web application providing stratified rates for key risk factors and data quality indicators.

PHE analyses the submitted data at quarterly intervals to identify hospitals whose SSI incidence falls above the 90th or below the 10th percentiles nationally for a given surgical category. PHE alerts these hospitals of their outlier status and encourages them to investigate possible reasons. Additional support is provided to hospitals who request advice or in-depth epidemiological analysis to assist with investigating persistent SSI problems. This service is extended to advice on setting up surveillance. On-site visits are offered by PHE as a vehicle for sharing in-depth analyses and further surveillance advice and in such visits multi-disciplinary discussions are encouraged.

1.3 Definitions

SSIs are defined according to a standard set of clinical criteria for infections that affect the superficial tissues (skin and subcutaneous layer) of the incision and those that affect the deeper tissues (deep incisional or organ-space). These are based on the definitions established by the US Centers for Disease Control and Prevention (CDC)[3] with a minor modification, involving the requirement for pus cells in addition a positive culture from wound sampling and the need for at least two symptoms to accompany a clinical diagnosis. One of the key risk factors collected by hospitals is the ASA score. This is the patient’s pre-operative physical status on a scale from one to five, a classification system developed by the American Society of Anesthesiologists (ASA score) with higher scores indicating severe systemic disease. This along with the category-specific T-time (duration of surgery exceeding the 75th percentile rounded to the nearest hour) and the degree of wound contamination constitute the three components of the CDC National Healthcare Safety Network (NHSN) Risk Index[4].

1.4 Changes to surgical categories under surveillance

In July 2008, the repair of neck femur category was introduced, comprising hip hemiarthroplasty and reduction of fractured neck of femur using open fixation. The reduction of long bone fracture category was also introduced at the same time and included open or closed reduction procedures. Spinal surgery was introduced as a new category in July 2008 followed by breast, cranial and cardiac (non-coronary artery bypass graft) surgery in April 2010.

1.5 Participation in international surveillance

PHE shares anonymised SSI surveillance data with the European Centre for Disease Prevention and Control (ECDC) HAI-Net on an annual basis using ECDC’s protocol,
also based on CDC definitions [5]. As data is anonymised, it cannot be traced back to individual patients, surgeons or named hospitals. ECDC collates SSI data from other European member states and publishes comparative analyses including trends. These provide an opportunity to examine variation in the SSI incidence between European countries and to improve understanding of how these infections may be prevented.

1.6 Analyses presented in this report

Data on surgical procedures carried out between April 2004 and March 2015 collected by NHS hospitals and independent sector NHS treatment centres was extracted on 15 October 2015 for this report. To evaluate trends, inpatient and readmission SSI data from 2008 was analysed. For benchmarking, cumulative five-year data was used (April 2010 to March 2015).

The cumulative SSI incidence (%) presented in this report was based on SSIs detected during the hospital stay combined with SSIs identified on readmission following the initial operation. Where appropriate, inpatient SSIs were analysed separately for meaningful interpretation. To take into account the variation in the length of follow-up, the incidence density was calculated using the number of cases in the numerator and the total number of days of patient follow-up (from inpatient surveillance) in the denominator giving the number of SSIs per 1,000 patient days of follow-up.

Funnel plots were constructed for each orthopaedic category using the inpatient/readmission cumulative SSI incidence per NHS trust in 2014/15. Each plot identifies trusts with estimates falling within the expected variation and outliers falling beyond the upper or lower 95% control limits (hence being significantly higher or lower than expected respectively). Independent sector NHS treatment centres are also included in these plots. An additional supplement to this report presents the cumulative SSI estimate by NHS trust in 2014/15 for the mandatory orthopaedic surveillance:

Section 2. Overview

2.1 Hospital participation and surgical volumes

Figure 1 shows trends in hospital participation and surgical volume in the national SSI surveillance scheme split by the mandatory orthopaedic and the voluntary non-orthopaedic modules. Overall, a total of 200 NHS hospitals represented by 143 NHS trusts and an additional eight NHS treatment centres participated in 2014/15.

From 2004/05 to 2014/15, the total orthopaedic surgical volume submitted by participating hospitals increased by 248%. In 2014/15 a total of 184 hospitals representing 138 NHS trusts participated in the mandatory orthopaedic along with eight NHS treatment centres), the total (n=192) being the same as in 2013/14. A marginal decrease (<1%) in surgical volume submitted was seen in 2014/15 from 102,572 in 2013/14 to 102,496 respectively. Four eligible NHS trusts did not participate in the orthopaedic surveillance in 2014/15. Of 138 NHS trusts that did so, 89% (n=123) fulfilled more than the minimum required for the mandatory surveillance (one surveillance category for a minimum of three months).

For the voluntary non-orthopaedic categories, the total surgical volume increased by 316% from 2004/05 to 2014/15 although a 10% decrease was seen between 2013/14 and 2014/15 (30,857 to 27,820). The number of participating hospitals also decreased slightly from 73 to 70 hospitals.

After excluding nine of 17 surgical categories that had a small number of participating hospitals in 2014/15 (<10), the remaining categories showed considerable variation in the proportion of hospitals undertaking continuous surveillance in 2014/15. This proportion was highest in reduction of long bone fracture (62%), followed by spinal surgery (60%), hip prosthesis (59%), knee prosthesis and repair of neck of femur (56% each). Coronary artery bypass graft (CABG) had the next highest proportion of hospitals undertaking continuous surveillance (53%) followed by large bowel surgery (37%) and breast surgery (29%). Among the orthopaedic categories only hip and knee prosthesis showed a moderate decrease compared to 2013/14 (where this was 62% each). In CABG surgery, the proportion of hospitals undertaking continuous surveillance remained the same as in 2013/14 and for breast, large bowel and spinal surgery, there was an increase over 2013/14.
2.2 Data quality

Data completion for key SSI risk factors is essential for risk stratification purposes, enabling hospitals to investigate factors underpinning unusual deviations from the SSI national benchmark or from previous local trends. Table 1 shows the proportion of records submitted with completed fields for key data items by surgical category during 2014/15.

At national level, data completion for age, patient sex, date of admission and procedure code remained at 100% for records submitted in 2014/15 across all surgical categories. For the risk factors used in the NHSN risk index, data completion was very high (≥99%) for wound class and duration of surgery across most surgical categories although for ASA score there was more variation ranging between 68% for cardiac (non-CABG) surgery and 98% for cholecystectomy. The variation observed for ASA score was also present in 2013/14. Data completeness was considerably lower for height and weight
used to calculate body mass index (BMI), from 9% in gastric surgery to 82% for CABG surgery. BMI data completion increased in 11 surgical categories compared to 2013/14 with the biggest increase in cholecystectomy, increasing from 29% in 2013/14 to 65% in 2014/15 followed by breast surgery from 18% in 2013/14 to 37% in 2014/15.

Table 1: Proportion of submitted surveillance records with complete data for key data items, NHS hospitals in England, 2014/15

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Total No. operations</th>
<th>Age</th>
<th>ASA score</th>
<th>Duration of operation</th>
<th>Wound class</th>
<th>BMI*</th>
<th>Patient sex</th>
<th>Date of admission</th>
<th>OPCS code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal hysterectomy</td>
<td>528</td>
<td>100</td>
<td>84</td>
<td>100</td>
<td>100</td>
<td>49</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Bile duct, liver and pancreatic surgery</td>
<td>400</td>
<td>100</td>
<td>97</td>
<td>100</td>
<td>100</td>
<td>35</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Breast surgery</td>
<td>4,169</td>
<td>100</td>
<td>93</td>
<td>100</td>
<td>100</td>
<td>37</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Cardiac (non-CABG)</td>
<td>2,843</td>
<td>100</td>
<td>65</td>
<td>100</td>
<td>100</td>
<td>75</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Cholecystectomy</td>
<td>257</td>
<td>100</td>
<td>98</td>
<td>100</td>
<td>100</td>
<td>65</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Coronary artery bypass graft</td>
<td>5,360</td>
<td>100</td>
<td>78</td>
<td>100</td>
<td>100</td>
<td>82</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Cranial surgery</td>
<td>1,224</td>
<td>100</td>
<td>92</td>
<td>99</td>
<td>100</td>
<td>35</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Gastric</td>
<td>256</td>
<td>100</td>
<td>97</td>
<td>100</td>
<td>100</td>
<td>9</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Hip replacement</td>
<td>38,795</td>
<td>100</td>
<td>97</td>
<td>100</td>
<td>100</td>
<td>52</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Knee replacement</td>
<td>41,648</td>
<td>100</td>
<td>97</td>
<td>100</td>
<td>100</td>
<td>60</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Large bowel surgery</td>
<td>3,705</td>
<td>100</td>
<td>95</td>
<td>100</td>
<td>100</td>
<td>55</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Limb amputation</td>
<td>387</td>
<td>100</td>
<td>83</td>
<td>100</td>
<td>98</td>
<td>23</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Reduction long bone fracture</td>
<td>2,138</td>
<td>100</td>
<td>96</td>
<td>100</td>
<td>100</td>
<td>17</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Repair of neck of femur</td>
<td>19,915</td>
<td>100</td>
<td>95</td>
<td>100</td>
<td>100</td>
<td>20</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Small bowel surgery</td>
<td>695</td>
<td>100</td>
<td>95</td>
<td>100</td>
<td>99</td>
<td>43</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Spinal surgery</td>
<td>7,208</td>
<td>100</td>
<td>95</td>
<td>94</td>
<td>100</td>
<td>25</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Vascular surgery</td>
<td>788</td>
<td>100</td>
<td>95</td>
<td>100</td>
<td>100</td>
<td>23</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>130,316</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* based on patients ≥16 years

Of the optional post-discharge surveillance methods available to hospitals, the proportion of procedures where patient post-discharge questionnaires (PDQs) were given to patients to identify potential problems with wound healing within 30 days of surgery, increased from 39% in 2010/11 to 48% in 2014/15 (Figure 2). The patient response rate based on PDQs completed increased from 70% of questionnaires given in 2010/11 to 74% in 2014/15. Uptake of outpatient follow-up surveillance was lower although increasing, from 21% of procedures in 2010/11 to 26% in 2014/15.
2.3 Patient and operation-related characteristics

Key patient and operation-related characteristics derived from surveillance records for patients undergoing surgery in 2014/15 are shown in Tables 2 and 3.

The median age varied by surgical category (Table 2) being lowest in abdominal hysterectomy (50 years) and highest in repair of neck of femur (85 years). Duration of operation was highest in bile duct/liver and pancreatic surgery, cardiac (non-CABG), CABG and gastric surgery, with all having median durations in excess of 200 minutes. The categories of surgery with the highest proportion of patients with an ASA score ≥3 were in CABG (97%), cardiac (non-CABG) (96%), and limb amputation surgery (79%). Small bowel, large bowel and limb amputation surgery had the highest proportion of procedures with a wound classified as contaminated or dirty (38%, 18% and 10%, respectively).

Excluding gastric surgery due to very low number of procedures available for BMI analysis (n=24), knee prosthesis, cholecystectomy, hip prosthesis and abdominal hysterectomy had the highest proportions of patients classed as obese (BMI ≥ 30kg/m²). The categories with the lowest proportion of obese patients were repair of neck of femur (9.4%) followed by reduction of long bone fracture (15.2%). However,
owing to low BMI data completion in some surgical categories, these results should be interpreted with caution. The proportion of patients that were obese in 2014/15 did not increase from the 2013/14 for any of the surgical categories in which BMI data completion was ≥45% in both years (abdominal hysterectomy, cardiac (non-CABG), CABG, hip prosthesis, knee prosthesis and large bowel surgery). For these six categories, the median BMI in 2014/15 was 28, 27, 28, 28, 31 and 26 respectively (data not shown), comparable with those in 2013/14 (29, 27, 28, 28, 31 and 26 respectively).

The proportion of operations performed on an emergency basis (defined as procedures that are immediate, unplanned and life-saving or those that are performed immediately after resuscitation) were most common for cranial and vascular surgery (13% and 10%, respectively). Although repair of neck of femur patients are usually admitted on an emergency basis, the proportion classified as emergency procedures based on the PHE surveillance definitions (as described above) was 1.3%.

The proportion of patients receiving surgical antimicrobial prophylaxis was ≥98% in 11 surgical categories including hip prosthesis, knee prosthesis and reduction of long bone fracture. The high proportions reflect the current recommendations aimed at defined surgical groups [6;7]. The lowest observed was in cholecystectomy (58%).

The proportion of patients where discontinuation of inpatient surveillance was due to death was highest in repair of neck of femur and small bowel surgery (6% each) followed by limb amputation and vascular surgery (5% and 4% respectively). These should be interpreted with caution as these data only capture deaths within the inpatient stay.

Table 3 shows primary indication for surgery in patients undergoing hip prosthesis, knee prosthesis and repair of neck of femur. In hip and knee prosthesis, osteoarthritis accounted for the majority of procedures (82% and 90%, respectively). The second most common indication for these procedures was revision (11% and 6%, respectively) with revision due to infection reported in just under 1% of procedures. For repair of neck of femur, the most common primary indication was trauma (99%).
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Table 2: Patient and operation-related characteristics by surgical category, NHS hospitals in England, 2014/15

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Median age in years (IQR)</th>
<th>Median duration operation in minutes (IQR)</th>
<th>Median length hospital stay in days (IQR)</th>
<th>ASA ≥ 3 (%)</th>
<th>Contaminated/dirty incision (%)</th>
<th>BMI ≥ 30 (%)</th>
<th>Male (%)</th>
<th>Emergency (%)</th>
<th>Revision (%)</th>
<th>Antibiotic prophylaxis (%)</th>
<th>Implant (%)</th>
<th>Lead surgeon consultant (%)</th>
<th>Discontinuation of patient surveillance due to death (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal hysterectomy</td>
<td>50 (45-62)</td>
<td>105 (83-141)</td>
<td>3 (2-4)</td>
<td>12.6</td>
<td>0.4</td>
<td>36.0</td>
<td>N/A</td>
<td>1.0</td>
<td>N/A</td>
<td>97.5</td>
<td>0.0</td>
<td>91.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Bile duct, liver or pancreatic</td>
<td>65 (57-73)</td>
<td>295 (185-410)</td>
<td>8 (6-24)</td>
<td>36.7</td>
<td>8.0</td>
<td>22.9</td>
<td>57.5</td>
<td>0.0</td>
<td>1.3</td>
<td>100</td>
<td>6.5</td>
<td>85.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Breast surgery</td>
<td>59 (49-68)</td>
<td>64 (41-95)</td>
<td>1 (1-1)</td>
<td>9.1</td>
<td>0.2</td>
<td>31.4</td>
<td>0.9</td>
<td>0.2</td>
<td>1.8</td>
<td>71.2</td>
<td>13.5</td>
<td>87.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Cardiac surgery</td>
<td>68 (57-76)</td>
<td>230 (185-285)</td>
<td>8 (6-12)</td>
<td>95.6</td>
<td>0.4</td>
<td>28.4</td>
<td>65.1</td>
<td>1.5</td>
<td>3.6</td>
<td>99.8</td>
<td>90.9</td>
<td>90.3</td>
<td>2.2</td>
</tr>
<tr>
<td>Cholecystectomy</td>
<td>57 (43-68)</td>
<td>83 (60-115)</td>
<td>1 (1-4)</td>
<td>9.2</td>
<td>0.0</td>
<td>45.2</td>
<td>32.3</td>
<td>0.0</td>
<td>0.0</td>
<td>N/A</td>
<td>57.9</td>
<td>8.4</td>
<td>61.5</td>
</tr>
<tr>
<td>Coronary artery bypass graft</td>
<td>68 (60-76)</td>
<td>230 (193-270)</td>
<td>7 (5-9)</td>
<td>97.4</td>
<td>&lt;0.1</td>
<td>32.9</td>
<td>81.2</td>
<td>1.2</td>
<td>0.3</td>
<td>99.5</td>
<td>77.8</td>
<td>90.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Cranial surgery</td>
<td>59 (44-71)</td>
<td>99 (52-165)</td>
<td>5 (3-11)</td>
<td>46.0</td>
<td>1.5</td>
<td>28.4</td>
<td>55.8</td>
<td>13.1</td>
<td>0.7</td>
<td>98.6</td>
<td>26.6</td>
<td>61.1</td>
<td>2.9</td>
</tr>
<tr>
<td>Gastric surgery</td>
<td>60 (48-70)</td>
<td>207 (121-320)</td>
<td>7 (2-12)</td>
<td>35.9</td>
<td>3.9</td>
<td>91.7</td>
<td>50.0</td>
<td>0.4</td>
<td>0.4</td>
<td>96.9</td>
<td>4.7</td>
<td>97.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Hip replacement</td>
<td>70 (62-78)</td>
<td>82 (65-105)</td>
<td>4 (3-6)</td>
<td>21.9</td>
<td>0.1</td>
<td>37.1</td>
<td>39.9</td>
<td>0.1</td>
<td>10.4</td>
<td>98.8</td>
<td>100</td>
<td>83.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Knee replacement</td>
<td>70 (63-77)</td>
<td>77 (61-96)</td>
<td>4 (3-5)</td>
<td>21.6</td>
<td>0.1</td>
<td>54.8</td>
<td>42.4</td>
<td>&lt;0.1</td>
<td>5.8</td>
<td>99.1</td>
<td>100</td>
<td>83.3</td>
<td>0.1</td>
</tr>
<tr>
<td>Large bowel surgery</td>
<td>68 (57-78)</td>
<td>165 (119-225)</td>
<td>8 (5-13)</td>
<td>37.6</td>
<td>17.7</td>
<td>23.4</td>
<td>50.5</td>
<td>7.5</td>
<td>N/A</td>
<td>98.0</td>
<td>1.4</td>
<td>86.2</td>
<td>3.2</td>
</tr>
<tr>
<td>Limb amputation</td>
<td>69 (57-78)</td>
<td>54 (28-75)</td>
<td>10 (3-23)</td>
<td>79.4</td>
<td>9.7</td>
<td>22.5</td>
<td>73.1</td>
<td>1.3</td>
<td>N/A</td>
<td>75.7</td>
<td>0.8</td>
<td>85.7</td>
<td>4.7</td>
</tr>
<tr>
<td>Reduction of long bone fracture</td>
<td>62 (40-79)</td>
<td>85 (60-120)</td>
<td>4 (1-11)</td>
<td>31.3</td>
<td>1.5</td>
<td>15.2</td>
<td>40.4</td>
<td>0.2</td>
<td>N/A</td>
<td>99.0</td>
<td>96.8</td>
<td>50.3</td>
<td>2.0</td>
</tr>
<tr>
<td>Repair of neck of femur</td>
<td>85 (78-90)</td>
<td>65 (51-87)</td>
<td>12 (7-21)</td>
<td>69.7</td>
<td>&lt;0.1</td>
<td>9.4</td>
<td>28.6</td>
<td>1.3</td>
<td>0.3</td>
<td>96.8</td>
<td>100</td>
<td>43.1</td>
<td>6.1</td>
</tr>
<tr>
<td>Small bowel surgery</td>
<td>62 (44-73)</td>
<td>123 (80-210)</td>
<td>9 (5-18)</td>
<td>43.1</td>
<td>37.8</td>
<td>24.0</td>
<td>53.2</td>
<td>3.0</td>
<td>0.3</td>
<td>98.9</td>
<td>1.3</td>
<td>82.6</td>
<td>5.9</td>
</tr>
<tr>
<td>Spinal surgery</td>
<td>53 (39-67)</td>
<td>123 (80-185)</td>
<td>3 (1-7)</td>
<td>21.6</td>
<td>0.2</td>
<td>30.3</td>
<td>46.0</td>
<td>0.3</td>
<td>38.1</td>
<td>99.1</td>
<td>51.9</td>
<td>86.7</td>
<td>0.3</td>
</tr>
<tr>
<td>Vascular surgery</td>
<td>73 (65-80)</td>
<td>165 (115-235)</td>
<td>5 (2-9)</td>
<td>74.6</td>
<td>0.3</td>
<td>18.6</td>
<td>70.2</td>
<td>10.3</td>
<td>0.5</td>
<td>95.2</td>
<td>60.9</td>
<td>98.0</td>
<td>3.6</td>
</tr>
</tbody>
</table>

Table 3: Primary indication for surgery, orthopaedic procedures, NHS hospitals in England, 2014/15

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No. operations</th>
<th>Osteoarthritis No. (%)</th>
<th>Inflammatory disease No. (%)</th>
<th>Avascular necrosis No. (%)</th>
<th>Fracture No. (%)</th>
<th>Infection No. (%)</th>
<th>Other No. (%)</th>
<th>Unknown No. (%)</th>
<th>All No. (%)</th>
<th>Trauma No. (%)</th>
<th>Other No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip replacement</td>
<td>38,069</td>
<td>31,168 (81.9)</td>
<td>236 (0.6)</td>
<td>283 (0.7)</td>
<td>366 (1.0)</td>
<td>357 (0.9)</td>
<td>2,925 (7.7)</td>
<td>407 (1.1)</td>
<td>4,055 (10.7)</td>
<td>1,644 (4.3)</td>
<td>683 (1.8)</td>
</tr>
<tr>
<td>Knee replacement</td>
<td>41,043</td>
<td>37,104 (90.4)</td>
<td>385 (0.9)</td>
<td>19 (&lt;1)</td>
<td>71 (0.2)</td>
<td>379 (0.9)</td>
<td>1,736 (4.2)</td>
<td>248 (0.6)</td>
<td>2,434 (5.9)</td>
<td>477 (1.2)</td>
<td>624 (1.5)</td>
</tr>
<tr>
<td>Repair of neck of femur</td>
<td>19,853</td>
<td>87 (0.4)</td>
<td>1 (&lt;0.1)</td>
<td>2 (&lt;0.1)</td>
<td>28 (0.1)</td>
<td>6 (&lt;0.1)</td>
<td>22 (0.1)</td>
<td>5 (&lt;1)</td>
<td>61 (0.3)</td>
<td>19,622 (99.0)</td>
<td>40 (0.2)</td>
</tr>
</tbody>
</table>
Section 3. Rates of surgical site infection

3.1 Inpatient and readmission rate by surgical category

Table 4 shows the volume of surgical procedures, the number of SSI cases and the cumulative SSI incidence (%) by surgical category for surgery undertaken between April 2010 and March 2015. Five year aggregated data was used to give a robust measure of the national average for benchmarking purposes. Over this period a total of 620,535 procedures across 17 surgical categories were submitted by 222 participating hospitals representing 148 NHS trusts. An additional 10 NHS treatment centres participated in the surveillance (this excluded one NHS treatment centre that became part of an NHS trust in 2012/13 and was counted as part of the NHS group).

The cumulative incidence (%) of SSI varied by surgical category depending largely on the inherent likelihood of microbial contamination at the operative site associated with that type of surgery. The highest incidence (risk) was observed in large bowel surgery at 10.4% over this five year period. The lowest incidence was observed in hip and knee prosthesis surgery (0.7% and 0.6% respectively).

SSIs detected through readmission accounted for a relatively high proportion of inpatient and readmission cases in surgical categories with a relatively short length of hospital stay such as breast surgery (89%), abdominal hysterectomy (72%), knee prosthesis (70%), and hip prosthesis (61%). In categories with longer length of hospital stay (gastro-intestinal, repair of neck of femur, cardiac and limb amputation surgeries), readmission SSIs accounted for ≤33% of all these SSIs detected.

To take into account the variation in the length of patient follow-up during their hospital stay, the incidence density was estimated. This metric takes into account the length of inpatient follow-up, defining SSI incidence per 1,000 days of inpatient follow-up. Using this metric, the variation between surgical categories was less pronounced when compared to the inpatient-based cumulative incidence. However, large bowel surgery remains as having the highest SSI incidence and knee surgery as the lowest (Table 4).
<table>
<thead>
<tr>
<th>Surgical Site Infections</th>
<th>No. operations</th>
<th>No. hospitals</th>
<th>No. Inpatient</th>
<th>No. inpatient &amp; readmission</th>
<th>Inpatient &amp; readmission %</th>
<th>95% CIs</th>
<th>Median time to infection (days)</th>
<th>Incidence density/1,000 inpatient days*</th>
<th>95% CIs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal hysterectomy</td>
<td>3,882</td>
<td>24</td>
<td>14</td>
<td>50</td>
<td>1.3%</td>
<td>1.0 - 1.7</td>
<td>10</td>
<td>0.9</td>
<td>0.5 - 1.6</td>
</tr>
<tr>
<td>Bile duct, liver and pancreatic surgery</td>
<td>2,572</td>
<td>6</td>
<td>130</td>
<td>150</td>
<td>5.8%</td>
<td>5.0 - 6.8</td>
<td>9</td>
<td>4.6</td>
<td>3.8 - 5.4</td>
</tr>
<tr>
<td>Breast</td>
<td>11,803</td>
<td>32</td>
<td>13</td>
<td>114</td>
<td>1.0%</td>
<td>0.8 - 1.2</td>
<td>14</td>
<td>0.7</td>
<td>0.4 - 1.1</td>
</tr>
<tr>
<td>Cholecystectomy</td>
<td>999</td>
<td>6</td>
<td>38</td>
<td>47</td>
<td>4.7%</td>
<td>3.5 - 6.2</td>
<td>7</td>
<td>4.9</td>
<td>3.5 - 6.7</td>
</tr>
<tr>
<td>Coronary artery bypass graft</td>
<td>29,765</td>
<td>20</td>
<td>852</td>
<td>1,225</td>
<td>4.1%</td>
<td>3.9 - 4.3</td>
<td>12</td>
<td>3.1</td>
<td>2.9 - 3.3</td>
</tr>
<tr>
<td>Cardiac (non-CABG)</td>
<td>12,288</td>
<td>14</td>
<td>98</td>
<td>146</td>
<td>1.2%</td>
<td>1.0 - 1.4</td>
<td>12</td>
<td>0.7</td>
<td>0.5 - 0.8</td>
</tr>
<tr>
<td>Cranial</td>
<td>6,187</td>
<td>6</td>
<td>35</td>
<td>85</td>
<td>1.4%</td>
<td>1.1 - 1.7</td>
<td>17</td>
<td>0.7</td>
<td>0.5 - 0.9</td>
</tr>
<tr>
<td>Gastric</td>
<td>1,239</td>
<td>8</td>
<td>21</td>
<td>24</td>
<td>1.9%</td>
<td>1.2 - 2.9</td>
<td>8</td>
<td>1.9</td>
<td>1.2 - 2.9</td>
</tr>
<tr>
<td>Hip prosthesis</td>
<td>187,735</td>
<td>197</td>
<td>498</td>
<td>1,288</td>
<td>0.7%</td>
<td>0.6 - 0.7</td>
<td>16</td>
<td>0.5</td>
<td>0.4 - 0.5</td>
</tr>
<tr>
<td>Knee prosthesis</td>
<td>195,154</td>
<td>190</td>
<td>360</td>
<td>1,195</td>
<td>0.6%</td>
<td>0.6 - 0.6</td>
<td>17</td>
<td>0.3</td>
<td>0.2 - 0.3</td>
</tr>
<tr>
<td>Large bowel</td>
<td>18,500</td>
<td>54</td>
<td>1,629</td>
<td>1,919</td>
<td>10.4%</td>
<td>9.9 - 10.8</td>
<td>8</td>
<td>8.2</td>
<td>7.8 - 8.6</td>
</tr>
<tr>
<td>Limb amputation</td>
<td>2,038</td>
<td>16</td>
<td>48</td>
<td>65</td>
<td>3.2%</td>
<td>2.5 - 4.0</td>
<td>13</td>
<td>1.7</td>
<td>1.3 - 2.3</td>
</tr>
<tr>
<td>Reduction of long bone fracture</td>
<td>14,035</td>
<td>31</td>
<td>81</td>
<td>158</td>
<td>1.1%</td>
<td>1.0 - 1.3</td>
<td>17</td>
<td>0.7</td>
<td>0.6 - 0.9</td>
</tr>
<tr>
<td>Repair of neck of femur</td>
<td>89,806</td>
<td>120</td>
<td>890</td>
<td>1,189</td>
<td>1.3%</td>
<td>1.3 - 1.5</td>
<td>15</td>
<td>0.6</td>
<td>0.6 - 0.6</td>
</tr>
<tr>
<td>Small bowel</td>
<td>4,097</td>
<td>21</td>
<td>265</td>
<td>289</td>
<td>7.1%</td>
<td>6.3 - 7.9</td>
<td>8</td>
<td>5.4</td>
<td>4.7 - 6.1</td>
</tr>
<tr>
<td>Spinal</td>
<td>34,147</td>
<td>30</td>
<td>182</td>
<td>402</td>
<td>1.2%</td>
<td>1.1 - 1.3</td>
<td>15</td>
<td>1.0</td>
<td>0.9 - 1.2</td>
</tr>
<tr>
<td>Vascular</td>
<td>6,270</td>
<td>27</td>
<td>113</td>
<td>170</td>
<td>2.7%</td>
<td>2.3 - 3.1</td>
<td>11</td>
<td>2.0</td>
<td>1.7 - 2.4</td>
</tr>
</tbody>
</table>

| Total                   | 620,535        | 232           | 5,267         | 8,516                      |                           |        |                              |                                        |        |

*eight records excluded (one with an SSI) due to missing date of operation or date of hospital discharge"
3.2 Risk factors for SSI

Figure 3 shows the cumulative incidence of SSI for selected risk factors by surgical category based on data for 2014/15. The selected risk factors presented are patient sex, ASA score, ‘T-time’ (duration of operation in minutes dichotomised into two groups – see Section 1.3), and BMI. The BMI analysis was restricted to surgical categories where BMI data completion was ≥45% of submitted records.

Observed differences in the in SSI incidence between male and female patients were noted in some surgical categories in 2014/15. SSI incidence was elevated for female patients in small bowel, CABG and limb amputation surgery compared to male patients. Conversely the SSI incidence was higher in male patients undergoing bile duct/liver/pancreatic surgery, cholecystectomy and vascular surgery.

Patients with ASA score of ≥3 typically had an increased SSI incidence except in cardiac (non-CABG), cholecystectomy and gastric surgery where the reverse pattern was observed. Duration of operation greater than the NHSN 75th percentile for that category had an increased risk of SSI compared to procedures below this threshold across all categories with the exception of cholecystectomy and cranial surgery where the opposite was observed. Excess incidence for longer duration of procedures was most marked in breast and large bowel surgery.

The risk of SSI increased among patients who were obese (BMI ≥30kg/m²) in the majority of surgical categories examined with the exception of cholecystectomy where the reverse was observed.

Table 5 shows the SSI incidence by primary indication for hip prosthesis, knee prosthesis and repair of neck of femur. For hip prosthesis, the risk of SSI was highest for surgery undertaken for revision due to fracture followed by revision for a previous infection (3.3% and 2.5% respectively). In knee prosthesis the SSI incidence was highest for avascular necrosis (5.3%) although this was based on a very small sample size (n=19). The next highest incidence was for revision due to a previous infection (1.6%). For repair of neck of femur the primary indication carrying the highest risk was revision due to ‘other reason’ (4.5%) followed by revision due to fracture (3.6%) although both estimates were based on very small sample sizes (n≤30). In this surgical category, aggregated data for revision (all reasons) carried the highest SSI risk at 3.3%.
Figure 3: Stratification of the inpatient/readmission SSI incidence by risk factor and surgical category, NHS hospitals, England 2014/15

The BMI analysis based on surgical categories where the BMI data completion was ≥ 40%
Table 5: SSI incidence by primary indication for surgery in orthopaedic categories, NHS hospitals in England, 2014/15

<table>
<thead>
<tr>
<th>Primary Indication</th>
<th>Hip prosthesis</th>
<th>Knee prosthesis</th>
<th>Repair of neck of femur</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No. operations</td>
<td>No. SSI</td>
<td>% SSI</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>31,168</td>
<td>156</td>
<td>0.5%</td>
</tr>
<tr>
<td>Inflammatory joint disease</td>
<td>236</td>
<td>2</td>
<td>0.8%</td>
</tr>
<tr>
<td>Avascular necrosis</td>
<td>283</td>
<td>4</td>
<td>1.4%</td>
</tr>
<tr>
<td>Infection</td>
<td>357</td>
<td>9</td>
<td>2.5%</td>
</tr>
<tr>
<td>Fracture</td>
<td>366</td>
<td>12</td>
<td>3.3%</td>
</tr>
<tr>
<td>Revision</td>
<td>2,925</td>
<td>32</td>
<td>1.1%</td>
</tr>
<tr>
<td>Other</td>
<td>407</td>
<td>1</td>
<td>0.2%</td>
</tr>
<tr>
<td>Unknown</td>
<td>4,055</td>
<td>54</td>
<td>1.3%</td>
</tr>
<tr>
<td>All</td>
<td>4,055</td>
<td>54</td>
<td>1.3%</td>
</tr>
</tbody>
</table>

Fracture          | 1,644          | 5       | 0.3%  | 167            | 0       | 0.0%  | 19,662        | 203     | 1.0%  |

Other             | 683            | 6       | 0.9%  | 841            | 0       | 0.0%  | 40            | 0       | 0.0%  |
Section 4. Trends in the rate of SSI

4.1 Orthopaedic categories

Figure 4 shows trends in the crude cumulative incidence of SSI in the mandatory orthopaedic categories between 2004/5 and 2014/15. For each category, three types of trends are shown according to SSI detection method: inpatient, readmission and combined inpatient and readmission SSIs.

To estimate the average annual change in SSI, a univariable logistic regression model was used with a linear assumption. Trends based on inpatient and readmission SSIs during the seven-year period from July 2008 to March 2015 were evaluated as this indicator formally superseded the inpatient indicator from July 2008. Since some categories exhibited variation in the annual crude incidence, estimates from the linear model were compared against those from an independent-year effect model (with 2008/9 as the baseline) using a likelihood ratio test (LRT) to determine if model fit improved compared to the linear model. The Odds Ratio (OR) with 95% CIs are reported.

Over the seven year period, no clear trend was evident in hip or knee prosthesis. The SSI incidence for hip prosthesis was at its peak in 2008/9 at 0.9% reducing to 0.6% in 2014/15 with small fluctuations in the intervening period. For hip prosthesis, there was evidence of non-linearity in the SSI trends (LRT p=0.0018) with a significant decrease compared to the baseline in four years (2009/10, 2011/12, 2013/14 and 2014/15), of which 2014/15 exhibited the largest decrease (OR: 0.66, 95% CI: 0.54 – 0.80, p <0.001). For knee prosthesis the observed incidence increased after 2008/9 but returned to baseline levels (0.5%) by 2013/14 and 2014/15. There was also evidence of non-linearity in the SSI trends in this category (LRT p=0.0002) with a significant increase in three years compared to 2008/9 (2010/11, 2011/12 and 2012/13) although no evidence of change was found in the odds of SSI in 2014/15.

For repair of neck of femur, there was no evidence against linearity (LRT p=0.2533) in the SSI trends with the incidence reaching 1.0% in 2014/15. The linear model was therefore an improvement over the year-effects model with evidence to support an average decrease of 8% per year (OR: 0.92; 95% CI: 0.90 – 0.94; p<0.001). For reduction of long bone fracture, the incidence peaked in 2009/10 at 1.5% with a subsequent decline until 2014/15 at which point the crude risk increased to 1.4%. Although there was no evidence against linearity (p=0.3925) the overall average annual decrease was not significant (0.95; 95%CI: 0.89 – 1.02; p=0.189).
4.2 Non-orthopaedic categories

Figure 5 shows the trends in the crude inpatient SSI incidence, the readmission SSI incidence and the combined inpatient and readmission SSI incidence for the non-orthopaedic categories. Surgical categories introduced after July 2008 are presented last.

For most of the 13 voluntary surgical categories, the crude SSI estimates varied substantially between years. The linear and year-effects model were compared to evaluate trends based on inpatient readmission SSIs from July 2008 to March 2015. Of thirteen categories examined, only two categories show linear trends: spinal surgery and gastric surgery.
Spinal surgery showed evidence of an increasing trend in the crude incidence albeit small from 1.1% in 2008/9 to 1.3% in 2014/15 with small fluctuations in the intervening period. There was no evidence against linearity (LRT p=0.6004) indicating that model fit was improved by the linear model. The average annual increase in the odds of SSI was 8% (OR: 1.08; 95% CI: 1.02 – 1.14; p=0.004). Gastric surgery showed a decreasing trend from 8.6% on 2008/9 to 1.6% in 2014/15 with no evidence against linearity (LRT p=0.0795). The average annual decrease in the odds of SSI was 18% (OR: 0.82; 95%: 0.68 – 0.99; p=0.038).

In the remaining 11 surgical categories, there was evidence for non-linearity in the trends. However seven of these surgical categories did not show evidence of change in the trends over time in either model: abdominal hysterectomy, breast surgery, cardiac (non-CABG), cranial surgery, limb amputation, small bowel surgery and vascular surgery. The remaining four surgical categories showed evidence of a decrease in some years compared to the baseline year (2008/9). Of these four categories, only large bowel surgery showed a significant decrease in 2014/15 compared to the baseline 2008/9: the crude SSI incidence was 9.7% in 2014/15 and 11.8% in 2008/9 (OR: 0.80; 95% CI: 0.67 – 0.97; p=0.021).
Figure 5: Trends in the annual cumulative incidence of SSI (%) in non-orthopaedic surveillance categories with lower and upper 95% CIs, NHS hospitals in England.
Section 5. Characteristics of surgical site infections

5.1 Type of SSI

Figures 6 and 7 show the distribution of SSI type for inpatient cases in 2014/15 compared to inpatient and re-admission cases combined by surgical category.

Information on SSI type was available for all but five of 1,518 SSIs detected through inpatient or readmission surveillance in 2014/15. SSI type data from the eight surgical categories with ≥45 inpatient and readmission SSIs were analysed yielding a total of 1,329 inpatient/readmission SSIs with SSI type data.

The proportion of inpatient-detected SSIs that were superficial incisional infections varied by surgical category ranging from 28.0% in hip prosthesis to 71.4% in small bowel surgery. The observed proportions were affected by differences in the length of post-operative hospital stay between surgical categories.

As re-admission-detected SSIs will involve more serious wound complications, inclusion of these readmission cases tended to increase the proportion of SSIs that were deep or organ-space, particularly in surgical categories where the median length of hospital stay was relatively short. For example, in hip and knee prosthesis surgery, the proportion of inpatient and readmission-detected cases that were either deep or organ-space increased to 75.9% and 60.9% respectively compared with the proportions based on inpatient-detected cases (72.0% and 37.7% respectively). In most other voluntary categories included in this analysis, the median length of hospital stay was longer than that for hip or knee prosthesis but typically the proportion of inpatient and readmission SSIs that were deep or organ-space was broadly similar to the corresponding proportion for inpatient-detected SSIs.
Figure 6: Distribution of SSI type in inpatient cases compared to combined inpatient and readmission cases, orthopaedic surgery, NHS hospitals in England, 2014/15

<table>
<thead>
<tr>
<th>Type</th>
<th>Inpatient (n=75)</th>
<th>Inpat/Readm (n=228)</th>
<th>Inpatient (n=69)</th>
<th>Inpat/Readm (n=220)</th>
<th>Inpatient (n=147)</th>
<th>Inpat/Readm (n=204)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip prosthesis</td>
<td>28.0</td>
<td>24.1</td>
<td>62.3</td>
<td>39.1</td>
<td>46.3</td>
<td>40.2</td>
</tr>
<tr>
<td>Knee prosthesis</td>
<td>72.0</td>
<td>75.9</td>
<td>37.7</td>
<td>60.9</td>
<td>53.7</td>
<td>59.8</td>
</tr>
</tbody>
</table>

% of total SSI type

Figure 7: Distribution of SSI type in inpatient cases compared to combined cases, non-orthopaedic surgery, NHS hospitals in England, 2014/15

<table>
<thead>
<tr>
<th>Type</th>
<th>Inpatient (n=103)</th>
<th>Inpat/Readm (n=176)</th>
<th>Inpatient (n=309)</th>
<th>Inpat/Readm (n=360)</th>
<th>Inpatient (n=49)</th>
<th>Inpat/Readm (n=53)</th>
<th>Inpatient (n=46)</th>
<th>Inpat/Readm (n=90)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coronary artery bypass graft</td>
<td>58.3</td>
<td>49.4</td>
<td>58.6</td>
<td>58.6</td>
<td>71.4</td>
<td>71.7</td>
<td>54.3</td>
<td>43.3</td>
</tr>
<tr>
<td>Large bowel</td>
<td>41.7</td>
<td>50.6</td>
<td>41.4</td>
<td>41.4</td>
<td>28.6</td>
<td>28.3</td>
<td>45.7</td>
<td>56.7</td>
</tr>
<tr>
<td>Small bowel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

% of total SSI type

Superficial  Deep/Organ-Space
5.2 Causative micro-organisms

Figure 8 shows trends in organisms reported as causing inpatient SSIs from 2004/5 to 2014/15 based on data from all surgical categories except breast, cardiac (non-CABG), cranial and spinal surgery as these modules were introduced more recently (April 2010). Inpatient SSIs were analysed to remove the effect of readmission surveillance introduced in July 2008. Overall, of 10,752 inpatient SSIs detected over this 11-year period, 67% (7,253/10,752) had data on micro-organisms reported as causing SSI.

*Staphylococcus aureus* as a reported cause of inpatient SSIs accounted for 13% of cases in 2014/15, a further decrease from 16% in 2013/14. This follows a decreasing trend commencing from 2006/7 where *S. aureus* accounted for 39% of cases. The decreases in *S. aureus* have been driven by concurrent decreases in methicillin-resistant *S. aureus* (MRSA). MRSA decreased to 25% of SSI cases in 2006/7 and continued to decrease since then, accounting for 3% of cases in 2014/15 (4% in 2013/14). Methicillin-susceptible *S. aureus* (MSSA) showed marginal changes although a decrease was observed in the last two successive years: 2013/14 (12%) and 2014/15 (10%). Coagulate-negative staphylococci (CoNS) exhibited marginal increases. Enterobacteriaceae as reported causes of SSIs accounted for 25% of cases in 2014/15 following a markedly increasing trend from 2008/9.

Table 6 shows the distribution of organisms reported to cause SSIs in 2014/15 by surgical category. Categories with organism data on more than 75 SSI cases were analysed. Spinal surgery and repair of neck of femur had the highest proportion of SSI cases with microbiology data at 84% (76/91) and 80% (165/205) respectively. Categories with the lowest proportion of SSI cases with microbiology data were large bowel surgery at 48% (171/360) and knee prosthesis surgery at 28% (61/220). Polymicrobial SSIs (cases with more than one organism reported as causing SSI) were most frequent in large bowel surgery at 42% (80/189) of cases and lowest in knee prosthesis surgery at 21% (33/159).

Among monomicrobial SSIs (one organism reported as causing SSI), those reported as having MRSA aetiology was highest in repair of neck of femur accounting for 8% (8/102). This may reflect the emergency nature of hip fracture admissions which may prevent pre-admission screening and eradication of MRSA. In knee prosthesis the MRSA proportion was 7%, which was higher than that observed in the previous year (3%). The lowest MRSA proportion was in large bowel surgery (3%). *S. aureus* aetiology was highest in repair of neck of femur accounting for 46% (47/102) of monomicrobial SSIs followed by knee prosthesis at 43% (54/126). SSIs reported as having Enterobacteriaceae aetiology were highest in large bowel surgery at 58% (63/109) followed by repair of neck femur at 26% (27/102). Organisms reported as ‘coliforms’ accounted for 20% (31/157) of all monomicrobial Enterobacteriaceae SSIs in 2014/15 hence an analysis of the leading species could not be undertaken. CoNS were highest in CABG surgery at 29% (25/85).
Figure 8: Trends in key micro-organisms reported as causing inpatient SSIs, all surgical categories*, NHS hospitals, England

*excludes breast, cardiac (non-CABG), cranial, and spinal surgery
Table 6: Distribution of micro-organisms reported as causing SSI (inpatient/readmission), by surgical category, NHS hospitals, England, 2014/15

<table>
<thead>
<tr>
<th>Reported causative organism</th>
<th>Hip Prosthesis</th>
<th>Knee Prosthesis</th>
<th>Repair of neck of femur</th>
<th>CABG</th>
<th>Large bowel</th>
<th>Spinal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methicillin-sensitive <em>S. aureus</em></td>
<td>33</td>
<td>26.2%</td>
<td>46</td>
<td>36.5%</td>
<td>39</td>
<td>38.2%</td>
</tr>
<tr>
<td>Methicillin-resistant <em>S. aureus</em></td>
<td>6</td>
<td>4.8%</td>
<td>9</td>
<td>7.1%</td>
<td>8</td>
<td>7.8%</td>
</tr>
<tr>
<td>Coagulase-negative staphylococci</td>
<td>36</td>
<td>26.6%</td>
<td>36</td>
<td>28.6%</td>
<td>13</td>
<td>12.7%</td>
</tr>
<tr>
<td>Enterobacteriaceae</td>
<td>22</td>
<td>17.5%</td>
<td>15</td>
<td>11.9%</td>
<td>27</td>
<td>26.5%</td>
</tr>
<tr>
<td><em>Pseudomonas</em> spp.</td>
<td>5</td>
<td>4.0%</td>
<td>3</td>
<td>2.4%</td>
<td>2</td>
<td>2.0%</td>
</tr>
<tr>
<td><em>Streptococcus</em> spp.</td>
<td>9</td>
<td>7.1%</td>
<td>4</td>
<td>3.2%</td>
<td>4</td>
<td>3.9%</td>
</tr>
<tr>
<td><em>Enterococcus</em> spp.</td>
<td>9</td>
<td>7.1%</td>
<td>3</td>
<td>2.4%</td>
<td>7</td>
<td>6.9%</td>
</tr>
<tr>
<td>Other bacteria</td>
<td>5</td>
<td>4.0%</td>
<td>9</td>
<td>7.1%</td>
<td>1</td>
<td>1.0%</td>
</tr>
<tr>
<td>Fungi including <em>Candida</em> spp.</td>
<td>1</td>
<td>0.8%</td>
<td>1</td>
<td>0.8%</td>
<td>1</td>
<td>1.0%</td>
</tr>
<tr>
<td><strong>Total monomicrobial</strong></td>
<td><strong>126</strong></td>
<td><strong>100%</strong></td>
<td><strong>126</strong></td>
<td><strong>100%</strong></td>
<td><strong>102</strong></td>
<td><strong>100%</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gram-positive combinations only</td>
<td>29</td>
<td>53.7%</td>
<td>12</td>
<td>36.4%</td>
<td>20</td>
<td>31.7%</td>
</tr>
<tr>
<td>Gram-negative combinations only</td>
<td>8</td>
<td>14.8%</td>
<td>4</td>
<td>12.1%</td>
<td>6</td>
<td>9.5%</td>
</tr>
<tr>
<td>Gram-positive and Gram-negative combinations</td>
<td>15</td>
<td>27.8%</td>
<td>15</td>
<td>45.5%</td>
<td>28</td>
<td>44.4%</td>
</tr>
<tr>
<td>Other combinations*</td>
<td>2</td>
<td>3.7%</td>
<td>2</td>
<td>6.1%</td>
<td>9</td>
<td>14.3%</td>
</tr>
<tr>
<td><strong>Total polymicrobial</strong></td>
<td><strong>54</strong></td>
<td><strong>100%</strong></td>
<td><strong>33</strong></td>
<td><strong>100%</strong></td>
<td><strong>63</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

*combination that include 'anaerobic bacilli' 'anaerobic cocci', 'other bacteria' or fungi.
Among SSIs reported as having polymicrobial aetiology (more than one organism reported as causing SSI), Gram-positive and Gram-negative combinations were the predominant type of SSIs in four of six categories analysed (knee prosthesis, CABG, repair of neck femur and large bowel surgery).

Figure 9 shows the distribution of organisms for hip and knee prosthesis surgery combined in 2014/15. Among inpatient cases, the top three pathogens were monomicrobial infections: CoNS (26%) followed by Enterobacteriaceae (17%) and MSSA (10%). Among readmission cases, MSSA (monomicrobial) was the top pathogen accounting for 29% of readmission cases followed by CoNS (monomicrobial) at 20%, then polymicrobial SSIs based on Gram-positive and Gram-negative combinations (9%).

**Figure 9: Distribution of micro-organisms reported as causing SSI in hip and knee prosthesis surgery, by detection method, NHS hospitals, England, 2014/15**
Section 6. Variation in rates of SSI between NHS hospitals

6.1 Box and whisker plots

Figure 10 is a box and whisker plot showing the distribution of individual hospital SSI estimates (%) against five percentiles (10th, 25th, 50th, 75th and 90th) by surgical category. Each percentile represents a value below which a proportion of the total observations lie. The box plots show inter-hospital variation within each surgical category as well as inter-category variation. SSI estimates that lie at extreme ends (above the 90th percentile or below the 10th percentile) may be indicative of a problem (either excess infections or failure to detect SSIs respectively).

Figure 10: Distribution of the cumulative SSI incidence (%) at hospital level* by surgical category, NHS hospitals in England, April 2010 to March 2015

* hospitals with <95 operations in hip, knee or abdominal surgery are excluded; in the remaining categories, hospitals with <45 operations are excluded. For categories with <10 hospital participants, the distribution without a box plot is presented only.
6.2 Funnel plots

In 2014/15, data on 95,762 orthopaedic procedures and 670 inpatient/readmission SSIs was submitted by 184 NHS hospitals representing 138 NHS trusts. An additional eight independent sector NHS treatment centres contributed data on 6,734 orthopaedic procedures and 12 SSIs. Four NHS trusts performing orthopaedic surgery did not contribute orthopaedic data in 2014/15.

Figure 11 shows funnel plots displaying variation in the trust SSI incidence in 2014/15 by orthopaedic category. The cumulative incidence of SSI per 100 operations is plotted against the number of procedures for each participating NHS site. The 95% control limits (dashed black lines) define the ‘limits’ of expected variation in the trust estimates. A data point lying outside these limits is considered an outlier. Outliers are described as having ‘special cause variation’ and should be used as triggers for further investigation as the results from funnel plots are designed to be indicative not confirmatory. The margin of error associated with 95% control limits is 5%. The 99% control limits (solid red lines) are presented for information. The funnel plots do not adjust for case-mix so the results should be interpreted with caution.

The funnel plots identified 16 providers that were statistical outliers with SSI estimates falling beyond the 95% CLs in 2014/15. Of these, eight NHS trusts were high outliers and eight (seven NHS trusts and one NHS treatment centre) were identified as low outliers. All high outliers were outliers in just one surgical category whereas one low outlier provider was an outlier in two surgical categories. Five NHS trusts were also outliers in the previous year.

Although a low outlier may reflect a high standard of infection control practice and surgical skill, other factors should be considered to eliminate methodological bias. For example failure to implement a systematic readmission alert system may miss SSI cases. All high and low outlier trusts have been contacted to make them aware of their outlier status and encouraged to review their practices including their surveillance methodology.

The individual trust SSI incidence are published separately as part of this report:

Figure 11: Cumulative incidence of inpatient/readmission SSI plotted against the number of operations by NHS trust and mandatory orthopaedic surgical category in England, 2014/15
Section 7. Hospital perspectives

In September 2015, PHE emailed all participating hospitals to contribute a short piece on their experience of SSI surveillance including how they used surveillance to change practice. The invitation was also included in the September edition of PHE’s SSI Newsletter. This was requested to provide Trusts with an opportunity to share experiences of surveillance of benefit to other hospitals. This chapter presents a selection of examples contributed by hospitals where they describe their own experiences with SSI surveillance and initiatives undertaken to prevent or reduce the SSI incidence at local level.

Royal Brompton and Harefield NHS Foundation Trust

Our trust developed a SSI risk stratification system (BHIS) for CABG patients. This scoring system was predictive of SSI with the area under Receiver Operating Characteristic curve of 0.727. BHIS comprises female gender (2), diabetes (1) or HbA1c >7.5 (3), BMI >35 (2) and LVEF <45% (1), with a gradient in SSI risk as BHIS score increases. Approximately 8% of CABG patients score ≥4, and considered at high risk for SSI. Using BHIS, two surgical teams at Royal Brompton determined an intervention package (BHIS-IP) for high risk patients, including: negative pressure therapy, extended antimicrobial regime, agreed surgical technique including endoscopic vein harvest, BHIS bra for females and a ‘photo at discharge’ scheme.

Over 18 months, interventional BHIS-IP audit data were collected on 953 patients included in PHE’s surveillance CABG module. Of these, the highest score group (≥4) was selected for the study (n=72): No intervention: 6 SSIs, 47 patients (12.8%). Intervention: 0 SSIs, 25 patients (0%).

BHIS is a simple and reproducible predictive score[6]. A multidisciplinary approach to pre-, peri- and post-operative interventions successfully reduces the SSI rate in high-risk CABG patients (0% vs 13% SSI rate). The project is extended to other surgical teams for our high risk patients. Our trust's inpatient/readmission SSI incidence falls below the 4% benchmark.

Melissa Rochon, clinical nurse specialist in surveillance

PHE commentary

The experience described by the Royal Brompton and Harefield NHS Foundation Trust emphasises the importance of a multi-disciplinary approach to SSI prevention. This trust also implemented an innovative targeted approach to high-risk patients undergoing CABG surgery.
Homerton University Hospital NHS Foundation Trust

In October 2013, the trust was contacted by PHE as the incidence of total knee replacement (TKR) SSIs was above the national 90th percentile. However, on further PHE epidemiological analysis, no direct cause was found and a review of ‘underlying processes’ was recommended.

As part of the response, a review of surveillance processes was carried out and implemented in April 2014. We introduced active surveillance, where data are collected in real time, identifying any possible SSI cases early. Case management is done conjointly by the orthopaedic team and microbiology consultants. An RCA is performed for every SSI, looking at both individual risk factors and common denominators which could contribute to joint replacement SSIs. The information from the orthopaedic SSI RCAs has helped to focus the ‘underlying process’ reviews of the surgical patient journey across all surgical specialities, from pre-admission assessment to theatre and ward environment as well as the management and care of surgical wounds; assessing every element of care within the patient journey against evidence-based best practice. The incidence of SSIs in TKR has significantly reduced by this approach and, all surgical patients have benefited from the changes we have implemented (eg pre-operative showering check, peri-operative normothermia monitoring, wound care updates).

Alleyna Claxton, microbiology consultant and DIPC
Gema Martinez-Garcia, infection prevention and control nurse

PHE commentary

At the request of Homerton University Hospital NHS Trust, PHE attended a multi-disciplinary meeting and presented an in-depth epidemiological analysis to identify possible causes for the trust’s excess SSI risk in knee prosthesis. Our analysis did not identify specific patient and surgical factors that would explain the elevated SSI rate and therefore advised a comprehensive investigation of clinical and surveillance processes.
Salford Royal NHS Foundation Trust

SRFT is committed to carrying out robust SSI surveillance to accurately identify all SSI and subsequently improve practice and patient outcomes. To ensure accurate SSI reporting in accordance with PHE protocols, a multi-disciplinary root cause analysis is undertaken for all suspected SSI.

To improve our understanding of the issues identified, an electronic database was developed to expand upon the data collected and submitted to PHE, which has since allowed us to both monitor practice in accordance with NICE guidelines and identify trends across all surveillance patients, not just those developing a SSI.

Findings from the analysis of this data has led to the undertaking of several projects, all aimed at improving practice and reducing SSI rates within the trust. One such project was the trial of a seven-day telephone service for patients with post discharge surgical wound problems; resulting in a significant overall decrease in hip and knee replacement SSI (p=0.0351). The readmission SSI rate for hips and knees fell from a combined average of 2.6% to 0.8% and patient reported SSI from 5.2% to 2.4% (comparing six months before and after the introduction of the service). Over the same period, wound related A&E attendances fell from 12.1% to 5.6% and wound related readmissions from 4.3% to 1.2%.

Andra Jones, orthopaedic SSI surveillance specialist nurse

PHE commentary

Salford Royal NHS Foundation Trust expanded its data collection in order to track compliance with NICE guidelines. It also developed enhanced methods to closely track patients with wound problems to help reduce readmission-related SSIs at the trust.
Based on all surveillance methods, including two optional post-discharge methods the incidence of breast SSIs at the Royal Devon and Exeter Hospital between April and June 2014 was 7.0%. The inpatient/readmission incidence was 2.2%, above the national 90th percentile for inpatient/readmission SSIs.

Results presented to the breast team were used to drive practice transformation through audit and observation, highlighting areas of change to reduce SSIs and improve patient safety while providing foundations for an MSc thesis.

Tools used to reduce SSI’s focused on the high impact intervention care bundle to prevent SSI and to improve and measure the implementation of key care elements[7]. Additional variables included antibacterial-coated sutures. Patients with implant reconstructions were screened for methicillin sensitive Staphylococcus aureus (MSSA) in line with current guidance and showered with 4% chlorhexidine gluconate prior to surgery[8]. The project presented opportunities to promote infection prevention while suggesting care improvement strategies in partnership with the breast team[9].

Repeating surveillance between April and June 2015 produced an overall SSI incidence of 3.1% compatible with the corresponding national benchmark of 4.2%. The inpatient and readmission total returned a zero percentage. Surveillance continued during the July to September 2015 quarter with encouraging figures for the overall and inpatient/readmission indicators.

Mel Burden, infection prevention and control nurse specialist
Peninsula NHS Treatment Centre (Care UK)

I have been involved in SSI surveillance since January 2014. It has personally helped me to be in touch with each patient, while capturing their individual SSI outcome.

On discharge, patients are equipped with a contact card with specific instructions to ring, should any problems develop with their wound. As required, patients are readmitted for further treatment. All patients are contacted after 24 hours of discharge. They are reviewed six weeks and also one year post surgery to assess their outcome. If patients are admitted to another facility, arrangements for immediate transfer are made for them to be treated by us.

The very few infections we have had in this period is likely to reflect our high standard of care (pre and peri-operatively) and our solid follow up activities. Our approach is based on 'leave no stones unturned'.

I have had a few challenges regarding the surveillance forms. They include inaccuracies, incomplete data, poor penmanship, double and missing surveillance forms. After discussing my concerns with colleagues, this made a positive impact on their general input, and improved the surveillance process. At the end of each period, I feel a genuine sense of accomplishment. The advice from the SSI team is also paramount for ensuring a high level of data collection.

Sophia Frater-Walcott, infection control lead nurse

PHE commentary

Capture of post-discharge including readmission cases may pose challenges for NHS treatment centres. It is important that providers have systems in place to capture such cases to assess the SSI burden accurately. Peninsula NHS Treatment Centre has ensured that patients are followed up and invited back for treatment in case of wound problems or readmitted back where necessary.
Guy's and St Thomas’ NHS Foundation Trust

Continuous mandatory SSI surveillance at Guys and St Thomas’ NHS Trust is done using protocols from PHE. Data is currently submitted for hip, knee replacement and fractured neck of femur surgery. Clinical staff collect data from operating rooms and wards using PHE SSI forms until day 7 or discharge, whichever comes first. Surveillance continues until the end of the surveillance period and documentation is only continued for patients with infections. Deep and organ-space infections are investigated using SSI detailed investigation local guidance produced in 2014 reflecting NICE SSI quality standards.

Feedback and constructive discussions is via clinical governance structures to highlight possible improvements. Regular SSI reports are fed back to clinical directorates and discussed at surveillance committee meetings.

Our SSI incidence has fallen for all specialties undertaking SSI surveillance; for mandatory reporting the SSI incidence for the last two years is as follows: total hip replacement 1.4% in 2014 and 0.3% in 2015; total knee replacement 0.8% in 2014 and 0.5% in 2015.

Our experience was challenging initially but engagement has significantly improved as focus on patient safety continues to be our main priority. A multidisciplinary collaborative approach to data collection has enabled us to undertake non-mandatory surveillance for nine other specialties as well as mandatory data submissions.

Lilian Chiwera, infection control surveillance team leader

PHE commentary

Guy’s and St Thomas’ NHS Foundation Trust has undertaken a range of measures to ensure successful outcomes for the mandatory orthopaedic categories. This includes regular feedback of SSI surveillance data via dedicated team structures and the use of a multi-disciplinary collaborative approach.

The trust has now expanded its surveillance programme to include surveillance of SSI in voluntary-based surgical categories undertaken locally.
The Royal Orthopaedic Hospital NHS Foundation Trust

Our trust contacts patients by phone at 14 days post operatively then at 30 days, 90 days, six months and one year via a questionnaire with a consistent return rate of over 85%. All readmissions within 12 months have been monitored prospectively for SSI since 2009. Readmission cases are investigated using a specially-developed post infection review (PIR) tool.

Implementation of national guidance and best practice began with a change in skin prep to 2% chlorhexidine in early 2011, followed by the introduction of a dedicated post-discharge wound care helpline that summer. Patients with wound problems are invited for review on the same day at the Trust’s nurse-led clinic for prompt management. Further interventions were introduced in 2013: antimicrobial sutures, impregnated drapes and interactive dressings (in January, November and December respectively).

Feedback to clinicians and the trust has raised the profile of SSI. Locally, the trust produces a monthly report on readmission SSIs and their PIRs. The surveillance continues for 12 months post operatively in line with PHE’s standard protocol. The overall SSI rate (all SSI detection methods) for hip procedures reduced significantly from 3.2% in 2009 to 1.4% in 2014 (p=0.0022). For knee procedures the overall SSI rate reduced significantly from 7.5% in 2009 to 2.7% in 2014 (p=0.0001).

Sarah Mimmack, senior nurse - infection prevention and control lead

PHE commentary

This trust employs all follow-up methods including readmission surveillance. The trust has also implemented a range of clinical interventions, a wound care helpline and feedback of surveillance results in efforts to reduce its SSI incidence.
Section 8. Conclusions

8.1 Summary of findings in 2014/15

Overall, a total of 200 NHS hospitals representing 143 NHS trusts and an additional eight NHS treatment centres participated in 2014/15. While overall participation in the SSISS remained high in 2014/15, a 10% decrease in the number of procedures submitted for the voluntary-based categories was seen compared to 2013/14. The reason for this is not clear and may be related to resource constraints in the NHS. However, only a marginal decrease (<1%) in the number of procedures submitted for the mandatory orthopaedic categories was observed in 2014/15 compared to 2013/14.

Data quality was high for most of the key data items in 2014/15 although improvements in the completion of ASA score and BMI would further enhance the interpretative value of the data collected. While BMI is not one of the NHSN risk index factors, it is a key risk factor for SSI, which may increasingly have an impact on the SSI incidence if levels of population obesity continue to rise[10;11].

Trends in the SSI incidence showed a variable picture between surgical categories. The incidence of SSI following hip and knee prosthesis remained low in 2014/15 (<1%) and comparable with other European estimates [12]. The decreasing trend in SSI rates following repair of neck of femur continued in 2014/15 whereas infection rates in patients undergoing reduction of long bone fracture increased slightly in 2014/15 to 1.4%. Among the voluntary-based surgical categories, spanning gastrointestinal, cardiac, vascular, obstetrics and gynaecology, neurology and other general surgery procedures, inter-year variations in SSI incidence were observed. Of these voluntary categories, an increasing trend, though small, was observed for spinal surgery and a large decreasing trend was observed for gastric surgery. Further investigations are needed to examine and explain the trends seen in these categories.

8.2 Variation in the SSI rate between participating hospitals

Analysis of data continues to show considerable variation in the SSI incidence for some surgical categories. This indicates that more can be done to reduce this variation with a range of interventions described by some hospitals earlier in this report.

Variation in the SSI incidence between hospitals or within hospitals provides a trigger for investigating possible causes and identifying ways of reducing infection rates. PHE undertakes quarterly outlier detection to ensure hospitals are aware of their elevated infection rates and works in partnership with high outlier hospitals to assist them with further investigations. Hospitals identified as low outliers are also alerted so that they
can investigate their case ascertainment methods. The use of reports available from the web-based application allows hospitals to risk-stratify elevated SSI rates to determine whether differences in case-mix or operation-related factors can explain some of the variation. Auditing clinical practice against NICE’s Quality Standards for SSI, comprising a simple evidence-based checklist of pre, peri-operative and post-operative interventions, provides an opportunity for hospitals to optimise clinical practices as a means of reducing or preventing SSIs[13]. The quality standards, based on the NICE SSI prevention guidelines, cover glucose control, normothermia, skin asepsis and surgical antibiotic prophylaxis (choice, timing of agent, frequency and dose)[14]. The guidelines on surgical antimicrobial prophylaxis are an additional resource with similar recommendations based on a review of the evidence[15]. The experience shared by a range of hospitals covering different specialities, included for the first time in this report, provide an opportunity for other hospitals to learn what interventions have worked for others in preventing SSIs.

8.3 Optional post-discharge surveillance

In addition to readmission surveillance, which all hospitals are required to undertake, optional post-discharge surveillance methods using patient questionnaires or surveillance in outpatient settings can provide hospitals with valuable additional post-discharge data on SSIs. Post-discharge surveillance is particularly important for surgical categories with a short length of hospital stay. The proportion of procedures followed up using optional post-discharge surveillance methods has been increasing steadily over the last few years, although there remains some variation in completion rates between hospitals. Such variation has a significant effect on the overall SSI incidence[16], precluding its use for national benchmarking. However, these optional methods are valuable for internal comparison of hospital trends, particularly for short-stay surgery, providing consistent response rates are achieved by hospitals over time.

8.4 Microbial aetiology

Following the markedly decreasing trend in *S. aureus* as a reported cause of SSI since 2006/7, a further decrease was observed in 2014/15, where this pathogen accounted for 13% of SSIs overall. These decreases are likely to be explained by concurrent reductions MRSA which had decreased to 25% of cases in 2006/7 and continued to reduce since then accounting for 3% of cases in 2014/15. The reduction in MRSA is likely to reflect the impact of infection control initiatives directed at controlling MRSA of which pre-admission screening and decolonisation of carriers represents an important impact[18]. MSSA decreased over two successive years 2013/14 (12%) and 2014/15 (10%) and it remains to be seen whether this trend will persist. Enterobacteriaceae as reported causes of SSIs started to increase from 2008/9 and accounted for 25% of cases in 2014/15.
At surgical-category level, data for 2014/15 showed that among monomicrobial infections, *S. aureus* was the predominant organism in orthopaedic surgery and spinal surgery accounting for between 30% and 46% of cases. Coagulase–negative staphylococci were the predominant organisms in CABG surgery that may reflect the use of implants. Enterobacteriaceae were the predominant organisms in large bowel surgery reflecting the expected organisms at the operative site.

Among polymicrobial infections, Gram-positive and Gram-positive combinations were the most frequent type of infections in most surgical categories examined. Although this combination affected a small set of patients, this may have implications for choice of surgical antimicrobial prophylaxis at local level.

### 8.5 Future directions

Further to the 2013 survey of NHS trusts’ future priorities for SSI surveillance, results were disseminated to all NHS trusts in England in September 2015. The survey asked trusts to prioritise categories of surgery for future surveillance in absence of any mandatory surveillance requirement from a list of 34 types of surgery, including procedures not currently included in the PHE SSISS programme. Among the categories currently included in the SSISS programme, all 17 categories were selected by one or more trusts as being top five priorities for surveillance over the next three years highlighting the value in having a breadth of categories for hospitals to choose from. Surveillance in hip replacement was given the highest ranked priority by trusts, the most common reason for this being the significant impact of infection on patients. The next highest ranked was CABG followed by knee prosthesis, repair of neck of femur surgery, vascular and large bowel surgery. Categories not currently offered by SSISS were prioritised by some trusts, including caesarean section, which was assigned the highest ranked priority for SSI surveillance over the next three years, with 80% of trusts performing this surgery ranking caesarean section as being in their top five priorities. This was followed by pacemaker surgery and appendectomy which were ranked highly by trusts performing these surgeries. Collated results will be used to inform the development of the national SSI surveillance programme.
Section 9. Glossary

Cumulative incidence
The total number of SSIs as a proportion of the total number of patients undergoing a procedure in the same category of surgery per 100 procedures (%).

Incidence density
The total number of SSIs (identified through inpatient surveillance) divided by the total number of days of inpatient follow-up expressed as the number of SSIs per 1,000 days of patient follow-up.

Confidence interval and control limits
The 95% confidence interval provide a guide to the precision of the estimate based on the number of procedures. Given the level of confidence, they indicate that the ‘true’ incidence’ could lie anywhere between the lower and higher confidence limits. Control limits (CL) used in funnel plots are equivalent to exact binomial confidence limits at 95% (warning) and 99% (action). These define the limits of expected variation. The probability of a cumulative incidence lying above the 95% CL by chance alone is less than 5% (there is a 1 in 20 chance that the observed estimate is due to chance alone in a defined period); if above the 99% CLs, this is less than 1%. The 99% control limits also define the limits of expected variation and are computed based on the same sample size; the confidence range is wider but this is offset with a lower margin of error (1%). The 99% control limits are presented for information since the conventional level of significance is 5%.

P-value
This measures the probability of an estimate (eg a risk) being as or more extreme than that observed in a study population occurring by chance alone if the null hypothesis is true (the assumption that there is no difference between different groups). The significance level for the P-value is conventionally set at ≤0.05. This means that we are prepared to accept no more than a 5% chance of being wrong in claiming that our observed result is true. If the p-value around an estimate is >0.05, this indicates that the data do not provide sufficient evidence to reject the null hypothesis.

Odds ratio
This is the odds or likelihood of an event eg an infection in an ‘exposed’ group of subjects compared to another group (‘non-exposed’). An odds ratio of one indicates that there is no difference in the odds of developing an SSI between the two groups. An odds ratio of >1 indicates that the odds or likelihood of developing an SSI is greater in the ‘exposed’ group compared to the ‘non-exposed’. An odds ratio of <1 indicates that the odds or likelihood of developing an SSI is higher in the ‘non-exposed group’.
Section 10. References


