Public Health England

Protecting and improving the nation's health

# Surveillance of surgical site infections in NHS hospitals in England

## April 2019 to March 2020

# Contents

# Key points

In 2019/2020, 195 NHS hospitals and 8 Independent Sector (IS) NHS treatment centres submitted surveillance data for 134,547 surgical procedures to the PHE Surgical Site Infection (SSI) Surveillance Service; across 17 surgical categories 1,197 SSIs were detected during the inpatient stay or on readmission.

106,670 procedures were submitted as part of mandatory surveillance of orthopaedics, with 3 trusts not meeting the mandatory surveillance requirements; 27,877 procedures were submitted as part of voluntary surveillance spanning 13 other surgical categories.

Cardiac surveillance (CABG and non-CABG) continued to be the most likely categories to be subject to continuous surveillance (CABG: 79% and non-CABG: 80%).

Six trusts were notified as high outliers for the mandatory surveillance categories (3 for knee replacement, 2 for hip replacement and 1 for repair of neck of femur).

Ten-year trends in annual inpatient and readmission SSI risk varied by surgical category. Nine of 13 categories assessed saw decreases in SSI risk from the previous year, with large bowel surgery decreasing to its lowest in 10 years at 7.7%. The national benchmark for large bowel surgery also decreased further this year from 8.7% (April 2014 to March 2019) to 8.3% (April 2015 to March 2020). Across surgical categories, the national benchmarks range from <1.0% for hip and knee replacement to 9.1% for bile duct, liver or pancreatic surgery.

All 4 mandatory orthopaedic categories have shown overall decreasing 10-year trends; annual inpatient and readmission SSI risk following hip replacement increased slightly from 0.4% to 0.5% in 2019/20 while SSI risk following knee replacement surgery remained around 0.4%.

Inter-hospital variation in SSI risk remained similar to that reported last year for the majority of surgical categories assessed (7 of 12); the greatest percentage change in inter-hospital variation from the previous year was seen in cardiac surveillance.

Enterobacterales continued to make up the largest proportion of causative organisms across all surgical categories in 2019/20 for both superficial SSIs (29.8%) and deep or organ/space (26.2%), however *S. aureus* still contributes to a large proportion of deep or organ space SSIs (24.2%). The proportion of superficial SSIs due to Enterobacterales varied from 10.6% for knee replacement to 48.5% for large bowel surgery. Among deep and organ/space SSI, the range is from 10.0% for knee replacement to 55.7% for large bowel surgery.

# Surgical Site Infection (SSI) Surveillance Service

## Introduction

This report summarises data submitted by NHS hospitals and independent sector (IS) NHS treatment centres in England to the national SSI Surveillance Service (SSISS) at Public Health England (PHE). The aim of the national surveillance program is to enhance the quality of patient care by encouraging hospitals to use data obtained from surveillance to compare their rates of SSI over time and against a national benchmark, and to use this information to review and guide clinical practice. The SSISS provides an infrastructure for hospitals to collect data on 17 surgical categories spanning general surgery, cardiothoracic, neurosurgery, gynaecology, vascular, gastroenterology, and orthopaedics. Surveillance is targeted at open surgical procedures, which carry a higher risk of infection than minimally invasive ('keyhole') procedures (1, 2).

The SSISS was established by the Public Health Laboratory Service (a predecessor of PHE) in 1997. From April 2004, NHS trusts performing orthopaedic surgery have been mandated by the Department of Health and Social Care to carry out surveillance for a minimum of 3 consecutive months per financial year in at least one of 4 orthopaedic categories: hip replacement, knee replacement, repair of neck of femur or reduction of long bone fracture (3). NHS hospital participation in other categories remains voluntary.

This report includes surveillance data submitted to the SSISS based on surgery which took place from 1 April 2010 to 31 March 2020, with a focus on the latest financial year (2019/20).

## Methods

### SSISS data collection

The PHE SSISS surveillance protocol outlines a standard methodology, including case definitions and case finding methods which all participating hospitals must adhere to (4). To maintain the quality of surveillance data, hospitals participating in PHE's national SSI surveillance programme are required to have staff trained by the PHE national co-ordinating centre in London before carrying out surveillance. Surveillance data are collected prospectively on a quarterly basis and include all eligible patients undergoing surgery in pre-selected surgical categories during each 3-month period. Patients are followed-up to identify SSIs for 30 days after surgery for non-implant procedures and for one year for procedures involving a prosthetic implant. A set of demographic and surgery-related data are collected for each eligible procedure and submitted to the PHE SSISS via a secure web-based application.

After each completed quarter, data are subject to quality assurance processes by the PHE SSISS to identify anomalies or missing data. Participating hospitals can download automated confidential reports securely from the web application for dissemination within their trust. These reports provide hospitals' crude and risk-stratified SSI incidence and the corresponding national benchmark by surgical category.

As part of ongoing support to help hospitals monitor SSI risk, the PHE SSISS team analyse submitted data at quarterly intervals to identify 'outliers', defined as hospitals whose SSI risk is above the national 90$^{th}$ percentile ('high outliers') or below the 10$^{th}$ percentile ('low outliers') for each surgical category. PHE alerts these hospitals of their outlier status and encourages them to investigate possible reasons. Hospitals identified as 'low outliers' are asked to investigate their case ascertainment methods, to ensure all cases are being reported, while hospitals identified as 'high outliers' are asked to explore their clinical practices and discuss their results at multidisciplinary team meetings so that possible reasons can be explored, and potential problems addressed at the earliest opportunity. PHE offers support to outlier hospitals to assist them with further investigations, including on-site visits to share in-depth local analyses and further surveillance advice.

## Case finding

Active surveillance is undertaken by hospital surveillance staff to identify patients with SSIs during their initial inpatient stay. Hospitals are also required to have systems in place to identify patients subsequently readmitted to hospital with an SSI. SSIs identified on readmission are assigned to the hospital where the original operation took place. Other post-discharge surveillance (PDS) methods are recommended and strongly encouraged for short-stay procedures like breast surgery where the majority of patients are discharged on the day of surgery. They comprise: a) systematic review of patients attending outpatient clinics or seen at home by hospital clinical staff trained to apply the case definitions and b) wound healing questionnaires completed by patients 30 days after their operation (4). As these methods are optional, data derived from other post-discharge surveillance are not currently included in the national benchmarks or used for outlier assessment to ensure an even playing field for drawing comparisons. The results in this national report include inpatient and readmission data only, but other PDS data remains important at the local level to provide a sensitive measure of an individual hospital's infection risk.

## Case definitions

The PHE SSISS protocol defines SSIs according to standard 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) (5) with minor modifications to 2 of the criteria, namely i) presence of pus cells for infections determined by positive microbiology without obvious clinical signs and symptoms and ii) at least 2 clinical signs and symptoms of infection to accompany a clinician's diagnosis for superficial incisional infections.

## 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 (6). As data are anonymised, they cannot be traced back to individual patients, surgeons or hospitals. All published results are aggregated at the country level. ECDC collates SSI data from European member states and affiliated countries 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. Inter-country variation can however be due to differences in surveillance methodology and/or risk factors (7). Future sharing of surveillance data following the United Kingdom leaving the European Union are subject to negotiation.

## Analyses presented in this report

Surveillance data for surgical procedures for a 10-year period, between 1 April 2010 and 31 March 2020, were extracted on 2 November 2020 for this report. For procedures performed in the last few months of the 2019/20 financial year and subject to a one-year follow-up (prosthetic implant surgery), late onset infections occurring after the first month of surgery will not be captured, although these constitute very small numbers (8). Trust-level results for the mandatory orthopaedic categories are rerun for the previous financial year (2018/19) to include updates reflecting any late onset infections reported since publication of the last annual report.

The SSI risk described in this report is the percentage of SSI per 100 operations measured by cumulative incidence [= (number of SSI/number of procedures) x 100]. Incidence density was calculated to account for differences in the length of follow-up in hospital. Incidence density is presented as number of inpatient SSIs per 1,000 patient days of follow-up [= (number of inpatient SSIs/number of days of follow-up) x 1000]. Where applicable, exact 95% confidence intervals have been provided for results. A binomial distribution was assumed for SSI risk, with the exception of incidence density which used a Poisson distribution.

Where hospital level results are used a minimum volume threshold is considered. For hip/knee replacement and abdominal hysterectomy, any hospitals with <95 operations submitted over the time period are excluded. For all other surgical categories, a threshold of 45 or more operations was used. At the national level, results are restricted to those surgical categories or breakdown groups that meet a minimum threshold for surgical volume or hospital participation. Analyses may also pool 5 years of data to ensure results are meaningful. For benchmarking purposes, the last 5 years of data including the current financial year are used (1 April 2015 to 31 March 2020).

Funnel plots were produced to compare SSI risk across NHS trusts and treatment centres for the most recent financial year for the mandatory orthopaedic categories. The plots account for differences in surgical volume and identify trusts that fall within the expected variation and those that are outliers (SSI incidence falling above or below the 95% confidence limits).

An additional supplement to this report contains 2018 to 2019 and 2019 to 2020 SSI risk results by NHS trust or treatment centre: www.gov.uk/government/publications/surgical-site-infections-ssi-surveillance-nhs-hospitals-in-england

# SSISS operational overview

## Hospital participation and surgical volumes

Overall, 195 NHS hospitals representing 133 NHS trusts and an additional 8 IS NHS treatment centres participated in the SSISS data collection in 2019/20. Surveillance data were submitted for 134,547 procedures. Of these, 106,670 were orthopaedic procedures submitted as part of mandatory surveillance and 27,877 procedures submitted as part of voluntary surveillance spanning 13 other surgical categories (see Figure 1). Whereas the number of operations submitted for mandatory orthopaedic surveillance was consistent to that for 2018/19, those for voluntary surveillance showed a 9% increase from 2018/19.

Mandatory surveillance requirements mean hip and knee replacement surveillance have the highest number of participating hospitals (both 156 hospitals in 2019/20). Participation in voluntary surgical categories in 2019/20 was highest for large bowel surgery (20 hospitals) and spinal and breast surgery (both 16 hospitals). Participation across the other surveillance categories was similar to last year, however the number of hospitals submitting abdominal hysterectomy data was half that of 2018/19 (4 vs. 8 hospitals).

**Figure 1: Annual participation in the SSISS, voluntary and mandatory surveillance, NHS hospitals England, April 2010 to March 2020**

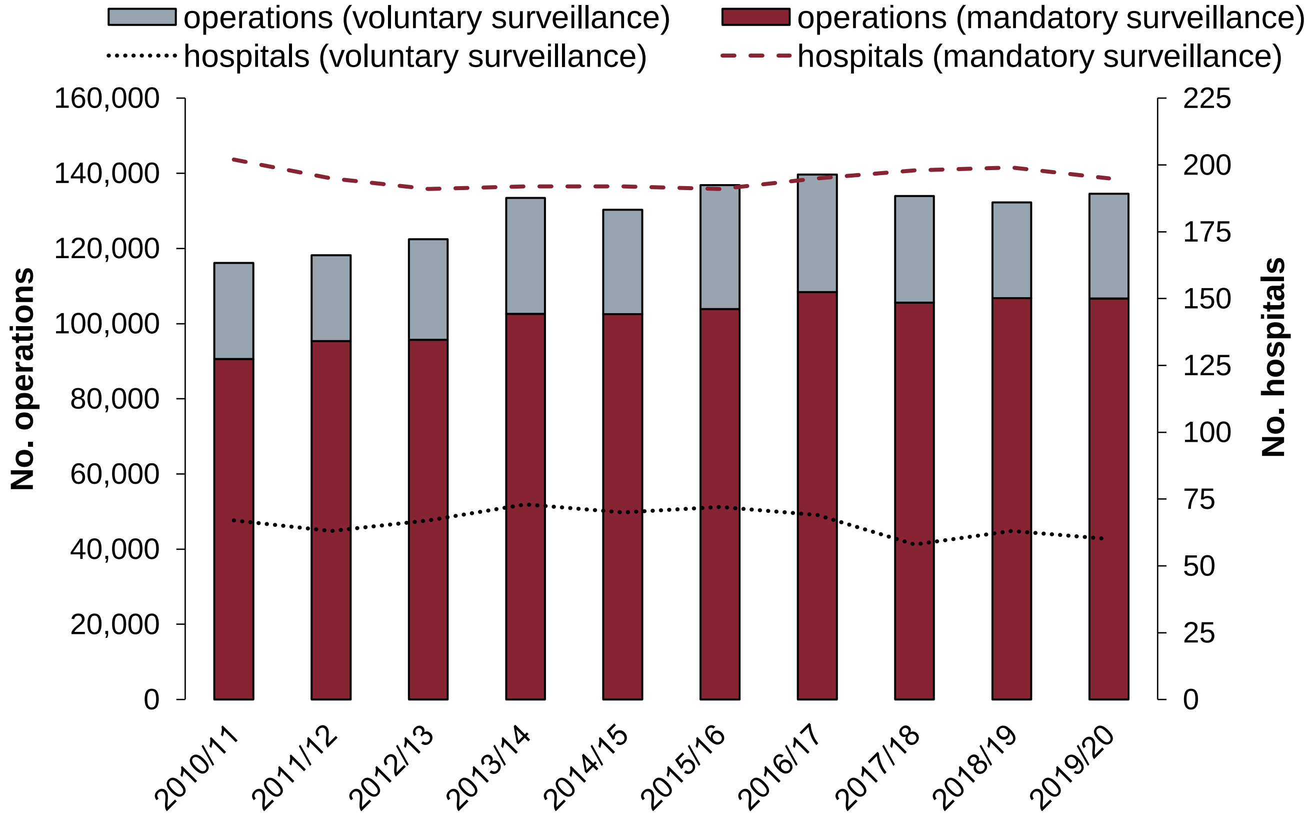
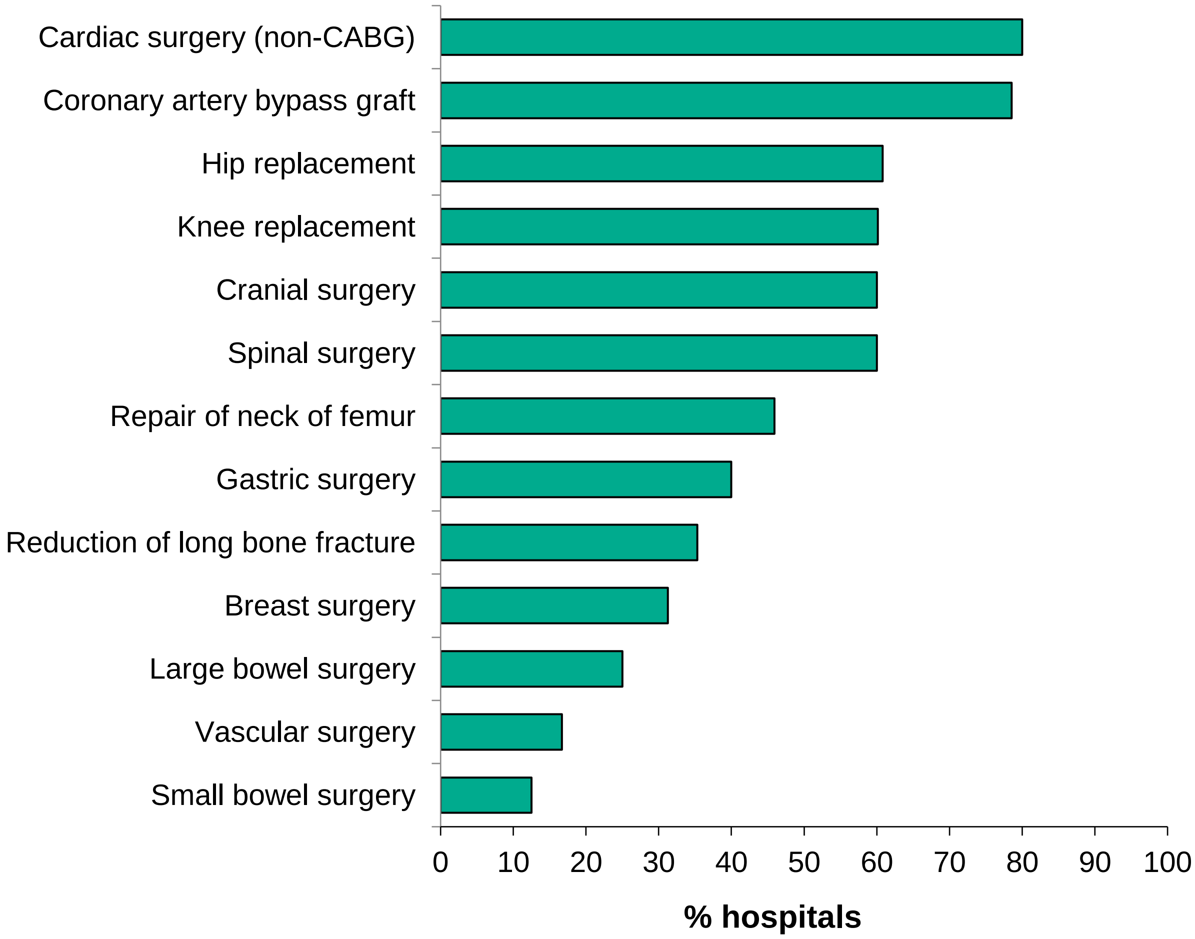


Figure 2 shows the proportion of hospitals carrying out continuous surveillance during 2019/20 by surgical category. Four SSISS surgical categories with <5 participating hospitals (abdominal hysterectomy, cholecystectomy, limb amputation and bile duct, liver or pancreatic surgery) were excluded.

Cardiac surgeries, CABG and non-CABG, had the highest proportion of hospitals carrying out continuous surveillance in 2019/20 (78.6% and 80.0%, respectively). For hip and knee replacement, subject to mandatory surveillance for a minimum of one 3-month surveillance period per financial year, more than half of hospitals elected to carry out continuous surveillance (60.8% and 60.1%, respectively). This was comparable to 2018/19 where 61% of hospitals undertook continuous surveillance for either hip or knee replacement surgery. At the trust level, 11% submitted the minimum requirement for orthopaedic surveillance of one category for one period.

**Figure 2: Proportion of hospitals undertaking continuous surveillance, by surgical category, NHS hospitals England, April 2019 to March 2020**



# Patient and surgical characteristics

Data completeness for the fields that inform key patient and surgical characteristics is high (≥95%) as most data fields are mandated for collection (see Appendix 1). An 'unknown' or 'missing' response however is an available option for some, which explains the variability in data completeness (see Appendix 2). An example of this is the American Society of Anesthesiologists' (ASA) score, where data completeness ranged from 73.9% in cardiac surgery (non-CABG) to 100% in cholecystectomy and gastric surgery. The height and weight fields are optional for collection, which means completeness of body mass index (BMI) information is lower and differs by category. In 2019/20, similar to last year, BMI was calculated for 63% of procedures and 14 of 17 surgical categories had BMI data available for ≥50% of those submitted. Cardiac surgeries (CABG and non-CABG) remain the categories with the most complete BMI information (87.4% and 87.9% in 2019/20).

Table 1 shows the distribution of key patient and surgical characteristics. These are important to help hospitals better understand their results by identifying factors which might be contributing to an increased SSI risk.

Knee replacement and abdominal hysterectomy have the highest proportion of obese (BMI ≥ 30kg/$m^2$) patients (55.8% and 44.5%, respectively) as has been the case for the last 6 years. Hip replacement surgery accounted for the third highest proportion of obese patients at 38.8%. Patient BMI was also noted to vary at the hospital level. In 2019/20, the proportion of obese patients undergoing hip replacement across hospitals, ranged from 22.5% to 52.8%. For knee replacement surgery, this range was between 34.5% to 69.2% of patients. The median patient BMI for hip replacement in 2019/20 was 28.4 kg/$m^2$ (IQR=25.1-32.3 kg/$m^2$) and for knee replacement, 30.8 kg/$m^2$ (IQR=27.3-34.7 kg/$m^2$). Median patient BMI for hip replacement decreased slightly from 2018/19 while remaining the same for knee replacement. Categories with the highest proportion of paediatric (<18 years) data submitted in 2019/20 continue to be small bowel (12.8% of procedures), cardiac (non-CABG) (7.6%) and spinal surgery (7.3%).

The primary indication for patients undergoing hip and knee replacement is shown in Figures 3a-b. Osteoarthritis continues to be the major reason why patients undergo joint replacement surgery (81.9% for hip; 91.7% for knee). The proportion of hip replacement surgeries carried out as a result of trauma or fracture increased slightly from last year (6.1% *vs* 5.6%).

## Table 1: Patient and surgery-related characteristics by surgical category*, NHS hospitals England, April 2019 to March 2020

| Surgical category | Patient-related characteristics | | | | Surgery-related characteristics | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Median age, IQR (years) | Male (%) | BMI ≥ 30 kg/m² (%) | ASA ≥ 3 (%) | Wound contaminated or dirty (%) | Median surgery duration, IQR (mins) | Median length of stay, IQR (days) | Pre-op stay >1 day (%) | Emergency surgery (%) | Multiple procedures performed (%) | Antibiotic prophylaxis not given (%) | Implant present (%) |
| Abdominal hysterectomy | 50 (45-60) | - | 44.5 | 16.7 | 0.0 | 105 (81-122) | 2 (1-3) | 0.5 | 0.0 | 5.4 | 4.1 | 0.0 |
| Bile duct, liver or pancreatic surgery | 63 (52-72) | 56.6 | 32.5 | 38.7 | 0.8 | 271 (180-398) | 8 (6-15) | 11.2 | 0.3 | 16.1 | 1.4 | 1.9 |
| Breast surgery | 57 (47-68) | 2.2 | 32.0 | 13.2 | 0.0 | 71 (46-103) | 0 (0-1) | 0.4 | 0.1 | 9.6 | 23.0 | 12.7 |
| Cardiac surgery (non-CABG) | 66 (53-74) | 67.1 | 30.3 | 95.5 | 0.0 | 235 (189-300) | 9 (7-17) | 26.5 | 2.0 | 41.0 | 0.6 | 89.0 |
| Cholecystectomy | 68 (58-72) | 62.1 | - | 55.2 | 0.0 | 330 (220-427) | 8 (6-13) | 6.9 | 1.7 | 69.0 | 3.6 | 1.7 |
| Coronary artery bypass graft | 67 (59-74) | 82.8 | 34.1 | 96.5 | 0.0 | 232 (195-275) | 9 (6-14) | 41.0 | 1.6 | 23.5 | 0.4 | 71.3 |
| Cranial surgery | 54 (39-66) | 48.9 | 30.2 | 22.2 | 1.8 | 124 (67-205) | 5 (3-11) | 14.6 | 7.9 | 0.4 | 4.5 | 38.1 |
| Gastric surgery | 62 (51-72) | 60.6 | 29.1 | 56.0 | 7.3 | 240 (126-368) | 8 (3-13) | 10.6 | 1.4 | 15.6 | 1.9 | 2.3 |
| Hip replacement | 71 (62-77) | 40.2 | 38.8 | 27.9 | 0.1 | 83 (65-105) | 3 (2-5) | 4.3 | 0.1 | - | 0.4 | 100.0 |
| Knee replacement | 70 (63-76) | 43.0 | 55.8 | 26.2 | 0.1 | 78 (61-99) | 3 (2-4) | 0.6 | 0.1 | - | 0.3 | 100.0 |
| Large bowel surgery | 68 (56-76) | 51.3 | 23.2 | 44.5 | 19.2 | 185 (132-251) | 8 (5-14) | 15.1 | 6.8 | 13.9 | 1.5 | 6.1 |
| Limb amputation | 68 (57-78) | 75.0 | 19.7 | 89.0 | 20.1 | 61 (41-84) | 26 (15-36) | 70.1 | 8.3 | 2.8 | 16.7 | 1.4 |
| Reduction of long bone fracture | 61 (39-78) | 42.8 | 19.7 | 36.1 | 4.2 | 93 (66-130) | 5 (1-12) | 26.8 | 0.9 | 2.8 | 1.0 | 99.8 |
| Repair of neck of femur | 84 (77-89) | 31.1 | 10.6 | 78.3 | 0.0 | 67 (52-87) | 13 (8-21) | 30.1 | 1.6 | - | 3.5 | 100.0 |
| Small bowel surgery | 58 (35-70) | 50.5 | 21.4 | 55.0 | 38.8 | 135 (88-210) | 10 (6-22) | 31.7 | 14.1 | 27.5 | 2.2 | 1.6 |
| Spinal surgery | 57 (42-70) | 47.2 | 35.9 | 24.2 | 0.5 | 119 (79-179) | 3 (1-7) | 10.5 | 1.9 | 2.7 | 4.2 | 41.1 |
| Vascular surgery | 72 (64-78) | 72.9 | 25.7 | 81.8 | 0.0 | 190 (140-274.5) | 4 (2-10) | 20.7 | 3.4 | 3.4 | 6.1 | 72.0 |

*results for surgical categories with <5 participating hospitals (see Appendix 1) should be interpreted with caution

**Figure 3a: Primary indication for hip replacement surgery, NHS hospitals England, April 2019 to March 2020 (N= 41,067)**

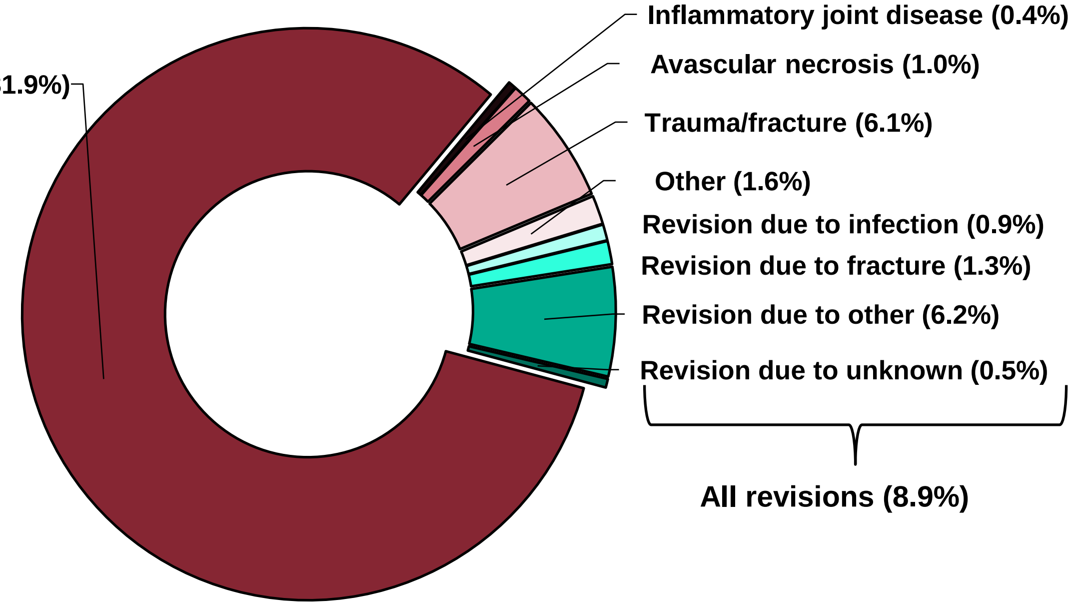
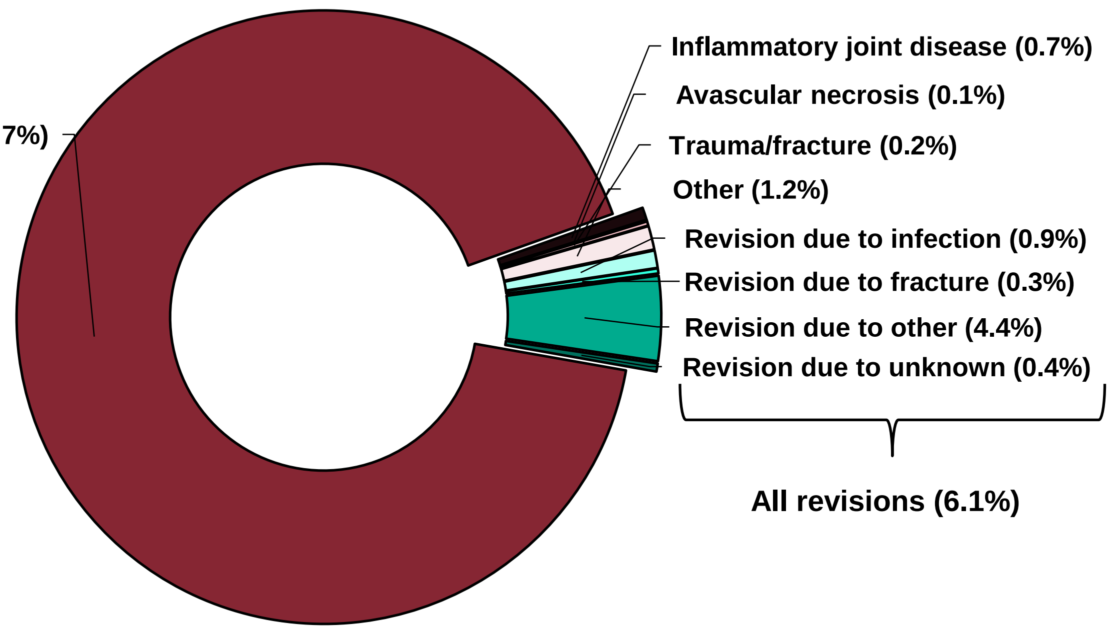



**Figure 3b: Primary indication for knee replacement surgery, NHS hospitals England, April 2019 to March 2020 (N= 44,213)**



# Assessing SSI risk

## Inpatient and readmission SSI risk

Table 2 presents the cumulative SSI incidence (risk) and incidence density by surgical category. Five years of data (April 2015 to March 2020) were used to produce national benchmarks. Inpatient and readmission SSI risk varies greatly depending on the type of surgical procedure.

The highest cumulative incidence (or risk) was observed in bile duct, liver or pancreatic surgery at 9.1%, followed closely by large bowel surgery at 8.3%. These are both procedures carried out on surgical sites with levels of bacterial contamination, contributing to a higher risk of SSI. Hip and knee replacement surgery carry the lowest SSI risk (both 0.5%).

As the national benchmarks are based on 5 years of data they tend to be very robust year to year. Inpatient and readmission SSI risk for bile duct, liver or pancreatic surgery showed the greatest increase this financial year (7.6% in 2018/19), however this surveillance category tends to have lower hospital participation with consequently lower numbers of surgical procedures and is therefore subject to fluctuation. The national benchmark for hip and knee replacement remained stable compared to last year, while a further 0.1% reduction from last year was noted for both reduction of long bone fracture and repair of neck of femur surgery. The national benchmark for large bowel surgery, which historically has always ranked highest, continued to decrease this year. Three years prior (April 2012 to March 2017) the national benchmark had been 9.2%.

For short stay surgeries, such as hip/knee replacement, abdominal hysterectomy, breast, spinal and vascular surgery, over half of SSIs were captured through readmission surveillance, emphasising the importance of post-discharge surveillance.

SSI incidence density accounts for the differences in length of hospital stay for capturing inpatient SSIs. The incidence density of in-hospital SSIs per 1,000 post-operative patient-days varied from 0.2 and 0.3 per 1,000 inpatient days for knee and hip replacement, respectively to 9.7 per 1,000 inpatient days for bile duct, liver or pancreatic surgery. Cholecystectomy had the second highest risk by incidence density (7.8 per 1,000 inpatient days) followed closely by large bowel surgery (6.8 per 1,000).

**Table 2: Inpatient and readmission SSI risk by surgical category, NHS hospitals England, April 2015 to March 2020**

| Surgical category | No. participating hospitals | No. operations | Inpatient and readmission | | | | Inpatient only | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | No. SSIs | SSI incidence (%) | 95% CI | Median time to infection (days) | No. SSIs | Incidence density (per 1,000 patient days) | 95% CI |
| Abdominal hysterectomy | 16 | 2,228 | 41 | 1.8 | (1.3-2.5) | 11 | 13 | 1.7 | (0.9-3.0) |
| Bile duct, liver or pancreatic surgery | 7 | 1,606 | 146 | 9.1 | (7.7-10.6) | 8 | 128 | 9.7 | (8.1-11.5) |
| Breast surgery | 39 | 19,832 | 159 | 0.8 | (0.7-0.9) | 17 | 17 | 0.7 | (0.4-1.2) |
| Cardiac surgery (non-CABG) | 16 | 18,629 | 249 | 1.3 | (1.2-1.5) | 14 | 168 | 0.7 | (0.6-0.9) |
| Cholecystectomy | 8 | 1,459 | 43 | 2.9 | (2.1-4.0) | 6 | 25 | 7.8 | (5.1-11.6) |
| Coronary artery bypass graft | 20 | 29,721 | 883 | 3.0 | (2.8-3.2) | 15 | 481 | 1.7 | (1.6-1.9) |
| Cranial surgery | 10 | 8,379 | 140 | 1.7 | (1.4-2.0) | 19 | 53 | 0.7 | (0.5-0.9) |
| Gastric surgery | 11 | 2,045 | 49 | 2.4 | (1.8-3.2) | 8 | 43 | 2.9 | (2.1-3.9) |
| Hip replacement | 186 | 205,849 | 1,079 | 0.5 | (0.5-0.6) | 19 | 300 | 0.3 | (0.3-0.3) |
| Knee replacement | 176 | 221,605 | 1,022 | 0.5 | (0.4-0.5) | 22 | 184 | 0.2 | (0.2-0.2) |
| Large bowel surgery | 47 | 16,047 | 1,330 | 8.3 | (7.9-8.7) | 8 | 1,126 | 6.8 | (6.4-7.2) |
| Limb amputation | 12 | 1,432 | 28 | 2.0 | (1.3-2.8) | 12 | 19 | 1.0 | (0.6-1.6) |
| Reduction of long bone fracture | 33 | 12,877 | 112 | 0.9 | (0.7-1.0) | 19 | 62 | 0.6 | (0.4-0.7) |
| Repair of neck of femur | 108 | 91,010 | 855 | 0.9 | (0.9-1.0) | 17 | 562 | 0.4 | (0.4-0.4) |
| Small bowel surgery | 22 | 3,730 | 245 | 6.6 | (5.8-7.4) | 8 | 205 | 4.9 | (4.2-5.6) |
| Spinal surgery | 24 | 35,472 | 522 | 1.3 | (1.2-1.5) | 14 | 193 | 0.9 | (0.8-1.1) |
| Vascular surgery | 15 | 5,422 | 137 | 2.5 | (2.1-3.0) | 14 | 61 | 1.7 | (1.3-2.2) |

# Risk factors for SSI

Participants are encouraged to assess their hospital's results stratified by important patient and surgery-related characteristics. The NHSN risk index is used in particular to account for potentially important differences in patient population. The risk index assigns a cumulative score from 0 to 3 based on the presence of the following risk factors: ASA score of 3 or higher, operation duration > 'T-time' (as defined by the $75^{th}$ percentile), and a contaminated or dirty wound. Figure 4 shows the 2019/20 SSI risk across surgical categories for patients whose operation was deemed low risk (NHSN risk index 0 or 1) compared to high risk operations (risk index 2 or 3). Results confirm the importance of this stratification as we see an increased risk in all but one of the presented categories (limb amputation). A risk ratio (RR) was calculated to compare the risk between the 2 groups. A RR >1 suggests an increased SSI risk among those operations deemed high risk with a score of 2 or 3. Where the lower part of the range is also greater than 1 the difference between the 2 groups is considered significant. Within the knee replacement, spinal surgery and reduction of long bone fracture surgical categories, patients who underwent high risk operations were 4 times more likely to experience infection than those undergoing low risk operations. The difference between the 2 groups was statistically significant for bile duct, liver or pancreatic surgery, CABG, hip replacement, knee replacement, large bowel, reduction of long bone fracture, repair of neck of femur and spinal surgery.

An elevated BMI has been shown to increase the likelihood of developing an SSI, particularly among CABG patients (9, 10). Figure 5 shows the 2019/20 SSI risk across surgical categories for patients who are deemed obese (BMI ≥ 30 $kg/m^2$) compared to non-obese patients. In all but one surgical category (large bowel), an increased SSI risk was seen for the obese patient group. The difference in SSI risk between obese and non-obese patients was statistically significant for CABG, hip replacement and reduction of long bone fracture surgery.

**Figure 4: Inpatient and readmission SSI risk adjusted for by NHSN risk index, NHS hospitals England, April 2019 to March 2020**

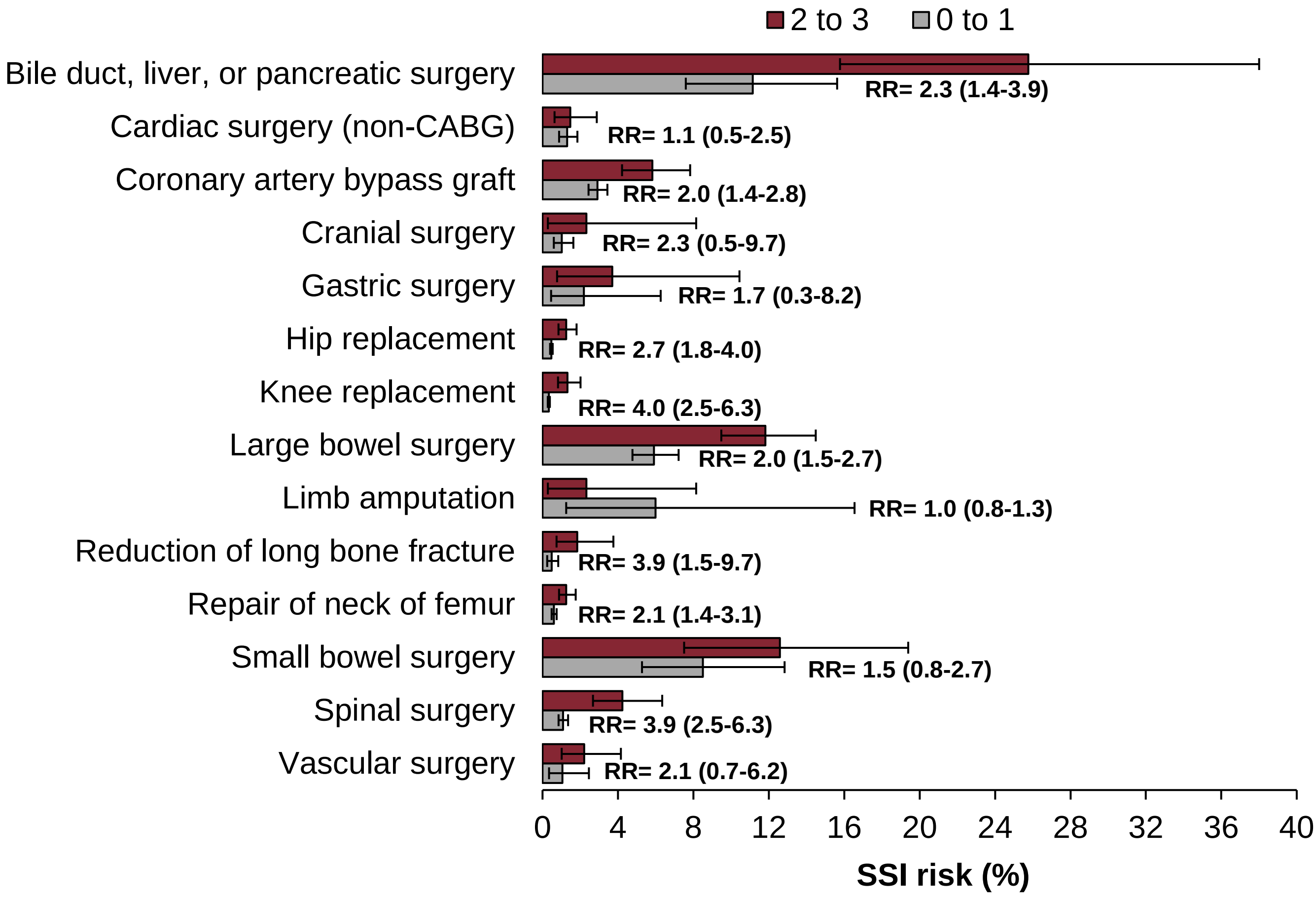



**Figure 5: Inpatient and readmission SSI risk adjusted for patient body mass index, NHS hospitals England, April 2019 to March 2020**

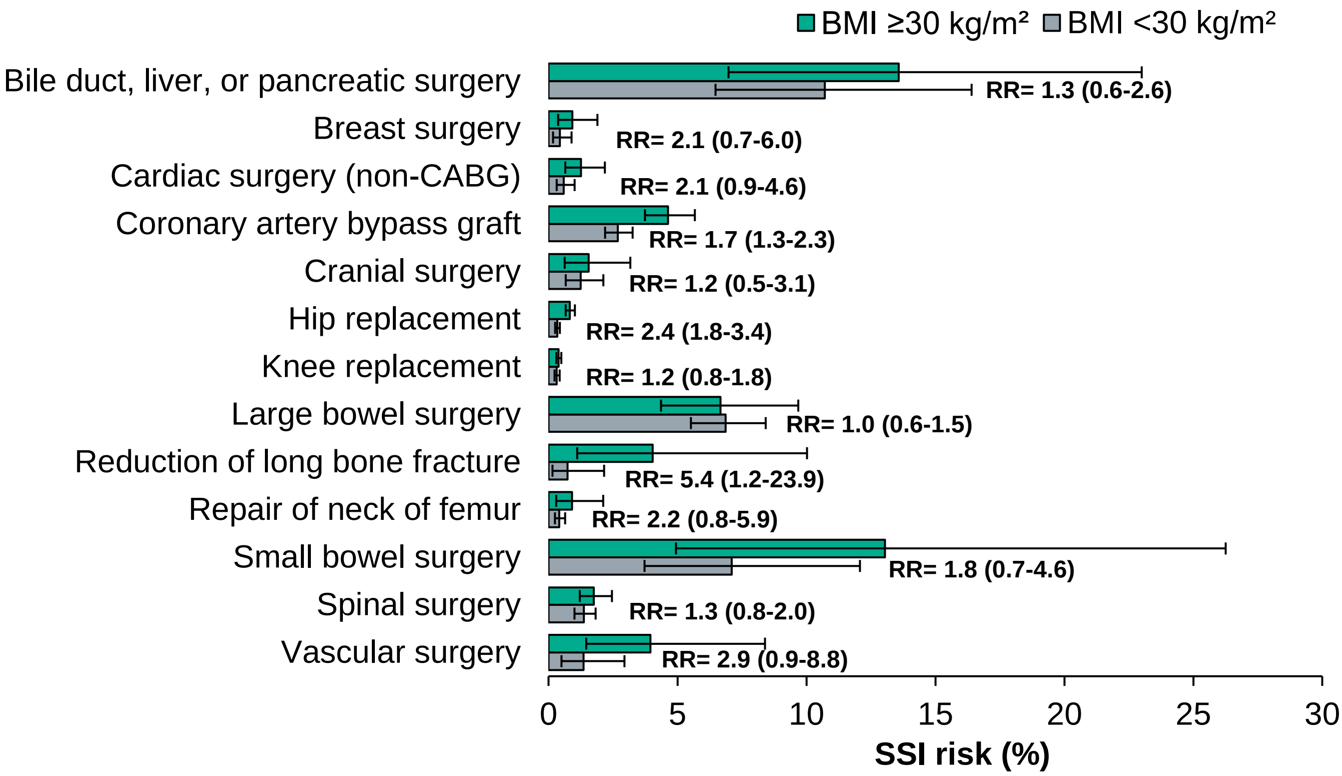


Table 3 shows SSI risk by the primary indication for hip replacement and knee replacement surgery. For both, revision procedures carried a much higher SSI risk than primary procedures (3 and 4 times higher for hip and knee).

**Table 3: Inpatient and readmission SSI risk by primary indication for joint replacement surgeries, NHS hospitals, England, April 2019 to March 2020**

| | | Hip replacement | | | | Knee replacement | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Indication for surgery** | No. operations | No. SSI | SSI risk (%) | 95% CI | No. operations | No. SSI | SSI risk (%) | 95% CI |
| **Primary** | Osteoarthritis | 33,632 | 131 | 0.4 | (0.3-0.5) | 40,567 | 127 | 0.3 | (0.3-0.4) |
| | Inflammatory joint disease | 184 | 2 | 1.1 | (0.1-3.9) | 290 | 0 | 0.0 | (0.0-1.3) |
| | Avascular necrosis | 430 | 5 | 1.2 | (0.4-2.7) | 30 | 0 | 0.0 | (0.0-11.6) |
| | Trauma/fracture | 2,513 | 14 | 0.6 | (0.3-1.0) | 97 | 0 | 0.0 | (0.0-3.7) |
| | Other | 667 | 9 | 1.3 | (0.6-2.5) | 550 | 4 | 0.7 | (0.2-1.9) |
| | **All** | **37,426** | **161** | **0.4** | **(0.4-0.5)** | **41,534** | **131** | **0.3** | **(0.3-0.4)** |
| **Revision** | Infection | 372 | 4 | 1.1 | (0.3-2.7) | 406 | 5 | 1.2 | (0.4-2.9) |
| | Fracture | 538 | 11 | 2.0 | (1.0-3.6) | 116 | 5 | 4.3 | (1.4-9.8) |
| | Other | 2,529 | 28 | 1.1 | (0.7-1.6) | 1,970 | 19 | 1.0 | (0.6-1.5) |
| | Unknown | 202 | 3 | 1.5 | (0.3-4.3) | 187 | 2 | 1.1 | (0.1-3.8) |
| | **All** | **3,641** | **46** | **1.3** | **(0.9-1.7)** | **2,679** | **31** | **1.2** | **(0.2-1.6)** |

# Trends in SSI risk

Figure 6 shows 10-year annual trends in SSI incidence (risk) for all surgical categories. SSI incidence is broken down by detection method: inpatient, readmission and combined inpatient and readmission. Trend analyses were not performed for surgical categories with <5 participating hospitals in the most recent financial year. It is important to note that annual trends use crude SSI incidence and do not account for potential changes in risk factors for SSI over time or level of annual hospital participation.

Over the past 10 years, inpatient and readmission SSI incidence following hip and knee replacement surgery has been relatively stable, with slight annual decreases from 2012/13. After annual inpatient and readmission SSI incidence for hip replacement reached its lowest at 0.4% in 2018/19, it returned to 0.5% in 2019/20 (Figure 6a). Annual inpatient and readmission SSI incidence following knee replacement has remained stable around 0.4% (Figure 6b). For both hip and knee replacement, historical declines from 2010/11 can largely be attributed to the reduction in SSIs detected during the inpatient stay. This may be explained by the decrease in the length of stay in hospital for hip and knee replacement surgery over time (both hip/knee median length of stay was 5 days in 2010/11 compared to 3 days in 2019/20). In 2019/20 however, although incidence of inpatient SSIs for hip replacement continued to decline, the incidence of readmission SSIs increased. The trend for the inpatient and readmission SSI risk following reduction of long bone fracture has shown greater variability over the years (Figure 6c). After a peak in 2014/15 at 1.4%, the rate showed a decreasing trend until 0.8% in 2016/17 and then increased again to 1.0% in 2018/19. In 2019/20 annual incidence decreased again by 0.4% to its lowest in 10 years at 0.6%. In contrast, repair of neck of femur (Figure 6d) has seen an overall continuous decline in the inpatient and readmission SSI incidence since 2009/10 despite no change in length of stay, from 1.6% to 0.7% in 2019/20.

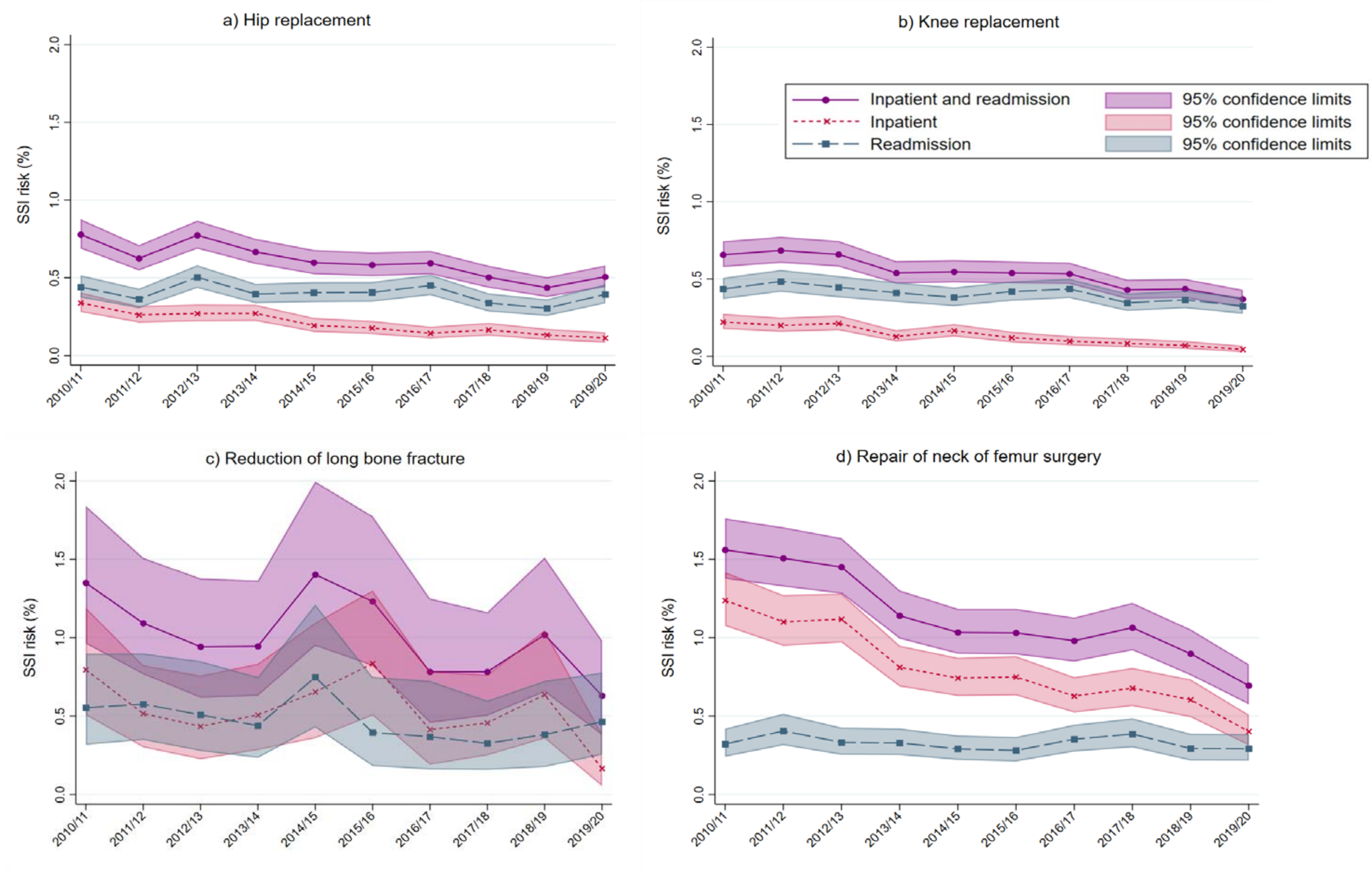
Of the gastrointestinal categories, all showed a differing trend to that reported in 2018/19 (Figures 6e-g). The SSI risk following large bowel surgery decreased again reaching its lowest reported annual inpatient and readmission risk of 7.7%. For small bowel surgery, the risk reached its highest in 10 years at 10.0%. This was 4.4% higher than what was seen in 2018/19. Volumes of small bowel procedures submitted for surveillance in 2019/20 were lower than in the previous year. Gastric surgery incidence has a fair degree of variability due to lower procedure numbers, but it also saw an annual increase (up 1.2%).

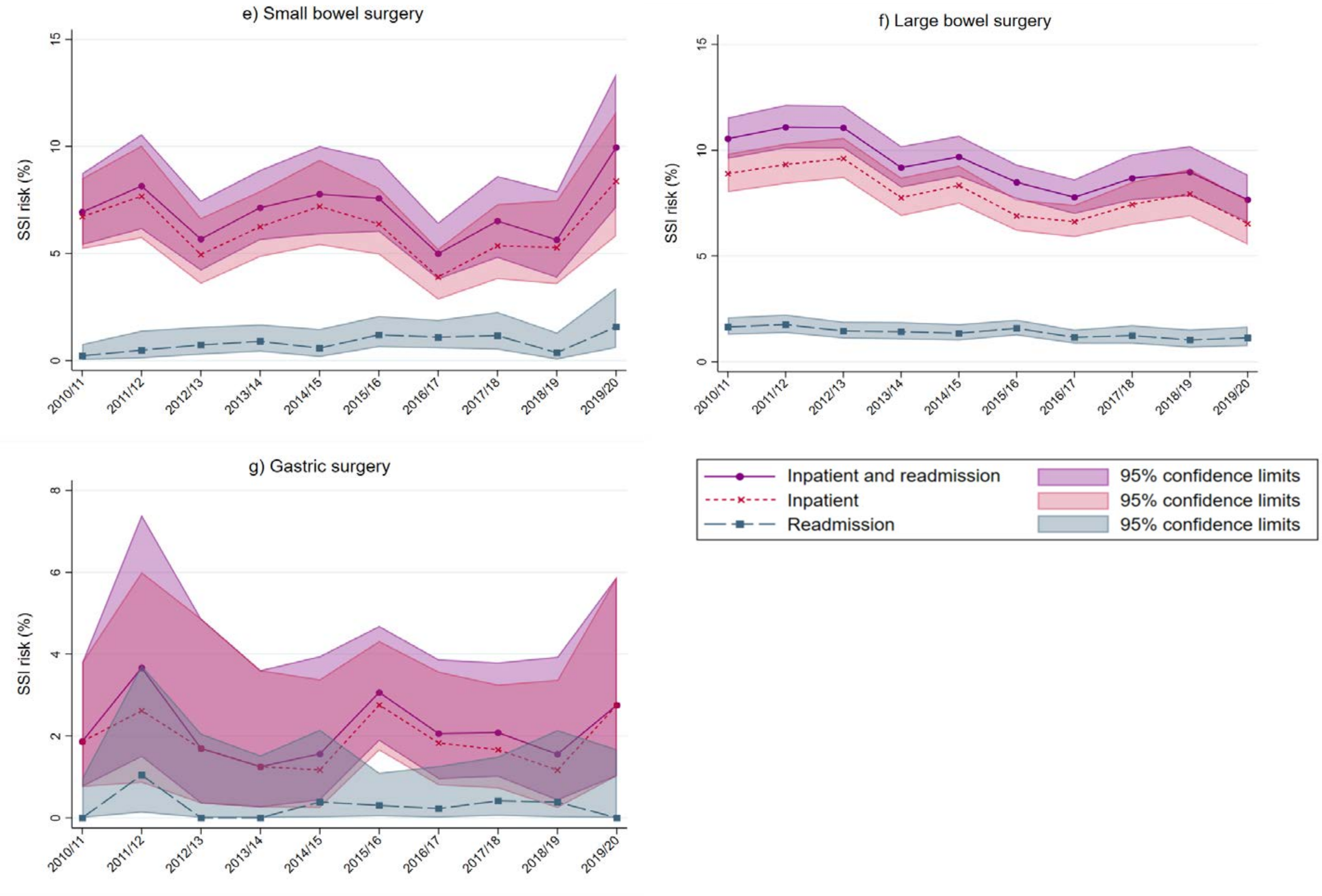
Despite reporting an overall decreasing 10-year trend for CABG last year (Figure 6h), SSI risk in 2019/20 increased to 3.3% from 2.3% in 2018/19. This included infections at vein harvesting sites and the sternum. Vascular surgery and cardiac surgery (non-CABG) show greater variability around the calculated annual incidence trend

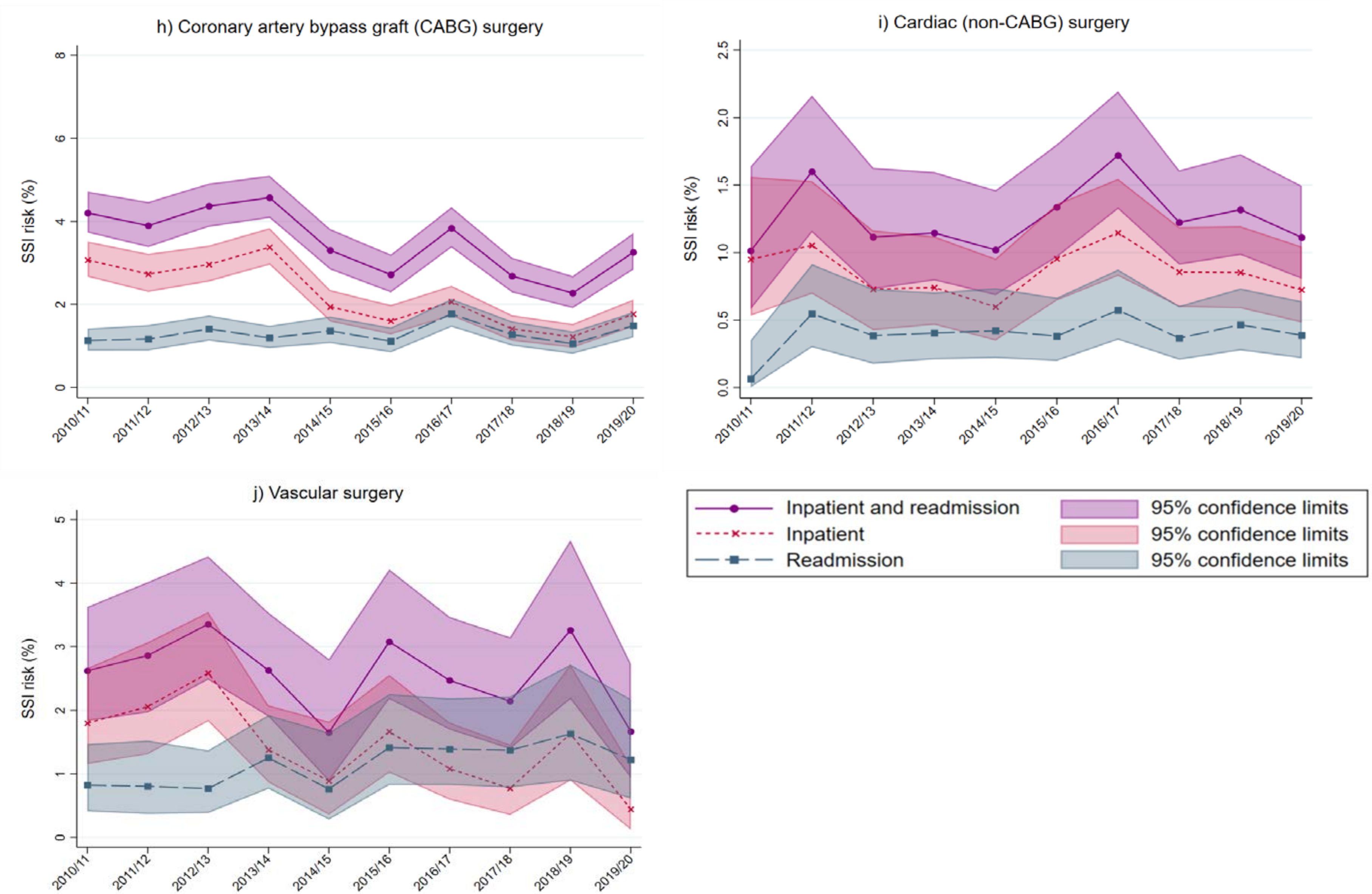
(Figure 6i-j). While both saw decreases in SSI risk for 2019/20, vascular surgery saw a steeper drop from 3.3% in 2018/19 to 1.7% in 2019/20.

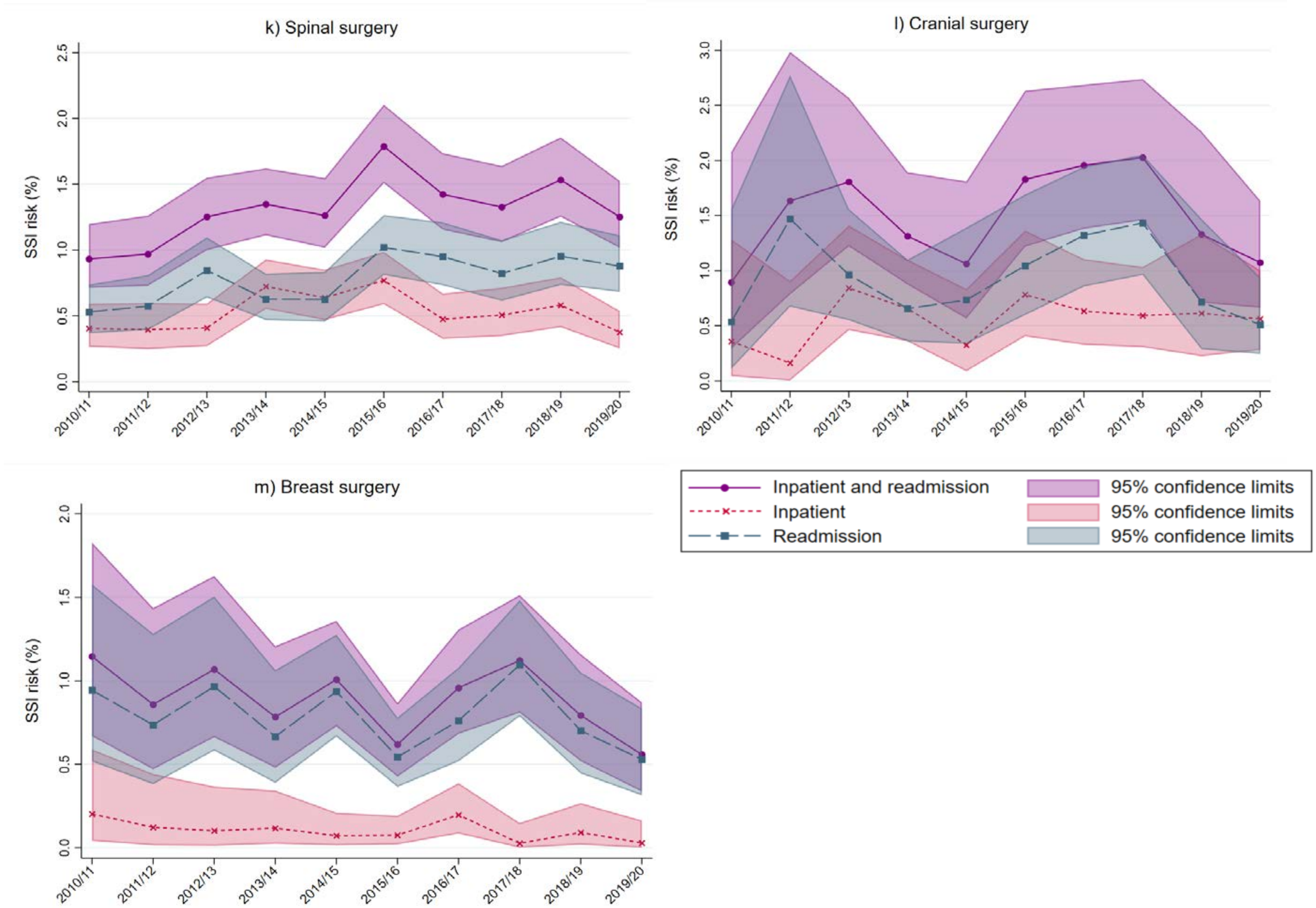
Overall, the SSI risk following breast surgery (Figure 6m) in 2019/20 (0.6%) was half of that reported in 2010/11 (1.2%) and has shown a declining trend over the last 3 years. Spinal surgery has been fluctuating over the past 10 years after peaking at 1.8% in 2015/16. In 2019/20 we saw a slight annual decrease (by 0.3%) to 1.2%. Among the remaining surgical categories, there were no sustained trends of note.

**Figures 6a-m: Trends in annual SSI incidence for all surgical categories, NHS hospitals England, April 2010 to March 2020**




e) Small bowel surgery
f) Large bowel surgery
g) Gastric surgery
SSI risk (%)
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/20
Inpatient and readmission
Inpatient
Readmission
95% confidence limits


h) Coronary artery bypass graft (CABG) surgery
SSI risk (%)
0
2
4
6
8
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/20
i) Cardiac (non-CABG) surgery
SSI risk (%)
0.0
0.5
1.0
1.5
2.0
2.5
j) Vascular surgery
SSI risk (%)
0
1
2
3
4
5
Inpatient and readmission
Inpatient
Readmission
95% confidence limits
95% confidence limits
95% confidence limits

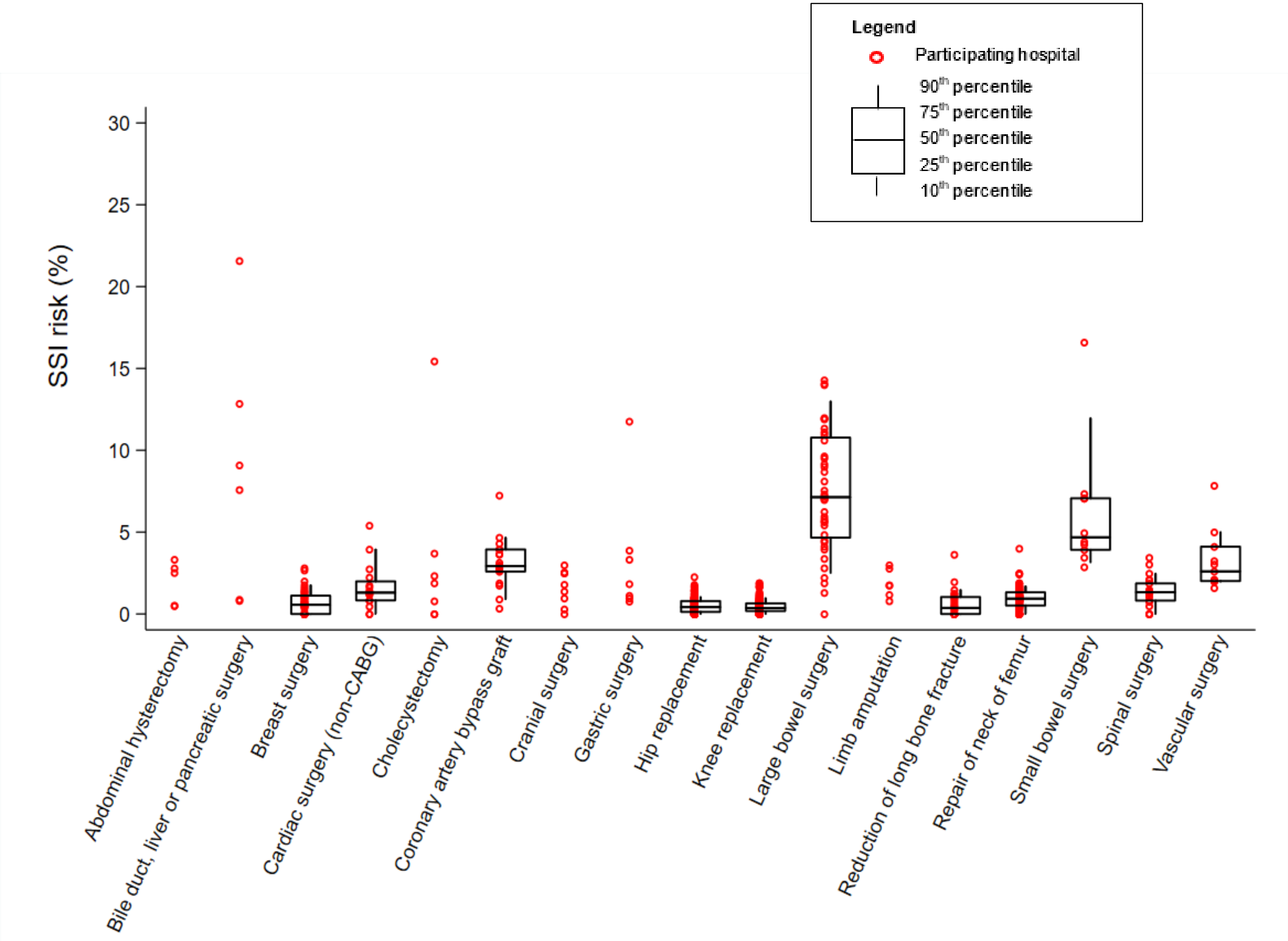

k) Spinal surgery
SSI risk (%)
0.0
0.5
1.0
1.5
2.0
2.5
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/20
l) Cranial surgery
SSI risk (%)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
m) Breast surgery
SSI risk (%)
Inpatient and readmission
Inpatient
Readmission
95% confidence limits
95% confidence limits
95% confidence limits

# Variation in SSI risk between hospitals

Figure 7 shows the distribution of the SSI risk, based on 5 years of cumulative data, across participating hospitals by surgical category using box-and-whisker plots. The box is formed of a lower quartile (25$^{th}$ to 50$^{th}$ percentile) and an upper quartile (50$^{th}$ to 75$^{th}$ percentile), defining an expected range of results. The 'whiskers', which are used to indicate variability outside the upper and lower quartile, use the 10$^{th}$ and 90$^{th}$ percentile to represent the extreme ends of the distribution and highlight hospital outliers which fall outside this range. Each red dot represents a participating hospital.

Large bowel surgery continues to show the greatest variability, with hospital SSI risk ranging from 0% to 25.6%, indicating that there may be room for improvement across hospitals in infection prevention, and possibly case ascertainment. Hip and knee replacement showed the least variation, with most hospitals hovering around the median. High outlier hospitals however, can still be identified for these categories. The degree of inter-hospital variation within categories remained consistent with that observed from the previous year (April 2014 to March 2019) for almost half of surgical categories with presented box plots (7 of 12). Two of the 12 surgical categories had a slightly narrower interquartile range (difference between the 25$^{th}$ and 75$^{th}$ percentiles) indicating less variation while 3 of the 12 surgical categories had wider interquartile ranges. When the current interquartile range was compared to the previous year, both cardiac surgeries (CABG and non-CABG) had the greatest percentage change (both 27%) meaning there was less variation seen this year in the SSI risk across hospitals.

**Figure 7: Distribution of inpatient and readmission SSI risk by surgical category*, NHS hospitals, England, April 2015 to March 2020**




*categories with <10 hospitals participating within this time period are presented as a distribution without a box plot

# Outlier assessment

In 2019/20, there were 3 NHS trusts performing orthopaedic surgery who did not comply with the mandatory requirements for participation in the SSISS and were notified by letter. For the mandatory orthopaedic categories, outliers are assessed at the end of each financial year across all NHS trusts and treatment centres using funnel plots to account for differences in surgical volume. Figures 8a-d show funnel plots displaying variation in the SSI risk among trusts in 2019/20 for orthopaedic categories. The cumulative incidence of SSI per 100 procedures is plotted against the number of procedures for each participating NHS trust/treatment centre. The upper and lower 95% confidence limits (red lines) define the 'limits' of expected variation. Trusts lying outside these limits are outliers. The 99% confidence limits (dashed lines) are presented to represent the expected variation within which 99% of results should fall. The 95% confidence limits represent warning lines, whereas falling outside of the 99% confidence limits would signify the need for action.

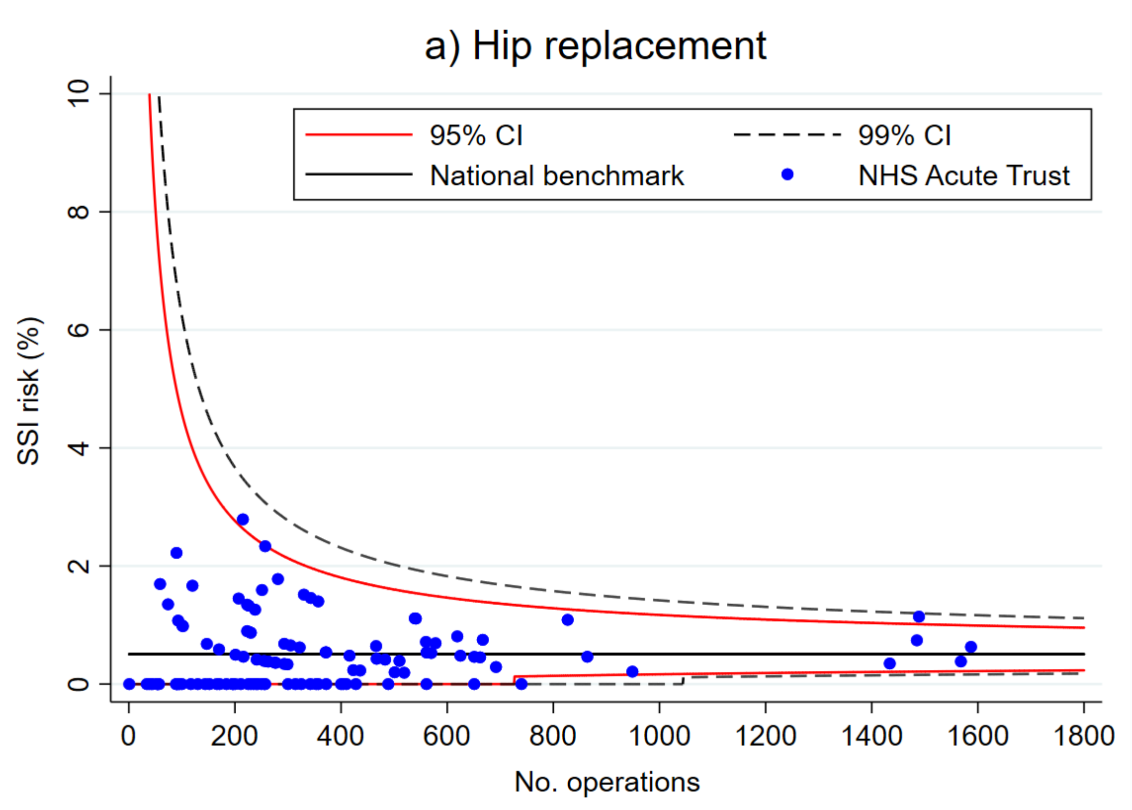
Results for 2019/20 continue to show decreased variation across trusts and more consistent grouping around the national benchmark for hip and knee replacement surgery. Compared to 2018/19, there was also less spread in the results for the reduction of long bone fracture and repair of neck of femur surgery.

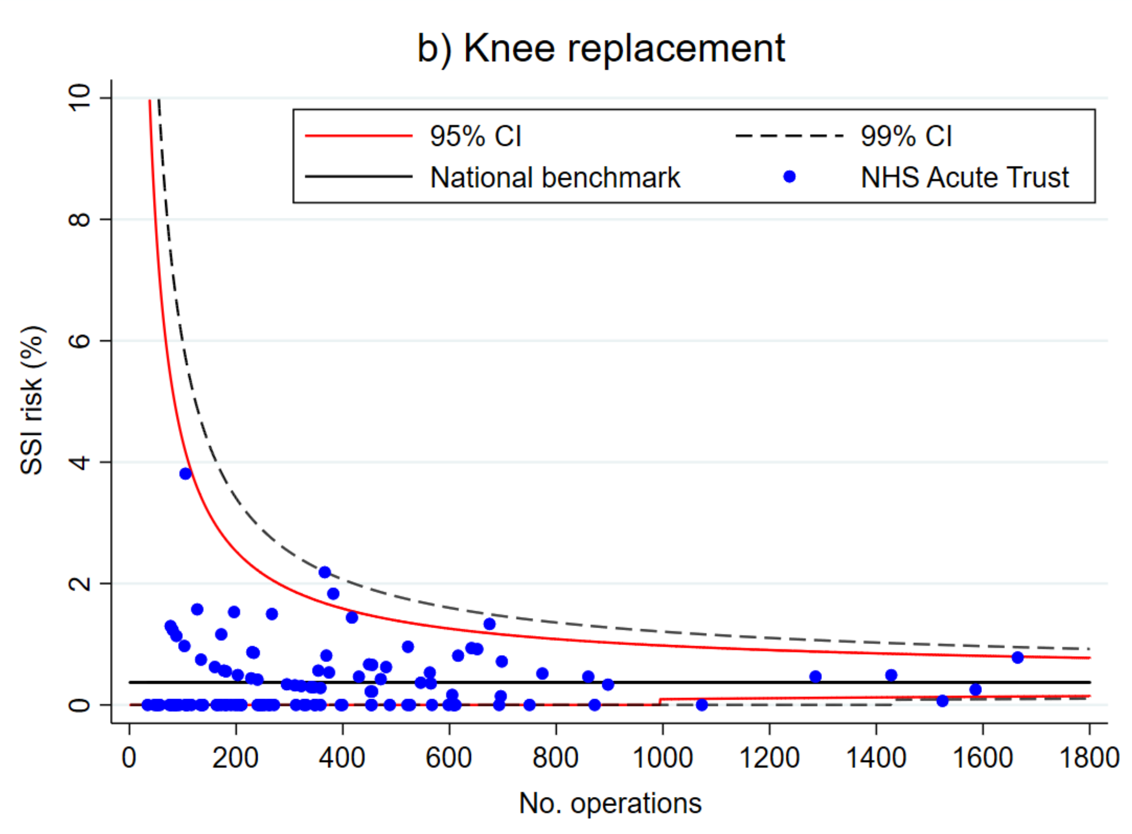
Six NHS acute trusts or treatment centres were identified as statistical high outliers (falling above the 95% upper confidence limits) across the 4 mandatory orthopaedic categories in 2019/20 (3 for knee replacement, 2 for hip replacement, 1 for repair of neck of femur). Four NHS acute trusts or treatment centres were identified as statistical low outliers (falling below the 95% lower confidence limits). Only one of the 6 providers notified as high outliers had a previous history of being an outlier in the same category within the last 3 years; while 3 quarters of the providers deemed low outliers had a previous notification. Those who receive notifications as low outliers are more likely to have had a previous history of being a low outlier.

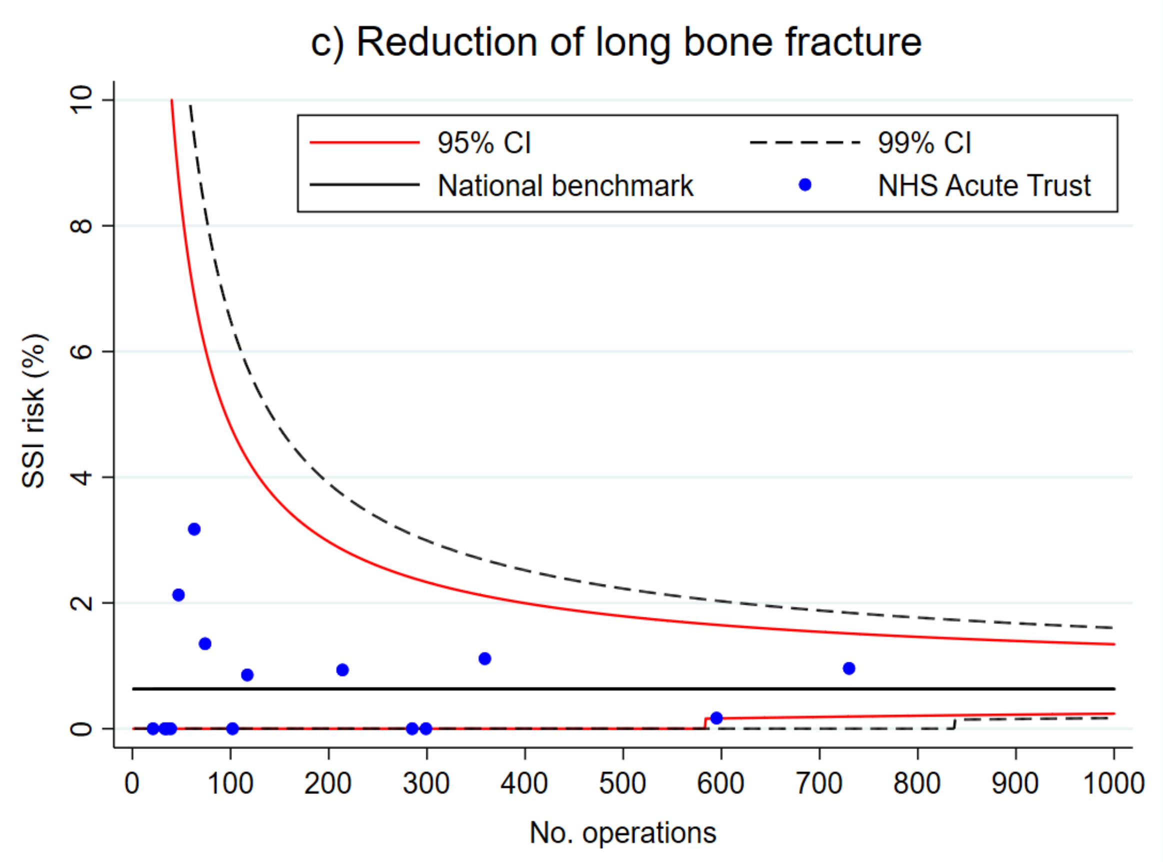
As part of this report, SSI risk results by NHS acute trust (and NHS treatment centre) for the last 2 financial years (2018/19 and 2019/20) are published in separate accompanying tables at www.gov.uk/government/publications/surgical-site-infections-ssi-surveillance-nhs-hospitals-in-england

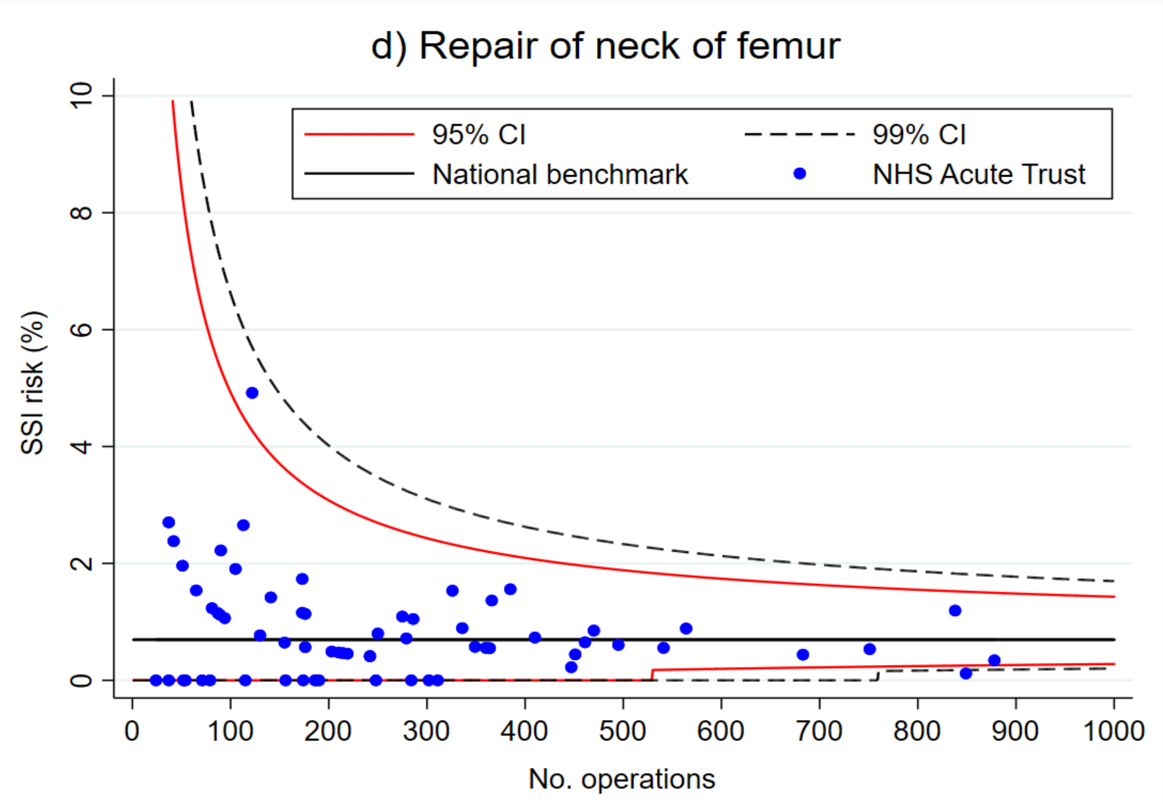
Annual trust-level results for hip and knee replacement surgery are also made available through PHE's public reporting tool, Fingertips at fingertips.phe.org.uk/profile/amr-local-indicators. The tool also allows users to group results by trust type (that is teaching, non-teaching, and specialty) or NHS sub-region and compare to a corresponding overall group average.

**Figures 8a-d: Distribution of inpatient and readmission SSI risk, NHS acute trusts and treatment centres England, April 2019 to March 2020**




c) Reduction of long bone fracture
95% CI
99% CI
National benchmark
NHS Acute Trust
SSI risk (%)
0
2
4
6
8
10
0
100
200
300
400
500
600
700
800
900
1000
No. operations


d) Repair of neck of femur
95% CI
99% CI
National benchmark
NHS Acute Trust
SSI risk (%)
0
2
4
6
8
10
0
100
200
300
400
500
600
700
800
900
1000
No. operations

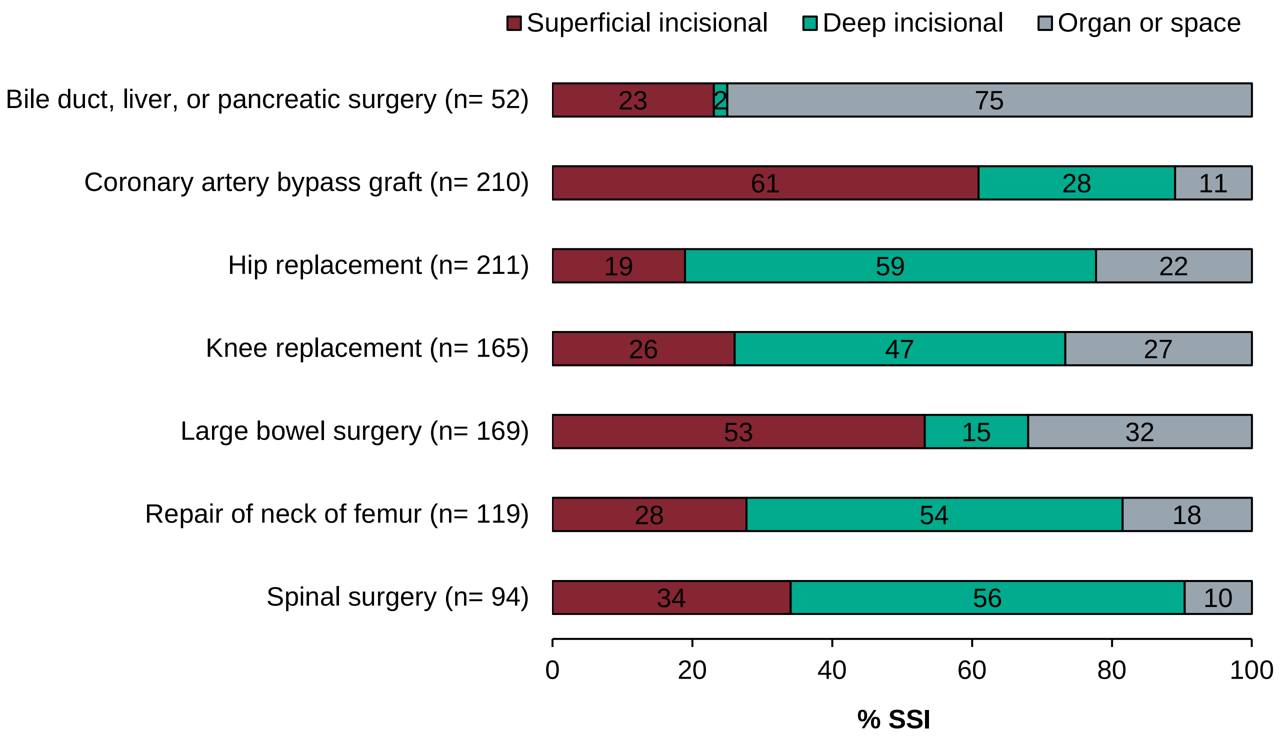
# Characteristics of SSIs

## Focus of SSI

The distribution of SSI types (superficial, deep or organ/space) by surgical procedure are shown in Figure 9 where the number of inpatient and readmission SSIs were ≥50. Type of infection varied between surgical category and may be attributed to differences in length of stay in hospital and follow-up care. Surgical categories with a shorter stay in hospital see relatively more readmission-detected SSIs, which in turn increases the proportion of more serious wound complications. Patients undergoing procedures with a longer stay in hospital will undergo regular wound reviews so that infections may be more likely to get detected during the inpatient stay.

CABG and large bowel surgery continue to report the highest proportions of superficial incisional infections (61.0% and 53.3%, respectively) and both are long stay procedures. Compared to 2018/19, the proportion of superficial SSIs following hip replacement surgery continues to decline (19.0% *vs* 29.0%) as the proportion of deep incisional SSIs increases (58.8% *vs* 42.6%). Organ or space SSIs make up the large majority of infections following bile duct, liver or pancreatic surgeries (75.0%).

**Figure 9: Distribution of SSI type for inpatient and readmission-detected cases by surgical category, NHS hospitals England, April 2019 to March 2020**



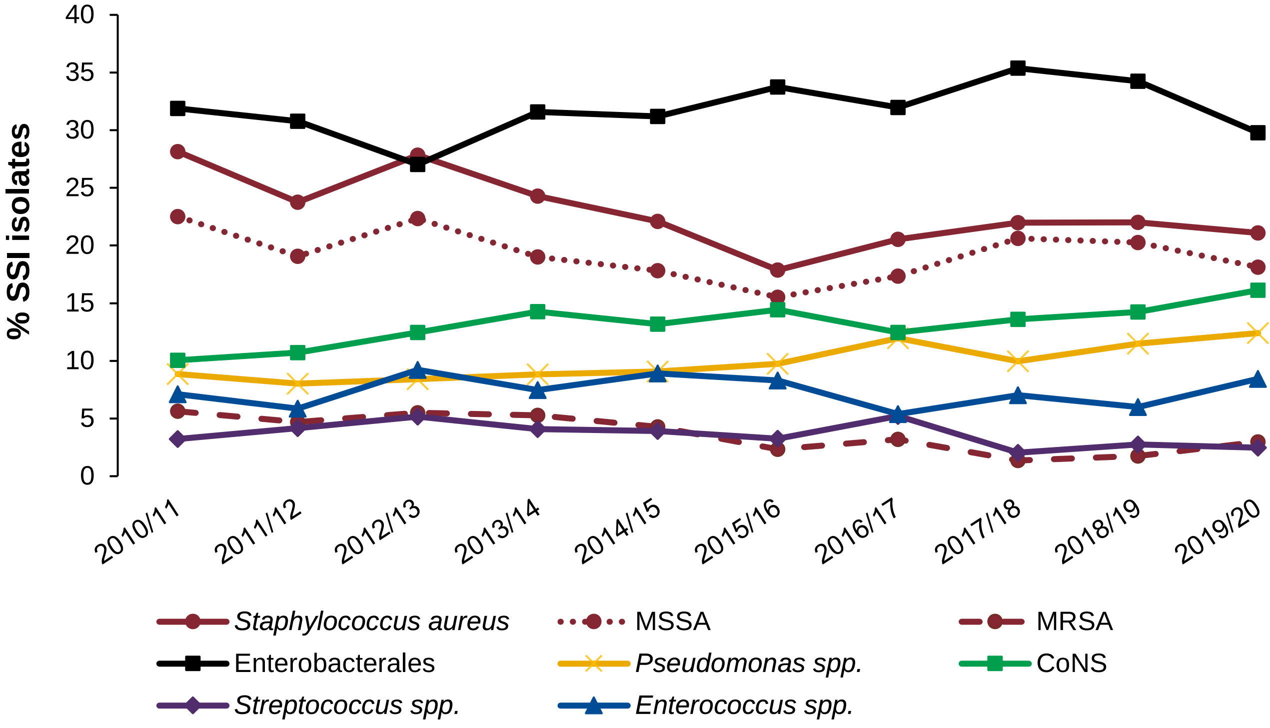
# Causative organisms

Figure 10 shows 10-year trends in microbial aetiology of inpatient and readmission-detected SSIs across all surgical categories. During this time period there were 15,552 inpatient and readmission-detected SSIs reported, 68% (N=10,592) of which had accompanying microbiology data. According to the PHE SSISS case definitions, positive microbiology is not essential to meet the SSI case definition provided there are other clinical indicators.

Enterobacterales remain the most prevalent causative organisms for all SSIs. In 2019/20 they were attributed to 29.8% of superficial SSIs and 26.2% of deep incisional or organ/space SSIs. The most common Enterobacterales species was *Escherichia coli* (32%). The second most prevalent causative organism is *Staphylococcu*s *aureus*. The margin between Enterobacterales-caused SSIs and *S. aureus* SSIs is much smaller for deep or organ/space SSIs where *S. aureus* is attributed to 24.2%. This represents a 5% increase from 2018/19, reflecting an increase in the methicillin-sensitive form (MSSA) in particular. In general, the proportion of *S. aureus* SSIs that were deep or organ/space has remained relatively stable over the last 10 years while the proportion of superficial *S. aureus* SSIs showed a decreasing trend. Coagulase-negative staphylococci (CoNS) made up a higher proportion of cases among the deep incisional or organ/space SSI (20.1% *vs* 16.1% in 2019/20), whereas *Pseudomonas* spp. was higher among superficial cases (12.4% *vs* 5.3%).

**Figure 10. Micro-organisms reported as causing inpatient and readmission SSIs, all surgical categories, NHS hospitals England, April 2010 to March 2020**

**a) superficial SSIs**




**b) deep incisional or organ/space SSIs**

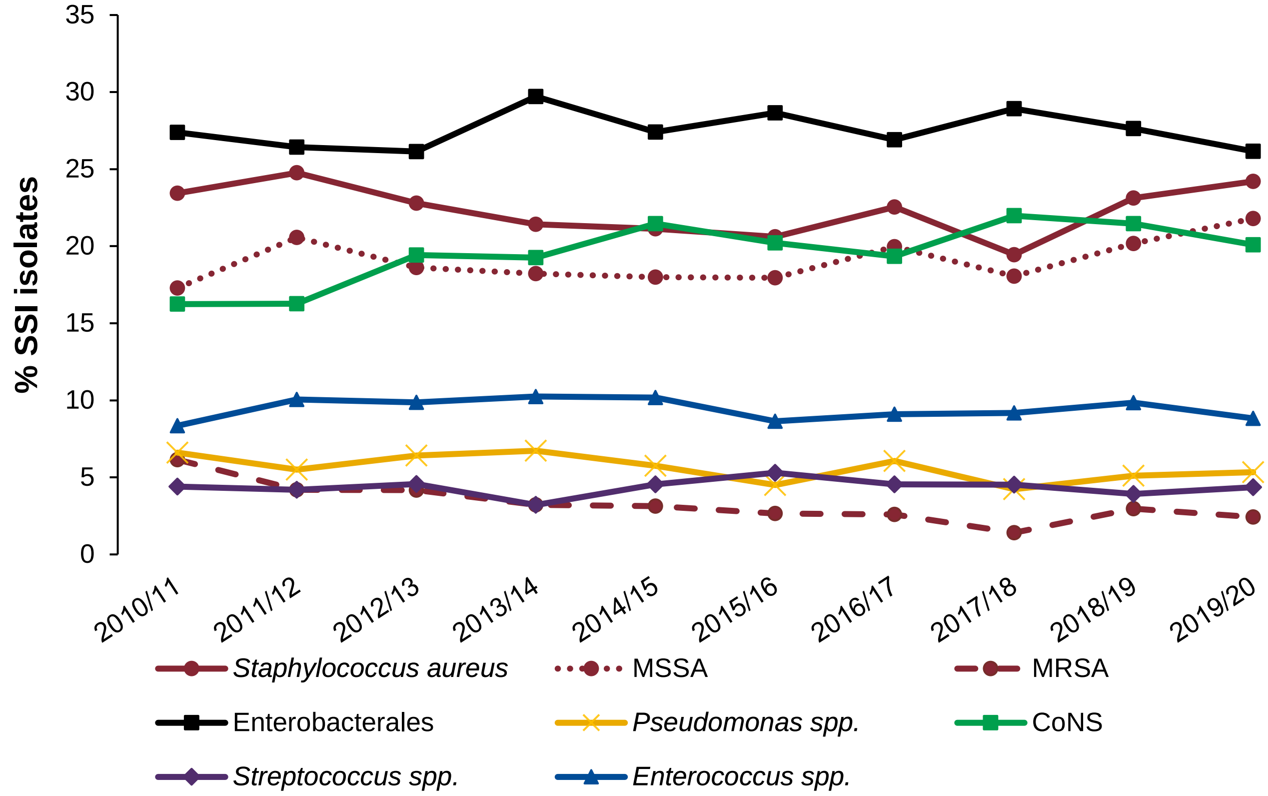


Table 4 breaks down the distribution of organisms reported as causing inpatient and readmission-detected SSIs by surgical category for a) superficial only SSIs and b) deep or organ/space SSIs. Five years of data were used for these analyses (April 2015 to March 2020) to increase sample sizes.

Among monomicrobial SSIs (single organism reported as causing SSI), MSSA is the dominant causative organism for joint replacement and spinal surgery. CoNs organisms make up a third of all spinal superficial SSIs (29.3%) and about a quarter of CABG (26.2%), hip replacement (21.6%) and knee replacement (22.1%) superficial SSIs. When deep incisional or organ/space SSIs only were considered, almost a quarter of repair of neck of femur surgeries were attributed to CoNs (22.4%). As expected, Enterobacterales-caused SSI are most prevalent in large bowel surgery, contributing 48.5% of superficial SSIs and 55.7% of deep or organ/space SSIs. Compared to last year the proportion of Enterobacterales-caused SSIs for CABG was slightly lower (superficial: 26.2% *vs* 29.5%; deep or organ/space: 29.5% *vs* 32.4%). Enterobacterales made up a larger proportion of SSIs for repair of neck of femur surgery and spinal surgery once restricted to deep and organ/space SSI only (repair of neck of femur: 22.0% ‘superficial SSI’ *vs* 28.2% ‘deep and organ/space SSI’; spinal: 15.9% ‘superficial SSI’ *vs* 19.3% ‘deep and organ/space SSI’.

Polymicrobial SSIs (cases with more than 1 organism reported as causing SSI) are most frequent in large bowel surgery (41%) and CABG (35%). The proportions are more pronounced in deep and organ/space SSI only compared to superficial (large bowel: 52.1% ‘deep and organ/space SSI’ *vs* 34.0% ‘superficial SSI’).

Around half of superficial polymicrobial infections involved a combination of Gram-positive and Gram-negative organisms across all surgical categories (ranging from 43.2% for knee replacement to 62.5% for hip replacement). Among deep and organ/space SSI however, the proportions of Gram-positive and Gram-negative polymicrobials decreased significantly for spinal surgery (47.1% *vs* 24.4%). The proportion of polymicrobial superficial SSIs caused by combinations of Gram-negative bacteria was highest for large bowel and CABG surgery (24.4% and 18.4%, respectively). The remaining categories had a higher proportion of Gram-positive only combinations (ranging from 21.6% for knee replacement to 35.3% for spinal surgery). For deep and organ/space SSI only, the Gram-negative polymicrobial infections decrease across all surgical categories, except CABG (18.4% ‘superficial SSI’ *vs* 22.4% ‘deep and organ/space SSI’). In turn, the proportion of deep and organ/space SSIs caused by Gram-positive combinations was almost double that for superficial SSI for hip replacement (44.4% ‘deep and organ/space SSI’ *vs* 22.5% ‘superficial SSI’), knee replacement (44.3% ‘deep and organ/space SSI’ *vs* 21.6% ‘superficial SSI’) and spinal (58.9% ‘deep and organ/space SSI’ *vs* 35.3% ‘superficial SSI’). Proportions for CABG and large bowel surgery remained relatively similar.

**Table 4. Micro-organisms causing inpatient and readmission-detected SSIs, by surgical category, NHS hospitals England, April 2015 to March 2020**

**a) superficial SSIs only**

| | | Hip replacement | | Knee replacement | | Repair of neck of femur | | Large bowel surgery | | Spinal surgery | | Coronary artery bypass graft | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Reported causative organism** | **No.** | **%** | **No.** | **%** | **No.** | **%** | **No.** | **%** | **No.** | **%** | **No.** | **%** |
| Monomicrobial | Methicillin-sensitive *S.aureus* | 42 | 30.2 | 45 | 43.3 | 49 | 39.8 | 14 | 4.6 | 41 | 50.0 | 51 | 20.6 |
| | Methicillin-resistant *S.aureus* | 6 | 4.3 | 5 | 4.8 | 12 | 9.8 | 4 | 1.3 | 0 | 0.0 | 9 | 3.6 |
| | Coagulase-staphylococci | 30 | 21.6 | 23 | 22.1 | 14 | 11.4 | 10 | 3.3 | 24 | 29.3 | 65 | 26.2 |
| | Enterobacterales | 28 | 20.1 | 11 | 10.6 | 27 | 22.0 | 147 | 48.5 | 13 | 15.9 | 65 | 26.2 |
| | *Pseudomonas* | 16 | 11.5 | 5 | 4.8 | 10 | 8.1 | 44 | 14.5 | 3 | 3.7 | 38 | 15.3 |
| | *Streptococcus* | 2 | 1.4 | 5 | 4.8 | 2 | 1.6 | 12 | 4.0 | 1 | 1.2 | 2 | 0.8 |
| | *Enterococcus* | 7 | 5.0 | 5 | 4.8 | 4 | 3.3 | 22 | 7.3 | 0 | 0.0 | 3 | 1.2 |
| | Other bacteria | 8 | 5.8 | 5 | 4.8 | 4 | 3.3 | 39 | 12.9 | 0 | 0.0 | 14 | 5.6 |
| | Fungi including *Candida* spp. | 0 | 0.0 | 0 | 0.0 | 1 | 0.8 | 11 | 3.6 | 0 | 0.0 | 1 | 0.4 |
| | **Total monomicrobial** | **139** | **100** | **104** | **100** | **123** | **100** | **303** | **100** | **82** | **100** | **248** | **100** |
| Polymicrobial | Gram-positive combinations only | 9 | 22.5 | 8 | 21.6 | 9 | 23.7 | 5 | 3.2 | 12 | 35.3 | 19 | 18.4 |
| | Gram-negative combinations only | 4 | 10.0 | 6 | 16.2 | 6 | 15.8 | 38 | 24.4 | 5 | 14.7 | 19 | 18.4 |
| | Gram positive and Gram-negative combinations | 25 | 62.5 | 16 | 43.2 | 17 | 44.7 | 77 | 49.4 | 16 | 47.1 | 56 | 54.4 |
| | Other | 2 | 5.0 | 7 | 18.9 | 6 | 15.8 | 36 | 23.1 | 1 | 2.9 | 9 | 8.7 |
| | **Total polymicrobial** | **40** | **100** | **37** | **100** | **38** | **100** | **156** | **100** | **34** | **100** | **103** | **100** |
| | **Total cases*** | **179** | **100** | **141** | **100** | **161** | **100** | **459** | **100** | **116** | **100** | **351** | **100** |

### b) deep incisional or organ/space SSIs

| | **Reported causative organism** | **Hip replacement No.** | **Hip replacement %** | **Knee replacement No.** | **Knee replacement %** | **Repair of neck of femur No.** | **Repair of neck of femur %** | **Large bowel surgery No.** | **Large bowel surgery %** | **Spinal surgery No.** | **Spinal surgery %** | **Cranial surgery No.** | **Cranial surgery %** | **Coronary artery bypass graft No.** | **Coronary artery bypass graft %** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monomicrobial | Methicillin-sensitive *S.aureus* | 153 | 32.3 | 184 | 40.7 | 76 | 21.8 | 2 | 1.4 | 108 | 44.4 | 25 | 28.4 | 42 | 23.0 |
| | Methicillin-resistant *S.aureus* | 19 | 4.0 | 14 | 3.1 | 26 | 7.5 | 2 | 1.4 | 6 | 2.5 | 1 | 1.1 | 9 | 4.9 |
| | Coagulase-negative staphylococci | 119 | 25.1 | 108 | 23.9 | 78 | 22.4 | 5 | 3.6 | 55 | 22.6 | 10 | 11.4 | 42 | 23.0 |
| | Enterobacterales | 103 | 21.7 | 45 | 10.0 | 98 | 28.2 | 78 | 55.7 | 47 | 19.3 | 28 | 31.8 | 54 | 29.5 |
| | *Pseudomonas* | 6 | 1.3 | 15 | 3.3 | 15 | 4.3 | 8 | 5.7 | 8 | 3.3 | 4 | 4.5 | 18 | 9.8 |
| | *Streptococcus* | 39 | 8.2 | 41 | 9.1 | 7 | 2.0 | 5 | 3.6 | 5 | 2.1 | 1 | 1.1 | 1 | 0.5 |
| | *Enterococcus* | 13 | 2.7 | 15 | 3.3 | 27 | 7.8 | 16 | 11.4 | 5 | 2.1 | 0 | 0.0 | 4 | 2.2 |
| | Other bacteria | 20 | 4.2 | 29 | 6.4 | 19 | 5.5 | 20 | 14.3 | 8 | 3.3 | 19 | 21.6 | 12 | 6.6 |
| | Fungi including *Candida* spp. | 2 | 0.4 | 1 | 0.2 | 2 | 0.6 | 4 | 2.9 | 1 | 0.4 | 0 | 0.0 | 1 | 0.5 |
| | **Total monomicrobial** | **474** | **100** | **452** | **100** | **348** | **100** | **140** | **100** | **243** | **100** | **88** | **100** | **183** | **100** |
| Polymicrobial | Gram-positive combinations only | 106 | 44.4 | 74 | 44.3 | 67 | 33.3 | 6 | 3.9 | 53 | 58.9 | 6 | 31.6 | 29 | 23.2 |
| | Gram-negative combinations only | 19 | 7.9 | 14 | 8.4 | 25 | 12.4 | 36 | 23.7 | 11 | 12.2 | 4 | 21.1 | 28 | 22.4 |
| | Gram positive and Gram-negative combinations | 107 | 44.8 | 67 | 40.1 | 94 | 46.8 | 69 | 45.4 | 22 | 24.4 | 6 | 31.6 | 50 | 40.0 |
| | Other | 7 | 2.9 | 12 | 7.2 | 15 | 7.5 | 41 | 27.0 | 4 | 4.4 | 3 | 15.8 | 18 | 14.4 |
| | **Total polymicrobial** | **239** | **100** | **167** | **100** | **201** | **100** | **152** | **100** | **90** | **100** | **19** | **100** | **125** | **100** |
| | **Total cases*** | **713** | **100** | **619** | **100** | **549** | **100** | **292** | **100** | **333** | **100** | **107** | **100** | **308** | **100** |

*total cases are specific to this analysis and refers to those with available microbiology information

# Hospital perspectives

Insights from peers provide an opportunity for hospitals to share and learn from each other. The following submission reflects one hospital's perspective on the benefits from using the new NHFD/PHE SSISS conversion macro to reduce the data collection burden.

**Using the NHFD/PHE SSISS conversion macro**

As Hip Fracture Clinical Nurse Specialist at Leeds Teaching Hospitals Trust, I complete both the National Hip Fracture Database (NHFD) and PHE SSISS database for Repair of Neck of Femur. Managing both audits for such a large group of patients requires a considerable investment in resources. In 2019 I approached PHE to find out if it would be possible to combine the two datasets in some way, to reduce the time and effort involved in audit completion. The team at PHE were most supportive and subsequently produced the NHFD/PHE SSISS conversion macro, which I was able to assist them in testing.

The macro is a valuable tool that allows me to complete my SSISS database records quickly and easily.

The macro converts my existing NHFD data into a format that can be uploaded onto the PHE surgical site surveillance online database. A patient record is created, populated with basic patient details and other shared data; the remaining data fields can be quickly completed manually.

Using the macro has considerably reduced the time I spend completing surveillance as I can convert a large amount of data in one upload. I am assured of data accuracy, and don't need to spend additional time checking each record for errors. The macro has also allowed paper free data collection for the first time.

The macro is easy to use, and the process is quick and straightforward. It would be of value to anyone involved in surgical site surveillance for this group of patients.

**Julie Parkinson**

**Hip Fracture Clinical Nurse Specialist**
**Leeds Teaching Hospitals NHS Trust**

# Discussion

## Summary

In 2019/20 a total of 195 NHS hospitals and 8 IS NHS treatment centres submitted surveillance data for 134,547 surgical procedures, for which 1,197 inpatient and readmission-detected SSIs were reported. The PHE SSISS represents a wealth of information, having accumulated surveillance data for almost 2.5 million operations and 52,000 SSIs since its inception in 1997. After declining submissions to the voluntary surveillance categories over the past 2 years, the number of operations submitted for voluntary surveillance in 2019/20 showed a 9% increase from the previous year although the number of hospitals carrying out voluntary surveillance remained stable. For a third year, hospitals participating in voluntary cardiac surveillance (CABG and non-CABG) were most likely to do so continuously (CABG: 78.6% and non-CABG: 80%).

Ten-year trends in the annual inpatient and readmission SSI risk showed that the majority of surgical categories assessed (8 of 13) have seen an overall declining trend in risk. Fluctuations still occur on a year-to-year basis and may reflect changes in the NHS hospital case mix, warranting further investigation. All the mandatory orthopaedic categories have shown overall decreasing 10-year trends. Annual inpatient and readmission SSI risk following large bowel surgery decreased this year to its lowest in 10 years at 7.7%. The national benchmark for large bowel surgery, which is based on 5 years of data, also showed a continual decrease to 8.3% from 8.7% last year. There is still a lot of inter-hospital variation in SSI risk following large bowel surgery, 5-year hospital rates ranged from 0% to 25.6%. This indicates that there may be room for improvement through best practice sharing or there may be differences in the distribution of patient risk factors across hospitals.

Annual trust-level SSI risk funnel plots in 2019/20 continue to show less variation in the SSI risk across trusts and more consistent grouping around the national benchmark for the mandatory orthopaedic surveillance categories. While this has been the case for the past 2 years for hip and knee replacement surgery, reduction of long bone fracture and repair of neck and femur also showed less variation this year. Six high outlier notifications were sent out for the mandatory surveillance categories (3 for knee replacement, 2 for hip replacement and 1 for repair of neck of femur) where 7 had been sent out the previous year. Of interest, none of the outlier trusts had a previous history of being a high outlier in the last 3 years. This emphasizes the importance of continued surveillance and monitoring as with changes in local practices, staffing and use of innovative devices, hospitals remain susceptible to periodic increases in infections regardless of their own prior history and the declining national benchmark. Among low outliers however, it was more likely that there was a prior history of receiving a low outlier notification. This may be indicative of low case ascertainment or true exceptional patient care. Annual trust outlier assessments are unadjusted for differences in the patient population and important risk factors. Hospitals who receive outlier notifications are encouraged to further drill down into their results through their web-based hospital reports which include risk-stratified data.

More than half of the patients undergoing a knee replacement procedure are obese (55.8% in 2019/20). Last year's Annual Report was the first to explore how changes in the distribution of patient BMI for hip and knee replacement may impact a patient's ability to undergo elective surgery and therefore may attribute to hospital variation in SSI risk or lower the overall national benchmark. A 2017 report found that 47% of clinical commissioning groups (CCGs) in the United Kingdom have a BMI threshold in place for funding surgery (9). The majority of these CCGs apply a threshold of 35 $kg/m^2$ or more however, 4% set a threshold of 25 $kg/m^2$ ('overweight') and 10% a threshold of 30 $kg/m^2$ ('obese'). The median patient BMI for hip replacement and knee replacement did decrease slightly at the national level, which might suggest selective access to elective surgery based on a lower patient BMI. The proportion of obese patients undergoing hip and knee replacement does vary across hospitals. For knee replacement surgery, this range was between 34.5% to 69.2%. BMI information will be important to consider when assessing high hospital outliers given the potential impact of CCG thresholds. Encouragingly, we continue to see better completion of BMI data, which has been at about 63% over the past 2 years.

The UK 5-year (2019 to 2024) national action plan for antimicrobial resistance sets out to reduce healthcare-associated Gram-negative bloodstream infections (BSI) by 50% (10). Given this concern it is important that we continue to monitor the proportion of SSI caused by Gram-negative bacteria such as Enterobacterales. For both superficial SSIs and deep or organ/space SSIs the last 3 years have shown a decreasing trend in the proportion of Enterobacterales-caused cases across all categories. Interestingly, the proportion of *S. aureus*-caused SSIs has remained more stable. Among deep or organ/space SSIs there was actually a 5% increase from 2018/19 to 2019/20 in the proportion of *S. aureus*-caused SSIs largely due to increases in MSSA. Enhanced infection control initiatives geared towards MRSA (that is pre-admission screening and decolonisation of carriers) have been largely successful in driving the proportion of MRSA-caused SSI down over the last 2 decades. This may indicate that similar enhanced efforts towards MSSA infection control would be beneficial. Hospital-onset cases of MSSA bacteraemia in England have also shown an increasing trend (11). Capture of microbial aetiology continues to play a key role in prevention of SSI through optimising choice of antibiotic prophylaxis in surgery and may result in downstream reduction of bacteraemia where caused by SSI.

# Future directions

The redesign of the hospital web-based data collection and reporting system has remained an important priority for the past year despite challenges due to shifting resources in response to the COVID pandemic. The team continues to work hard to deliver a more intuitive and efficient data collection tool.

In an effort to further reduce the burden on surveillance participation through information technology systems, we launched the National Hip Fracture Database (NHFD) Excel macro for hospital use this July. The macro can be used to reformat data already submitted to NHFD into a viable formatted CSV file for uploading data into the SSISS web system. The macro has been successful in reducing the time taken to upload data for hospitals participating in both programs. One of our stakeholders who has trialled the macro highlights the advantages of this tool in the Hospital Perspectives section.

The development of the electronic version of the patient post-discharge questionnaire (ePDQ) and a new caseload management system which will integrate into the redesigned web system is currently in Beta phase. The use of the digital PDQ, which would be sent automatically to patient email or SMART phone, should reduce the burden of PDQ surveillance administration. In addition, hospital staff will have the ability to administer the PDQ over the phone and complete answers within the caseload management system, further streamlining the data collection process and helping to improve completeness and uptake of the post-discharge questionnaire.

This has been an unprecedented year and the SSISS Team is very appreciative of the efforts among all hospitals to maintain engagement and participation with SSI surveillance during this time.

# Glossary

**ASA score**
Patient's pre-operative physical status scored by the anaesthetist according to the American Society of Anesthesiologists' classification of physical status. There are 5 ASA scores, ranging from A1 denoting normally healthy patient to A5 denoting moribund patient with little chance of survival.

**Confidence intervals**
Confidence intervals are used to show where the true range of results might lie. 95% confidence intervals are used throughout to provide a guide to the precision of the estimate based on the denominator, number of operations (or days of follow-up). A 95% confidence interval can also be interpreted as a "1 in 20 chance that the observed estimate is due to chance alone". The funnel plots use both 95% and 99% confidence limits to represent the limits of expected variation among trusts and establish a threshold for "warning" of an unexpected result and needing to take "action". A 99% confidence range is wider but is offset with a lower margin of error (1%).

**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.

**Independent sector NHS treatment centres**
Centres that provide services to NHS patients but are owned and run by organisations outside the NHS. They perform common elective (that is non-emergency) surgeries, diagnostic procedures and tests in an effort to help the NHS reduce waiting times.

**NHSN Risk Index**
The CDC National Healthcare Safety Network (NHSN) Risk Index assesses a patient's risk of developing an SSI based on the presence of 3 key risk factors (ASA score, duration of operation, and wound class). Patients are assigned a cumulative score from 0 to 3 based on the following: an ASA score of 3 or more, duration of surgery exceeding the 75th percentile, and a contaminated or dirty wound class. A score of 3 would indicate a high risk operation.

**Risk ratio**

A measure of the risk of a certain event happening in one group compared to the risk of the same event happening in another group. A risk ratio of 1 means there is no difference between the 2 groups in terms of their risk, based on whether or not they were exposed to a certain factor or possess a certain risk factor. A risk ratio >1 usually means that being exposed to a certain factor or possessing a certain risk factor increases the risk of infection. A risk ratio <1 means that being exposed to a certain factor or possessing a certain risk factor decreases the risk of infection.

**T time**

T time represents the expected duration for a particular surgical procedure based on the 75th percentile for the duration of all such procedures, rounded to the nearest hour. T times for all surgical categories are as follows:

| Surgical category | T Time (hours) |
|---|---|
| Abdominal hysterectomy | 2 |
| Bile duct, liver, or pancreatic surgery | 5 |
| Breast surgery | 3 |
| Cholecystectomy | 2 |
| Cardiac surgery (non-CABG) | 5 |
| Coronary artery bypass graft | 5 |
| Cranial surgery | 4 |
| Gastric surgery | 3 |
| Hip replacement | 2 |
| Knee replacement | 2 |
| Large bowel surgery | 3 |
| Limb amputation | 1 |
| Reduction of long bone fracture | 2 |
| Repair of neck of femur | 1.5* |
| Small bowel surgery | 3 |
| Spinal surgery | 3 |
| Vascular surgery | 3 |

*T time derived from SSISS data

**Wound class**

This describes the degree of wound contamination at the time of the operation, based on an international standard classification system. The classification ranges from W1 denoting a clean uninfected wound outside the respiratory, alimentary, and genital or urinary tract to W4 denoting dirty or infected wounds and include operations in which acute inflammation with pus is encountered or in which perforated viscera are found.

# Appendix 1

**Data completeness for patient and surgery-related characteristics by surgical category, NHS hospitals England, April 2019 to March 2020**

| | | | Patient-related characteristics | | | | Surgery-related characteristics | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Surgical category | No. participating hospitals | No. operations | Age (%) | Sex (%) | BMI* (%) | ASA score (%) | Wound class (%) | Operation duration (%) | Pre-op stay (%) | Elective surgery (%) | Trauma surgery* (%) | Primary indication (%) | Antibiotic prophylaxis (%) |
| Abdominal hysterectomy | 4 | 185 | 100 | 100 | 64.3 | 90.8 | 100 | 100 | 100 | 100 | 99.5 | - | 91.4 |
| Bile duct, liver or pancreatic surgery | 3 | 366 | 100 | 100 | 68.2 | 88.8 | 100 | 100 | 100 | 100 | 97.8 | - | 98.4 |
| Breast surgery | 16 | 3,400 | 100 | 100 | 69.7 | 96.8 | 100 | 100 | 100 | 100 | 97.4 | - | 87.3 |
| Cardiac surgery (non-CABG) | 10 | 3,866 | 100 | 100 | 87.9 | 73.9 | 100 | 99.9 | 100 | 99.9 | 98.8 | - | 99.9 |
| Cholecystectomy | 1 | 58 | 100 | 100 | 0.0 | 100 | 100 | 100 | 100 | 100 | 96.6 | - | 96.6 |
| Coronary artery bypass graft | 14 | 6,451 | 100 | 100 | 87.4 | 81.3 | 99.9 | 100 | 100 | 100 | 99.8 | - | 99.5 |
| Cranial surgery | 5 | 1,956 | 100 | 100 | 78.0 | 89.7 | 99.5 | 100 | 100 | 100 | 99.0 | - | 98.6 |
| Gastric surgery | 5 | 218 | 100 | 100 | 65.9 | 100 | 100 | 100 | 100 | 100 | 98.2 | - | 94.5 |
| Hip replacement | 156 | 41,686 | 100 | 100 | 64.8 | 98.5 | 99.7 | 100 | 100 | 100 | - | 98.5 | 97.8 |
| Knee replacement | 156 | 44,844 | 100 | 100 | 67.6 | 98.3 | 99.9 | 100 | 100 | 100 | - | 98.6 | 98.8 |
| Large bowel surgery | 20 | 2,206 | 100 | 100 | 74.1 | 99.1 | 99.9 | 100 | 100 | 99.9 | 98.7 | - | 97.0 |
| Limb amputation | 4 | 144 | 100 | 100 | 52.8 | 94.4 | 100 | 100 | 100 | 100 | 100 | - | 100 |
| Reduction of long bone fracture | 17 | 3,013 | 100 | 100 | 17.4 | 96.2 | 99.9 | 100 | 100 | 100 | 99.8 | - | 99.5 |
| Repair of neck of femur | 74 | 17,127 | 100 | 100 | 30.1 | 97.2 | 99.7 | 100 | 100 | 100 | - | 99.7 | 95.8 |
| Small bowel surgery | 8 | 382 | 100 | 100 | 64.2 | 97.1 | 99.7 | 100 | 100 | 100 | 95.8 | - | 94.8 |
| Spinal surgery | 16 | 7,745 | 100 | 100 | 71.5 | 95.6 | 99.4 | 100 | 100 | 100 | 82.9 | - | 92.0 |
| Vascular surgery | 6 | 900 | 100 | 100 | 67.0 | 97.6 | 100 | 100 | 100 | 100 | 99.7 | - | 99.1 |

*indicates an optional data entry field

# Appendix 2

### Requirements for data fields that inform patient and surgery-related characteristics

| Characteristic | Requirement |
|---|---|
| Patient age | Calculated from mandatory date of birth and date of operation data fields |
| Patient sex | Mandated for submission, however “unknown” is an available response option |
| Patient BMI | Calculated from optional height and weight data fields |
| Patient ASA score | Mandated for submission, however “unknown” is an available response option |
| Wound class | Mandated for submission, however “unknown” is an available response option |
| Operation duration | Mandated for submission |
| Pre-operative stay | Calculated from mandatory date of admission and date of operation data fields |
| Elective surgery | Mandated for submission, however “missing” is an available response option |
| Trauma surgery | Mandated for submission, however “missing” is an available response option |
| Primary indication for surgery | Mandated for submission, however “unknown” is an available response option |
| Antibiotic prophylaxis given | Mandated for submission, however “unknown” is an available response option |

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# About Public Health England

Public Health England exists to protect and improve the nation's health and wellbeing, and reduce health inequalities. We do this through world-leading science, research, knowledge and intelligence, advocacy, partnerships and the delivery of specialist public health services. We are an executive agency of the Department of Health and Social Care, and a distinct delivery organisation with operational autonomy. We provide government, local government, the NHS, Parliament, industry and the public with evidence-based professional, scientific and delivery expertise and support.

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