UK Health Security Agency

Surveillance of surgical site infections in NHS hospitals in England

April 2021 to March 2022

Contents

Main points

In the financial year 2021 to 2022, 184 NHS hospitals representing 123 NHS trusts and 8 Independent Sector (IS) NHS treatment centres submitted surveillance data for 115,796 surgical procedures to the Public Health England (now UK Health Security Agency, UKHSA) Surgical Site Infection (SSI) Surveillance Service. The number of hospitals contributing data increased from 168 in the previous year and trusts increased from 117. Across 17 surgical categories, 968 SSIs were detected during the inpatient stay or on readmission.

A total of 92,930 procedures were submitted as part of mandatory surveillance of orthopaedic surgery, an 87.7% increase from 49,519 procedures in the previous financial year. Three trusts did not meet the mandatory surveillance participation requirements. A total of 22,866 procedures were submitted as part of voluntary surveillance spanning 13 other surgical categories, a 57.9% increase from 14,592 procedures in the previous financial year (2020 to 2021). However, the number of submitted procedures was still lower than pre-pandemic (financial year 2019 to 2020) for both mandatory categories (12.8% lower than 106,630 procedures) and voluntary categories (18.0% lower than 27,874 procedures), a likely reflection of the ongoing disruption to healthcare delivery.

Cardiac surveillance (CABG and non-CABG) continued to have the highest degree of continuous surveillance (CABG: 82% and non-CABG: 100%).

Four trusts were notified as high outliers for the mandatory orthopaedic surveillance categories (one in each category).

Ten-year trends in the annual inpatient and readmission SSI risk showed a decrease for 8 of 10 categories assessed. However, SSI risk in the current financial year compared to the previous financial year varied by category; 6 of 10 categories saw increases in SSI risk, including hip replacement (up to 0.44%), knee replacement (0.35%), reduction of long bone fracture (0.54%), CABG (2.7%), cardiac (non-CABG) (1.4%) and breast surgery (0.6%). The SSI risk for large bowel surgery saw the greatest drop (10.5% to 7.9% in financial year 2021 to 2022), reaching the lowest SSI risk in 10 years.

Among SSIs with accompanying microbiological confirmation, Enterobacterales continued to make up the largest proportion of causative organisms across all surgical categories in financial year 2021 to 2022 for both superficial (33.1%) and deep or organ and space (30.1%) SSIs. In 2021 to 2022, the proportion of SSIs caused by methicillin-resistant *Staphylococcus aureus* (MRSA) and methicillin-sensitive *Staphylococcus aureus* (MSSA) both increased compared to the previous year. For MRSA, the proportion in 2021 to 2022 was higher than or similar to pre-pandemic for superficial SSIs (3.4% versus 3.0%) and deep or organ and space (2.3% versus 2.5%), while MSSA remained lower than pre-pandemic (superficial: 15.0% versus 18.3%; deep or organ and space: 17.0% versus 21.8%).

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), Public Health England (now UK Health Security Agency (UKHSA)). 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), however laparoscopic-assisted procedures are included for some categories.

The SSISS was established by the Public Health Laboratory Service (a predecessor of UKHSA) 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 2012 to 31 March 2022, with a focus on the latest financial year (2021 to 2022), and a regular comparison to the previous financial year (2020 to 2021). The coronavirus (COVID-19) pandemic coincided with the 2020 to 2021 financial year and continued into financial year 2021 to 2022. Disruption to healthcare services that occurred due to the pandemic likely impacted the trends seen in this report.

Methods

SSISS data collection

The UKHSA SSISS 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 UKHSA's national SSI surveillance programme are required to have staff trained by the UKHSA national co-ordinating centre in London before carrying out surveillance.

Surveillance data is collected prospectively on a quarterly basis and includes all eligible patients undergoing surgery in pre-selected surgical categories during each 3-month period (quarter). 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 is collected for each eligible procedure and submitted to the UKHSA SSISS via a secure web-based application.

After each completed quarter, data is subject to quality assurance processes by the UKHSA 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 UKHSA SSISS team analyse submitted data at quarterly intervals to identify 'outliers', defined as hospitals whose SSI risk is above the national 90th percentile ('high outliers') or below the 10th percentile ('low outliers') for each surgical category. UKHSA 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 examine their clinical practices and discuss their results at multidisciplinary team meetings to explore possible reasons for potential problems addressed at the earliest opportunity. UKHSA offers support to outlier hospitals to assist them with further investigations, including on-site visits to share in-depth local analyses and provide 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 such as breast surgery where the majority of patients are discharged on the day of surgery. They comprise: a) systematic review and documentation of patients attending outpatient clinics or seen at home by hospital clinical staff trained to apply the case definitions and b) wound healing post-discharge questionnaires (PDQs) completed by the patient or their carer at 30 days after their operation (4). SSIs detected through PDQs are recorded as 'patient reported only' if they have not been identified by one of the other detection methods involving a hospital clinician.

As PDS is optional, data derived from these methods is not currently included in the national benchmarks, or used for outlier assessment, to ensure comparability of data. The results in this national report do not feature optional PDS data, but its use remains important at the local

level to provide a more complete measure of an individual hospital's infection risk, especially for categories with short post-operative length of stay, such as breast surgery.

Case definitions

The UKHSA 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.

Analyses presented in this report

Surveillance data for surgical procedures for a 10-year period, between 1 April 2012 and 31 March 2022, was extracted on 20 October 2022 for this report. For procedures performed in the last few months of the 2021 to 2022 financial year and subject to a one-year follow-up (prosthetic implant surgery), late onset infections reported after the data was extracted will not be captured, although these constitute very small numbers (6). Trust-level results will be provided in the next annual report and will include updates reflecting any late onset infections reported since publication of this annual report.

The SSI risk described in this report is the percentage of SSI per 100 operations measured by cumulative incidence. 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. 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 presented, a minimum volume threshold is applied. For hip or knee replacement and abdominal hysterectomy, any hospitals with less than 95 operations submitted over 5 years 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 that meet a minimum threshold for hospital participation. For benchmarking purposes, the last 5 years of data including the current financial year is used (1 April 2017 to 31 March 2022).

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 SSI risk results from the financial years 2020 to 2021 and 2021 to 2022 by NHS trust or treatment centre.

SSISS operational overview

Hospital participation and surgical volumes

Overall, 184 NHS hospitals representing 123 NHS trusts and an additional 8 IS NHS treatment centres participated in the SSISS data collection in financial year 2021 to 2022. The number of hospitals contributing data increased from 168 in financial year 2020 to 2021 and Trusts increased from 117. Surveillance data was submitted for 115,796 procedures. Of these, 92,930 were orthopaedic procedures submitted as part of mandatory surveillance and 22,866 procedures submitted as part of voluntary surveillance spanning 13 other surgical categories. Compared to financial year 2020 to 2021, the number of operations submitted for mandatory orthopaedic surveillance increased by 87.7% (from 49,519 procedures), while voluntary surveillance increased by 57.9% (from 14, 592 procedures) (Figure 1), an overall change of 72.8% across both sets of categories.

During the COVID-19 pandemic, hospitals saw a decrease in surgical throughput due to a combination of deferral of non-urgent surgery, cancellations, staff sickness, and reduced operating theatre capacity (7-9). The increase in surgical volume submitted to SSISS in financial year 2021 to 2022 may be due to the increase in capacity for non-urgent surgery following easing of certain COVID-19 restrictions and impact of vaccination on staff sickness. The number of submitted operations was still lower than pre-pandemic (financial year 2019 to 2020) for both mandatory categories (12.8% lower than 106,630 procedures) and voluntary categories (18.0% lower than 27,874 procedures), a likely reflection of the ongoing disruption to healthcare delivery.

Mandatory surveillance requirements mean hip and knee replacement surveillance had the highest number of participating hospitals in financial year 2021 to 2022 (147 and 138 hospitals, respectively). Participation in voluntary surgical categories in financial year 2021 to 2022 was highest for breast surgery (15 hospitals), followed by large bowel surgery and spinal surgery (13 hospitals each).

Figure 1. Annual participation in the SSISS, voluntary and mandatory surveillance, NHS hospitals England, April 2012 to March 2022

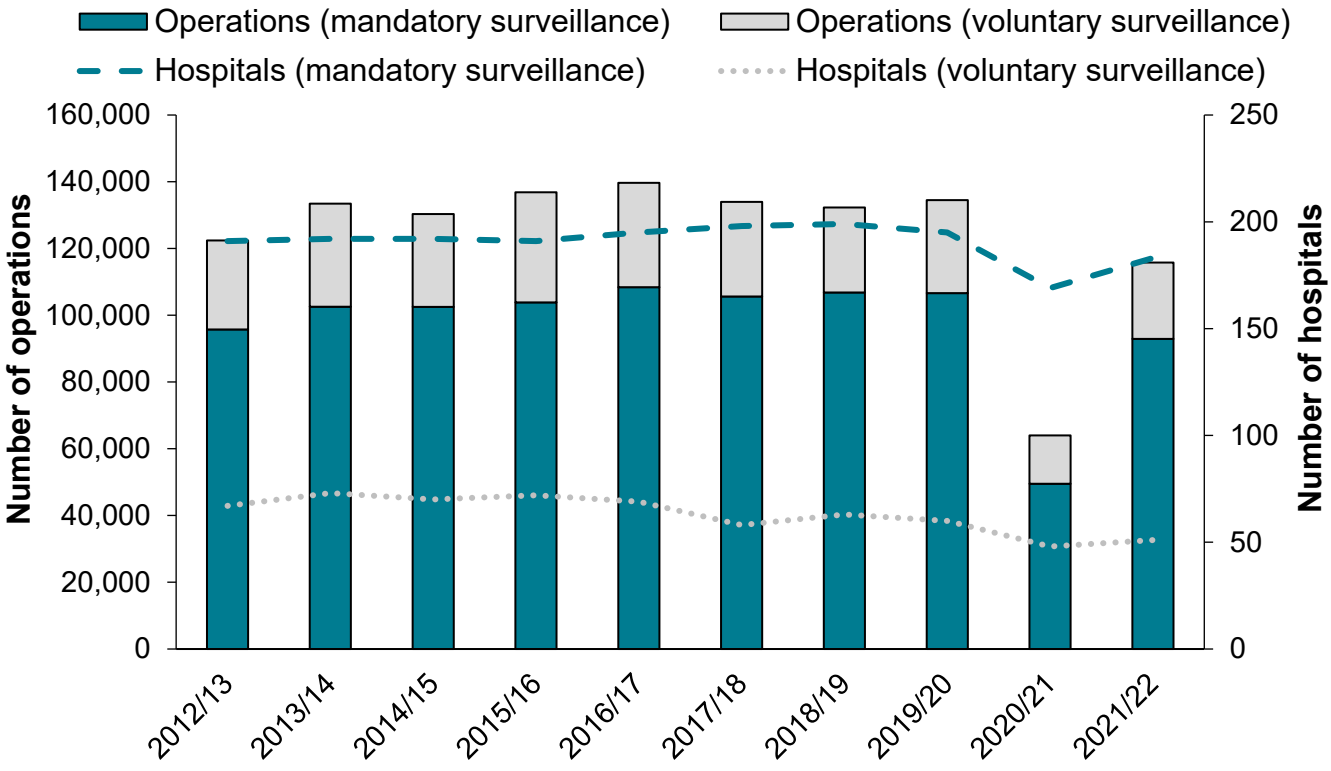
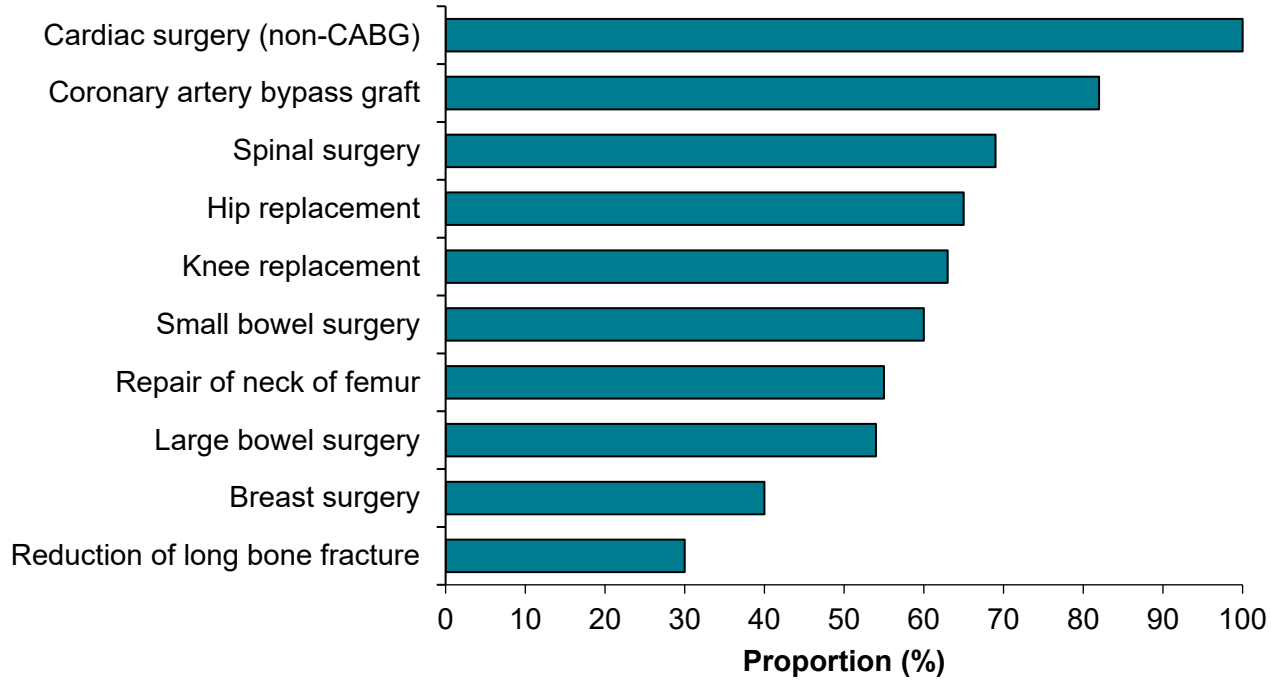


Figure 2 shows the proportion of hospitals carrying out continuous surveillance during financial year 2021 to 2022 by surgical category. There were 7 SSISS surgical categories with less than 5 participating hospitals (abdominal hysterectomy, bile duct, liver or pancreatic surgery, cholecystectomy, cranial, gastric, limb amputation, and vascular surgery) which were excluded from this analysis.

Cardiac procedures, coronary artery bypass graft (CABG) and non-CABG (open chest procedures on valves or septum of the heart) had the highest proportion of hospitals carrying out continuous surveillance in financial year 2021 to 2022 (82.0% and 100%, respectively). For hip and knee replacement, subject to mandatory surveillance for a minimum of one 3-month surveillance period per financial year, almost two thirds of hospitals carried out continuous surveillance in financial year 2021 to 2022 (65.0% and 63.0%, respectively). This was much higher than the previous financial year where 29.0% and 13.0% of hospitals undertook continuous surveillance for either hip or knee replacement surgery.

Figure 2. Proportion of hospitals undertaking continuous surveillance, by surgical category, NHS hospitals England, April 2021 to March 2022



Patient and surgical characteristics

Data completeness for key patient and surgical characteristics was high (equal to or greater than 90%), with most being mandated for collection (see Appendix 1 and Appendix 2). Data completeness was similar to the previous financial year. Data completeness across all patient and surgical-related fields ranged from 84.1% to 97.3% in financial year 2021 to 2022, compared to 83.0% to 98.3% in financial year 2020 to 2021.

Some variability between categories occurs in the American Society of Anesthesiologists' (ASA) score, as hospitals may use an alternative assessment score for certain categories (for example cardiac and CABG). The height and weight fields are optional for collection, which means completeness of body mass index (BMI) information was low compared to mandatory fields and differed by category.

In financial year 2021 to 2022, BMI was available for 59.2% of procedures (8% higher than financial year 2020 to 2021). Thirteen of 17 surgical categories had BMI data available for ≥50% of those submitted, 2 higher than the previous year. As in the previous financial year, cardiac surgeries (CABG and non-CABG) had the most complete BMI information in financial year 2021 to 2022 (85.5% and 82.9%, respectively).

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

In the previous Annual Report, we discussed the increase in surgical complexity in financial year 2020 to 2021 compared to financial year 2019 to 2020. As a measure of complexity, we compared an ASA score of 3 or more, median surgery duration, median length of stay, and if multiple procedures were performed for categories with 5 or more participating hospitals in financial year 2020 to 2021. We hypothesised that the increase in complexity was due to the postponement or cancellation of less urgent elective surgeries. Overall, the increased complexity seen in financial year 2020 to 2021 was also seen in 2021 to 2022.

Compared to the previous financial year (2020 to 2021), of the 10 categories assessed, 5 categories had a decreased percentage of patients with an ASA score of 3 or more (3 the same, 2 increased), 5 categories had an increased surgery duration (3 the same, 2 decreased), 4 categories had an increased percentage of patients undergoing multiple procedures (4 decreased, 2 same) and 2 categories had an increased length of stay (8 stayed the same). None of the categories had consistent increases or decreases in all 4 fields indicating complexity. The percentage of patients undergoing multiple procedures showed the most change between the most recent financial years. For example, patients undergoing multiple procedures for spinal surgery increased from 1.0% to 6.2% in financial year 2021 to 2022 compared to 2020 to 2021, and breast surgery decreased from 14.4% to 4.6%.

In financial year 2021 to 2022, knee replacement had the highest proportion of obese (BMI greater than or equal to 30kg/m^2) patients among the 17 categories (55.7%), slightly higher than the previous financial year (55.1%). Abdominal hysterectomy was the second highest (48.8%) and spinal surgery third highest (41.2%). The median patient BMI for hip replacement was 28.5 kg/m^2 (IQR=25.1-32.5kg/m^2) and for knee replacement, 30.8 kg/m^2 (IQR=27.4 to 34.8 kg/m^2); similar to the previous financial year. The highest proportion of paediatric (under 18 years) data submitted in 2021 to 2022 was for spinal surgery (11.0% of procedures) followed by small bowel (8.5%), and cardiac (non-CABG) (4.5%) the next most common.

The primary indication for patients undergoing hip and knee replacement is shown in Figures 3a-b. Osteoarthritis continues to be the main reason why patients undergo joint replacement surgery (82.6% for hip; 91.6% for knee). The proportion of hip replacement surgeries carried out as a result of trauma or fracture decreased by 10.0% from last year (8.1% versus 9.0%), a likely reflection of the increase in elective surgeries. The proportion of replacements due to revision decreased for both hip (from 11.0% to 8.1%) and knee (from 8.4% to 6.2%), however this returned to similar proportions as financial year 2019 to 2020 (8.9% and 6.1%, respectively).

Table 1. Patient and surgery-related characteristics by surgical category, NHS hospitals England, April 2021 to March 2022

Surgical category	Patient-related characteristics				Surgery-related characteristics							
	Median age, IQR	Male	BMI ≥ 30 kg/m²	ASA ≥ 3	Wound contaminated or dirty	Median surgery duration, IQR	Median length of stay, IQR	Pre-op stay more than one day	Emergency surgery	Multiple procedures performed	Antibiotic prophylaxis not given	Implant present
	(years)	(%)	(%)	(%)	(%)	(minutes)	(days)	(%)	(%)	(%)	(%)	(%)
Abdominal hysterectomy*	52 (46-62)	-	48.8	12.5	1.3	111 (87-133)	2 (1-3)	0.7	0.7	4.6	19.9	0.0
Bile duct, liver or pancreatic surgery*	63 (55-70)	60.7	-	59.5	0.0	397 (268-523)	10 (6-21)	9.5	1.2	42.9	1.4	0.0
Breast surgery	60 (50-70)	0.9	33.8	14.3	0.2	75 (51-104)	0 (0-1)	0.2	0.1	4.6	27.6	9.0
Cardiac surgery (non-CABG)	65 (55-73)	68.9	31.5	98.9	0.0	250 (200-323)	10 (7-18)	48.0	2.5	43.7	0.2	95.0
Cholecystectomy*	60 (52-69)	54.2	0	38.6	1.4	273 (108-464)	7 (3-14)	12.5	0.0	40.3	3.8	1.4
Coronary artery bypass graft	66 (59-73)	82.4	34.7	98.9	0.0	240 (202-285)	9 (7-16)	58.6	1.6	23.1	1.2	76.7
Cranial surgery*	55 (42-67)	49.7	35.9	18.2	1.3	154 (84-243)	5 (3-9)	8.3	9.2	6.4	1.3	33.2
Gastric surgery*	62 (51-72)	51.1	34.6	47.1	6.3	207 (135-399)	7 (2-12)	9.4	0.0	20.2	2.4	6.3
Hip replacement	71 (62-77)	40.3	39.8	30.8	0.1	84 (65-106)	3 (2-5)	4.4	0.2	1.2	0.6	100.0

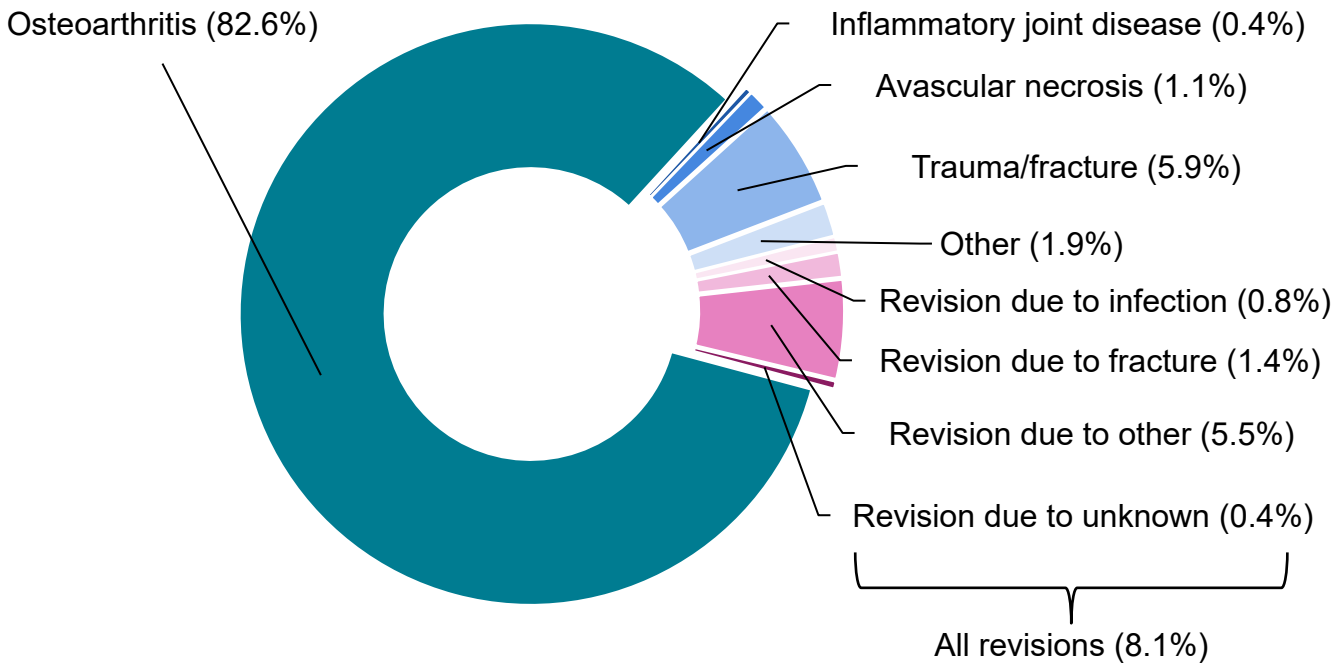
Surgical category	Patient-related characteristics				Surgery-related characteristics							
	Median age, IQR	Male	BMI ≥ 30 kg/m^2	ASA ≥ 3	Wound contaminated or dirty	Median surgery duration, IQR	Median length of stay, IQR	Pre-op stay more than one day	Emergency surgery	Multiple procedures performed	Antibiotic prophylaxis not given	Implant present
	(years)	(%)	(%)	(%)	(%)	(minutes)	(days)	(%)	(%)	(%)	(%)	(%)
Knee replacement	70 (63-76)	44.4	55.7	29.0	0.1	81 (63-102)	3 (2-4)	0.8	0.0	0.0	0.4	100.0
Large bowel surgery	68 (57-76)	50.8	26.4	44.6	19.8	185 (132-255)	7 (5-13)	13.4	8.0	13.7	1.0	4.3
Limb amputation*	68 (59-77)	67.4	29.9	93.5	1.4	73 (50-98)	28 (17-37)	77.8	0.0	0.0	5.1	0.0
Reduction of long bone fracture	59 (38-76)	42.5	21.5	35.3	3.4	96 (69-130)	5 (1-14)	29.4	1.4	2.5	1.1	94.3
Repair of neck of femur	84 (77-89)	31.1	10.6	80.3	0.0	70 (55-89)	13 (8-21)	29.9	2.5	0.0	3.5	100.0
Small bowel surgery	61 (46-73)	54.6	27.5	47.3	36.2	135 (94-222)	12 (6-25)	35.4	4.6	42.6	2.7	3.8
Spinal surgery	56 (38-69)	45.5	41.2	25.0	0.0	128 (88-192)	3 (1-7)	8.1	0.9	6.2	1.4	41.1
Vascular surgery*	72 (65-79)	73.2	28.7	82.7	0.2	220 (157-320)	5 (2-12)	23.0	4.1	2.4	1.8	76.2

* Surgical categories with fewer than 5 participating hospitals (see Appendix 2). Results should be interpreted with caution.

Abbreviations

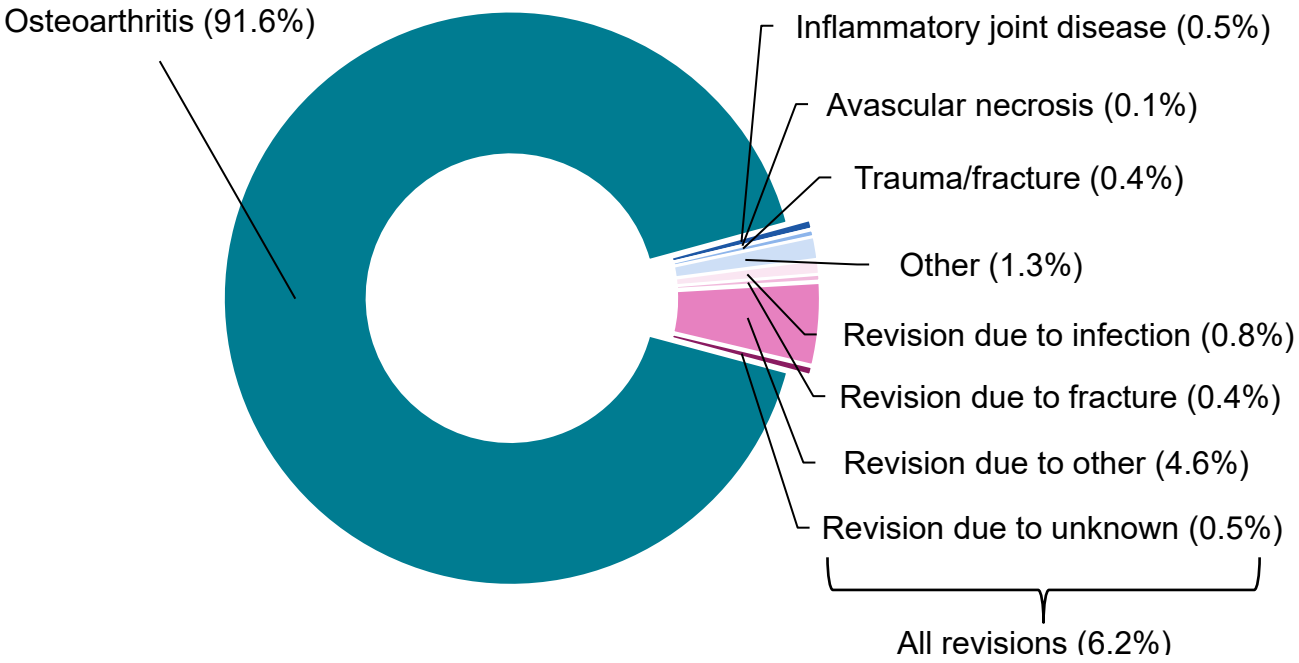
IQR = interquartile range; BMI = body mass index; ASA = American Society of Anesthesiologists

Figure 3a. Primary indication for hip replacement surgery, NHS hospitals England, April 2021 to March 2022 (N= 35,088*)



* Total does not include patients who had missing data for primary indication (n=392).

Figure 3b. Primary indication for knee replacement surgery, NHS hospitals England, April 2021 to March 2022 (N= 32,737*)



* Total does not include patients who had missing data for primary indication (n=512).

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 2017 to March 2022) were used to produce national benchmarks. Inpatient and readmission SSI risk varied greatly depending on the type of surgical procedure.

The highest risk was observed in bile duct, liver or pancreatic surgery at 15.4%, followed by cholecystectomy at 9.7%, then large bowel surgery at 8.6%. These are procedures carried out at the site of body with high levels of bacterial contamination, contributing to a higher risk of SSI. Hip and knee replacement surgery carried the lowest SSI risk (0.5% and 0.4%, respectively).

As the national benchmarks are based on 5 years of data, they tend to be very robust year-to-year. In the current financial year, there were 7 categories with less than 5 participating hospitals included in the benchmark. This is the same as the previous financial year, although an increase from previous financial years. This may be due to COVID-19 disruptions to healthcare delivery, and may result in more fluctuation compared to previous years. Inpatient and readmission SSI risk for cholecystectomy surgery showed the greatest increase this financial year (from 5.5% in the previous financial year to 9.7%), however this surveillance category only had data from 3 participating hospitals included in the benchmark.

Among the orthopaedic categories, the national benchmark for hip replacement, knee replacement and reduction of long bone fracture all remained the same (0.5%, 0.4% and 0.7%, respectively), while repair of neck of femur decreased (from 0.9% to 0.8%). For large bowel surgery, which historically ranked highest prior to financial year 2019 to 2020, the national benchmark increased by 1.4% to 8.6% in financial year 2021 to 2022.

For short-stay surgeries (0 to 3 days), such as hip or knee replacement, abdominal hysterectomy, and breast, over half of SSIs were captured through readmission surveillance (range: 73.3% to 95.4%) in financial year 2021 to 2022, emphasising the importance of post-discharge surveillance.

SSI incidence density accounts for the differences in length of hospital stay in capturing inpatient SSIs. The incidence density of in-hospital detected SSIs per 1,000 post-operative patient-days varied from 0.1 per 1,000 inpatient days for knee replacement to 11.9 per 1,000 inpatient days for bile duct, liver or pancreatic surgery. Cholecystectomy had the second highest risk by incidence density (9.2 per 1,000 inpatient days) followed by large bowel surgery (7.4 per 1,000).

Table 2. Inpatient and readmission SSI risk by surgical category, NHS hospitals England, April 2017 to March 2022

			Inpatient and readmission				Inpatient only		
Surgical category	**Number of participating hospitals**	**Number of operations**	**Number of SSIs**	**SSI incidence (%)**	**95% CI**	**Median time to infection (days)**	**Number SSIs**	**Incidence density (per 1,000 patient days)**	**95% CI**
Abdominal hysterectomy	14	1,429	25	1.7	(1.1-2.6)	11	6	1.3	(0.5-2.9)
Bile duct, liver or pancreatic surgery	4	773	119	15.4	(12.9-18.1)	8	103	11.9	(9.7-14.4)
Breast surgery	33	14,451	108	0.7	(0.6-0.9)	20	5	0.5	(0.1-1.1)
Cardiac surgery (non-CABG)	13	17,693	220	1.2	(1.1-1.4)	15	153	0.8	(0.6-0.9)
Cholecystectomy	3	268	26	9.7	(6.4-13.9)	7	22	9.2	(5.8-13.9)
Coronary artery bypass graft	16	27,424	722	2.6	(2.4-2.8)	15	371	1.6	(1.4-1.7)
Cranial surgery	8	7,200	101	1.4	(1.1-1.7)	16	35	0.6	(0.4-0.8)
Gastric surgery	11	1,275	24	1.9	(1.2-2.8)	10	20	2.0	(1.2-3.0)
Hip replacement	184	175,167	817	0.5	(0.4-0.5)	21	218	0.3	(0.2-0.3)
Knee replacement	177	180,071	716	0.4	(0.4-0.4)	23	106	0.1	(0.1-0.2)
Large bowel surgery	35	10,844	930	8.6	(8.1-9.1)	8	798	7.4	(6.9-7.9)
Limb amputation	11	785	23	2.9	(1.9-4.4)	12	18	1.4	(0.8-2.2)
Reduction of long bone fracture	40	14,456	98	0.7	(0.6-0.8)	20	49	0.4	(0.3-0.5)
Repair of neck of femur	114	91,811	729	0.8	(0.7-0.9)	18	436	0.3	(0.3-0.3)
Small bowel surgery	17	2,322	172	7.4	(6.4-8.5)	7	149	5.3	(4.5-6.2)
Spinal surgery	25	30,586	386	1.3	(1.1-1.4)	15	130	0.8	(0.6-0.9)
Vascular surgery	11	3,971	87	2.2	(1.8-2.7)	14	39	1.3	(0.9-1.8)

Risk factors for SSI

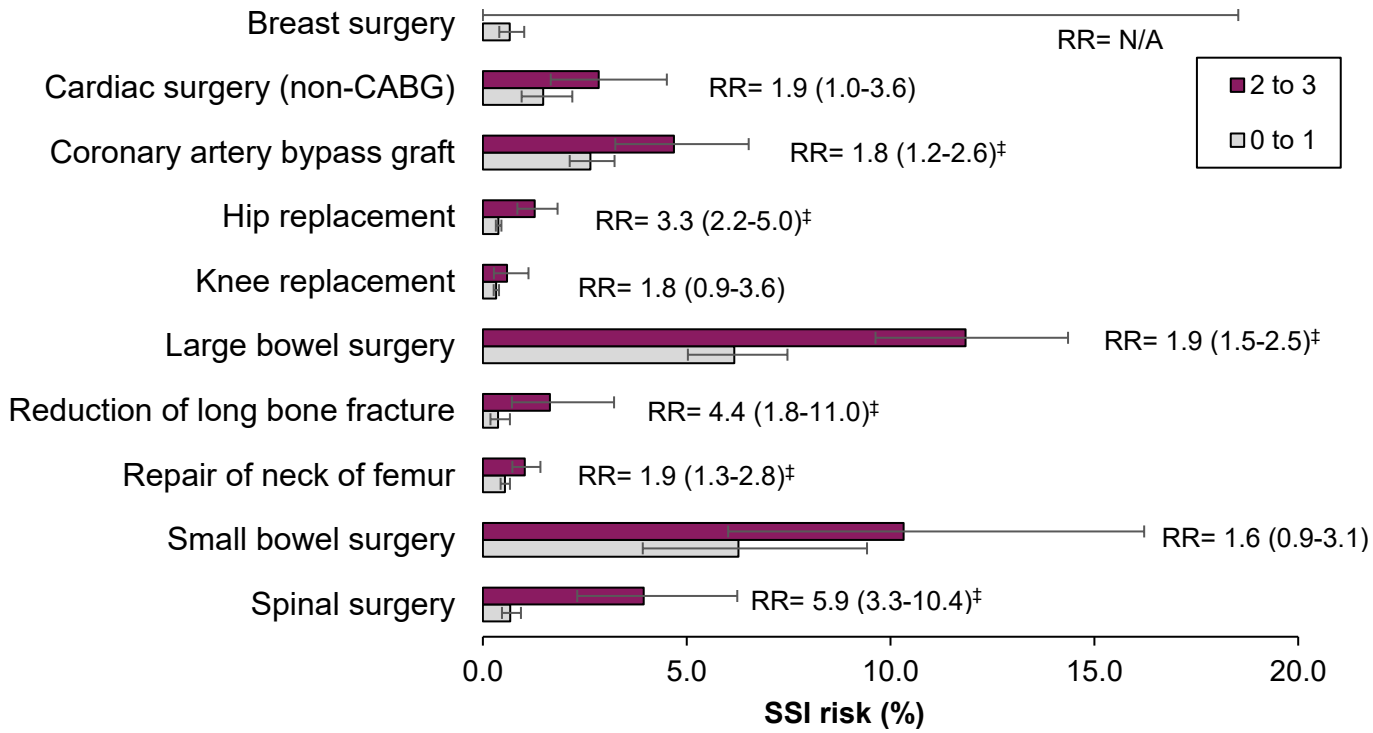
Participants are encouraged to assess their hospital's results stratified by important patient and surgery-related characteristics. The National Healthcare Safety Network (NHSN) risk index is used to account for potentially important differences in patient population. The risk index assigns a cumulative score from 0 to 3 based on the presence of the following risk factors: American Society of Anesthesiologists (ASA) score of 3 or higher, operation duration greater than 'T-time' (as defined by the 75th percentile), and a contaminated or dirty wound.

Figure 4 shows the SSI risk for financial year 2021 to 2022 across surgical categories for patients whose operation was deemed at low risk of SSI (NHSN risk index 0 or 1) compared to patients with a higher risk of SSI after surgery (risk index 2 or 3). Results confirm the importance of this stratification as we see an increased risk in all categories.

A risk ratio (RR) was calculated to compare the risk between the 2 groups. A RR greater than one 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 one the difference between the 2 groups is considered significant. In all categories except breast surgery, patients who underwent operations with a higher risk index were more likely to experience infection than those with a lower risk index. The difference between the 2 groups was statistically significant for all categories except small bowel surgery and knee replacement.

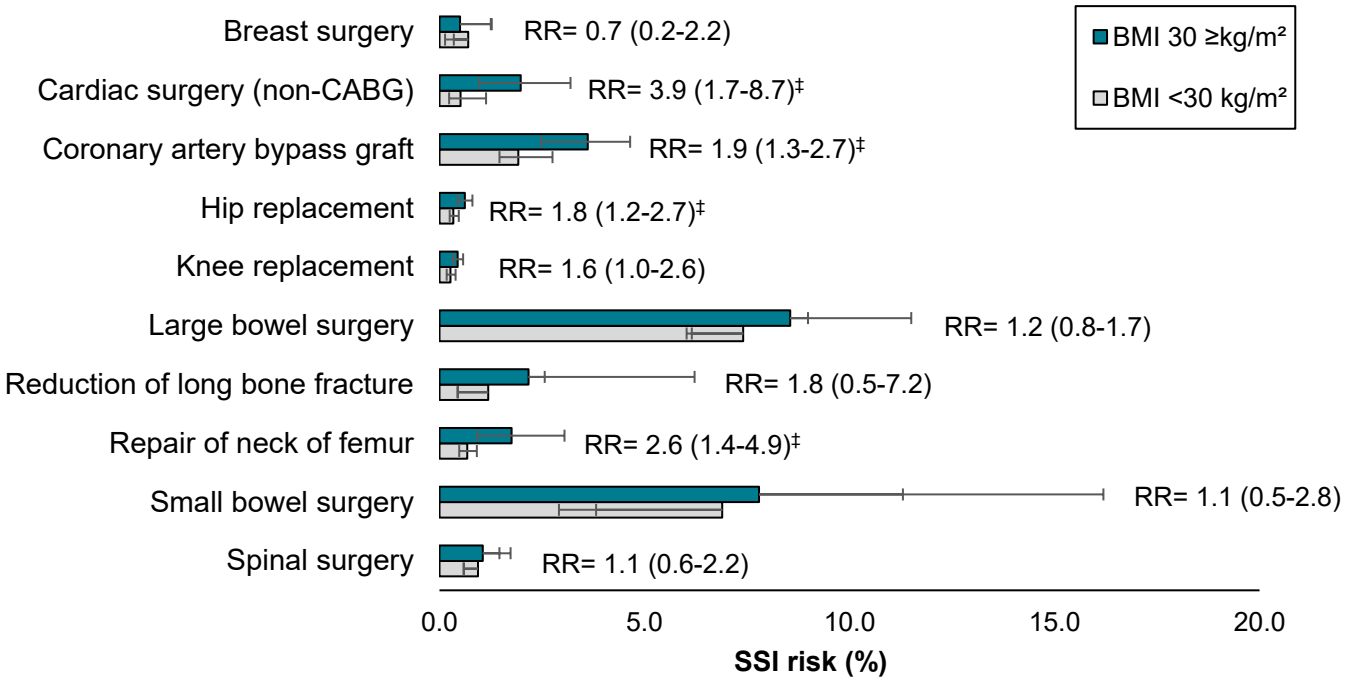
An elevated BMI has been shown to increase the likelihood of developing an SSI, particularly among CABG patients (10, 11). Figure 5 shows the SSI risk for financial year 2021 to 2022 across surgical categories for patients who are classed as obese (BMI equal to or greater than 30 kg/m^2) compared to non-obese patients. In all categories except breast surgery, 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 cardiac (non-CABG), CABG, hip replacement and repair of neck of femur surgery.

Figure 4. Inpatient and readmission SSI risk adjusted for by NHSN risk index, NHS hospitals England, April 2021 to March 2022*



* Categories with less than 5 participating hospitals excluded.
‡ Relative risk (RR) is statistically significant.

Figure 5. Inpatient and readmission SSI risk adjusted for patient body mass index, NHS hospitals England, April 2021 to March 2022*



* Categories with less than 5 participating hospitals excluded.
‡ Relative risk (RR) is statistically significant.

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

Table 3. Inpatient and readmission SSI risk by primary indication for joint replacement surgeries, NHS hospitals England, April 2021 to March 2022*

		Hip replacement				Knee replacement			
	Indication for surgery	**Number of operations**	**Number of SSI**	**SSI risk (%)**	**95% CI**	**Number of operations**	**Number of SSI**	**SSI risk (%)**	**95% CI**
Primary	Osteoarthritis	28,996	103	0.4	(0.3-0.4)	29,563	95	0.3	(0.3-0.4)
	Inflammatory joint disease	126	2	1.6	(0.2-5.6)	163	2	1.2	(0.1-4.4)
	Avascular necrosis	394	5	1.3	(0.4-2.9)	16	0	0.0	(0.0-20.6)
	Trauma or fracture	2,062	9	0.4	(0.2-0.8)	117	1	0.9	(0.0-4.7)
	Other	660	5	0.8	(0.2-1.8)	405	3	0.7	(0.2-2.1)
	Total	**32,238**	**124**	**0.4**	**(0.3-0.5)**	**30,264**	**101**	**0.3**	**(0.3-0.4)**
Revision	Infection	291	1	0.3	(0.0-1.9)	257	1	0.4	(0.0-2.1)
	Fracture	480	12	2.5	(1.3-4.3)	115	2	1.7	(0.2-6.1)
	Other	1,931	14	0.7	(0.4-1.2)	1,490	10	0.7	(0.3-1.2)
	Unknown	148	1	0.7	(0.0-3.7)	149	1	0.7	(0.0-3.7)
	Total	**2,850**	**28**	**1.0**	**(0.7-1.4)**	**2,011**	**14**	**0.7**	**(0.4-1.2)**

* Totals do not include patients who had missing data for primary indication.

Trends in SSI risk

Figure 6 shows 10-year trends in annual 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 fewer than 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, hospital participation or other factors affecting healthcare delivery such as length of inpatient stay.

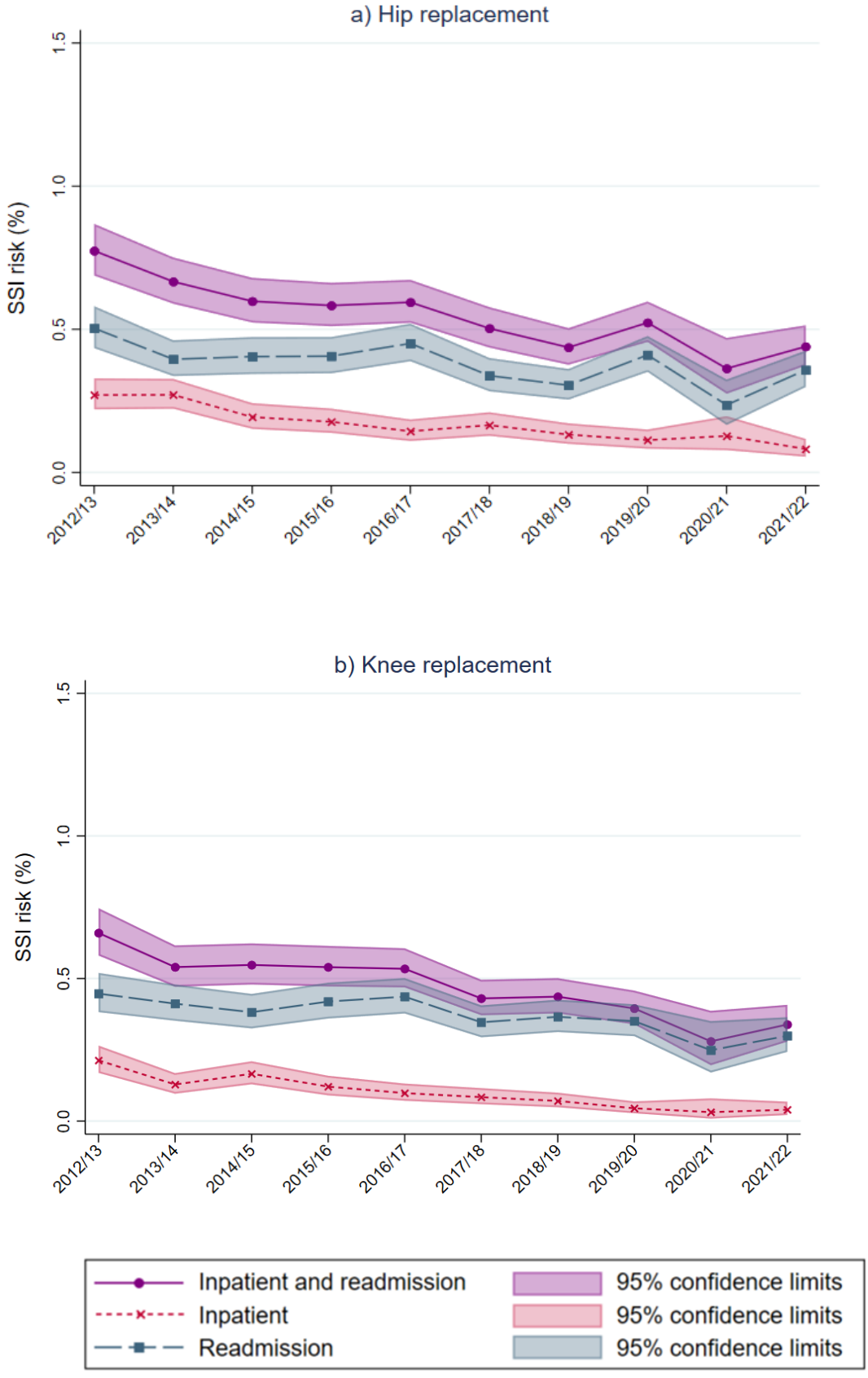
Over the past 10 years, inpatient and readmission SSI incidence following hip and knee replacement surgery has been relatively stable, with slight annual decreases from financial year 2012 to 2013. The decreasing trend in SSI risk may be explained by the decrease in the length of stay in hospital for hip and knee replacement surgery over time (both hip and knee median length of stay was 4 days in financial year 2012 to 2013 compared to 3 days in financial year 2021 to 2022). However, in the current financial year, SSI risk increased for both hip and knee replacement. Annual inpatient and readmission SSI incidence for hip replacement reached its lowest point at 0.36% in financial year 2020 to 2021 (Figure 6a), before a slight increase to 0.44% in the financial year 2021 to 2022. Annual inpatient and readmission SSI incidence following knee replacement similarly showed a slight increase to 0.35% after a drop to 0.28% in the previous financial year (2020 to 2021) (Figure 6b). 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 financial year 2014 to 2015 at 1.40%, the rate showed a decreasing trend until the current financial year, with an increase from 0.44% to 0.54%. Repair of neck of femur (Figure 6d) has seen an overall continuous decline in SSI incidence since financial year 2012 to 2013 (from 1.45% to 0.63%), despite an 8.3% increase in length of stay.

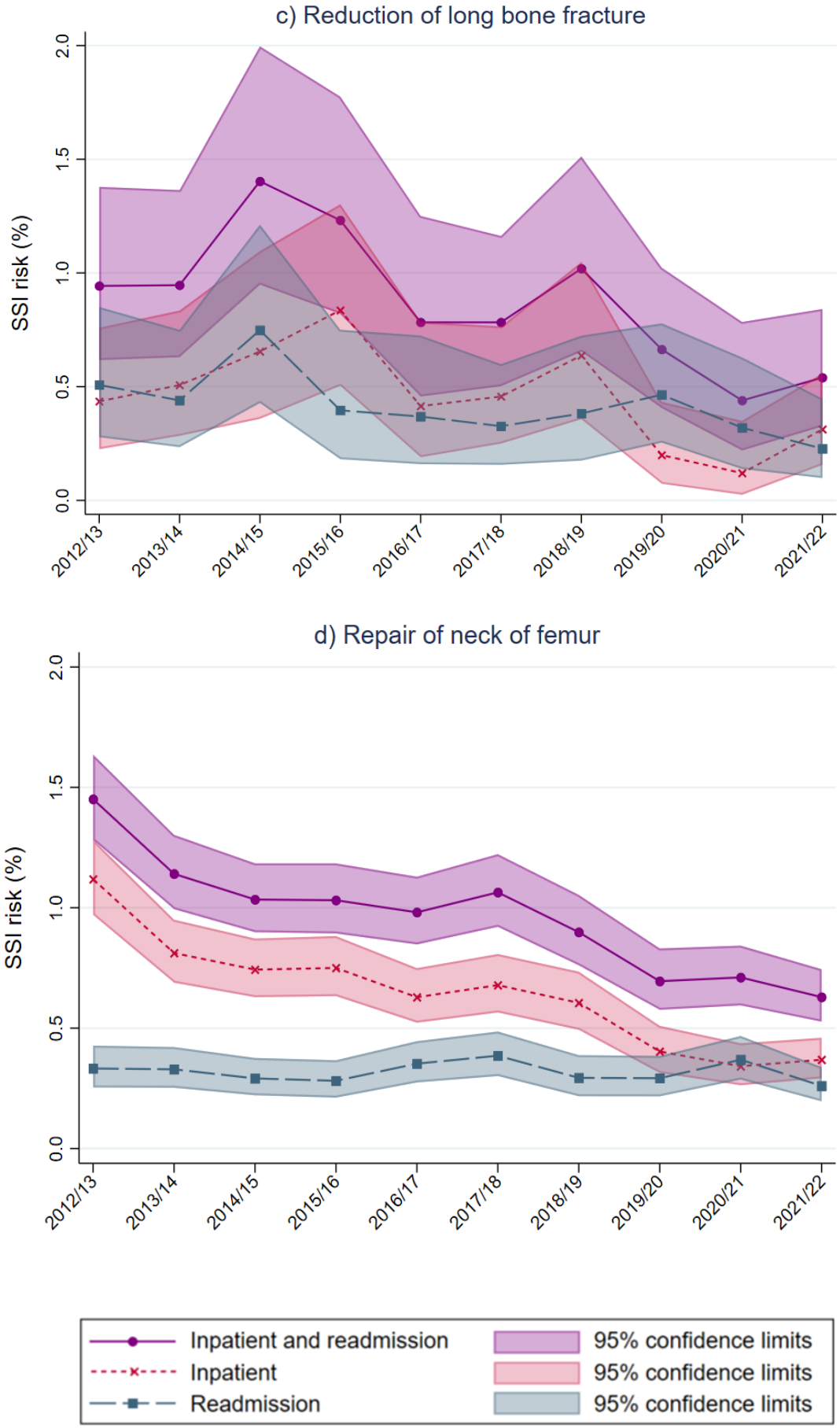
Figure 6e shows an overall decreasing 10-year trend for CABG, however the SSI risk has increased from 2.0% to 2.7% in financial year 2021 to 2022. This included infections at vein harvesting sites and the sternum. Cardiac surgery (non-CABG) shows an overall increasing 10-year trend in annual SSI risk reaching 1.4% in financial year 2021 to 2020, despite decreasing for the previous 2 financial years (Figure 6f).

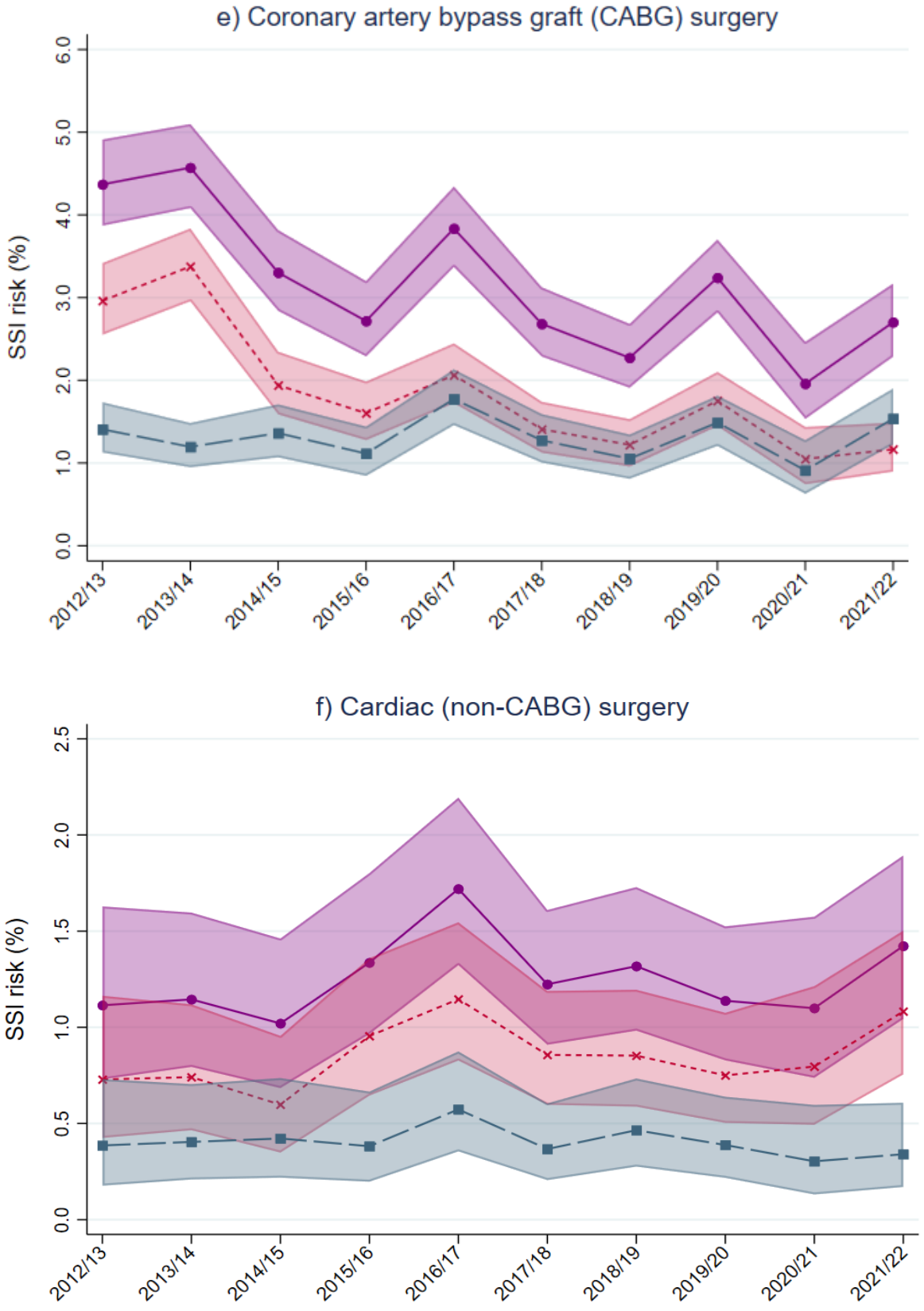
Of the gastrointestinal categories, large bowel surgery (Figure 6g) decreased from 10.5% in financial year 2020 to 2021 to 7.9% in the current financial year, which is the lowest SSI risk in 10 years. Annual SSI risk for small bowel surgery decreased from 10.8% in the previous financial year to 7.3% in financial year 2021 to 2022.

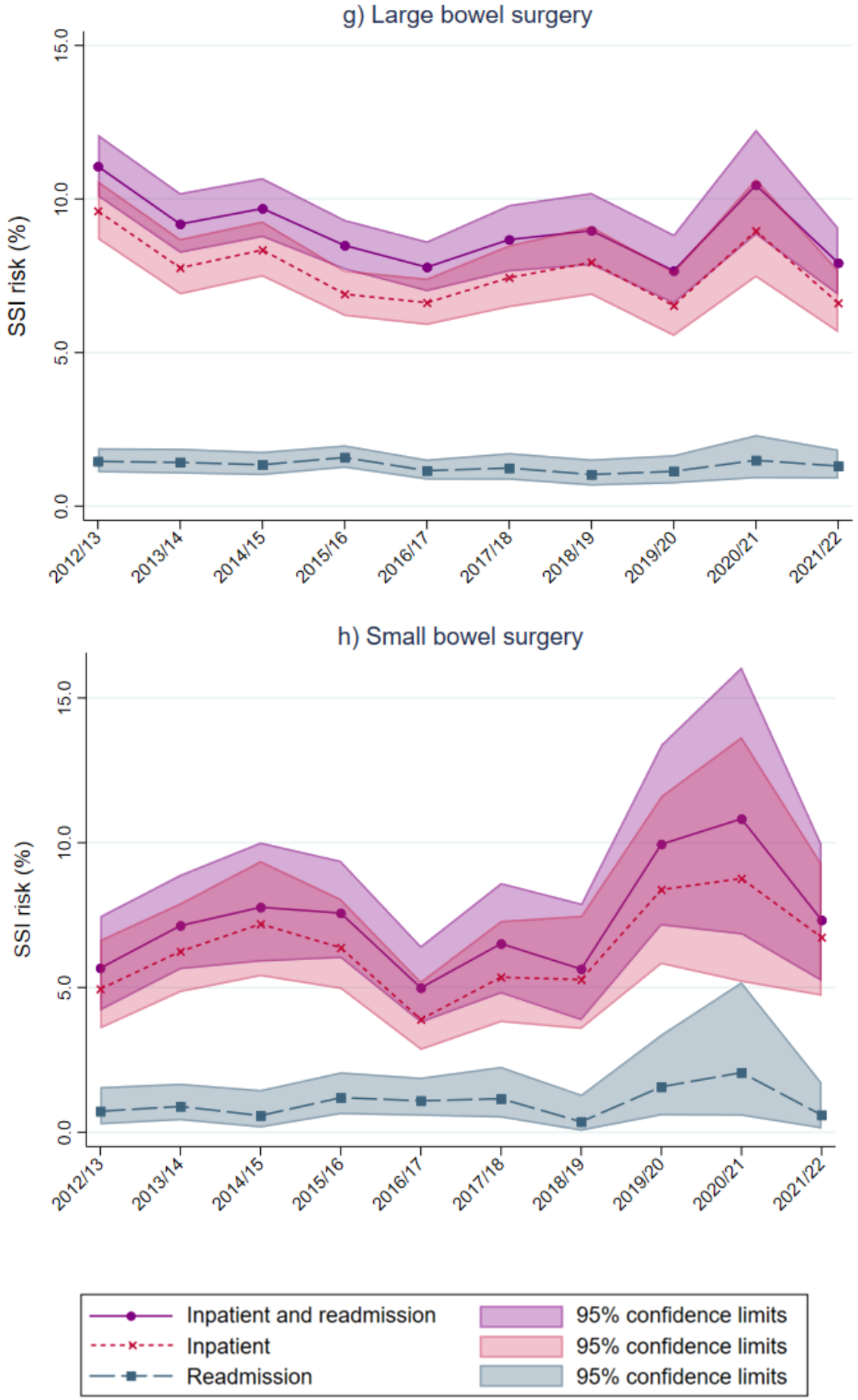
Since a peak in financial year 2015 to 2016 at 1.8%, in financial year 2021 to 2022 SSI risk after spinal surgery decreased to the lowest SSI risk in 10 years (0.9%) (Figure 6h). The SSI risk following breast surgery (Figure 6i) has been decreasing since financial year 2017 to 2018, however the SSI risk increased this financial year from 0.1% to 0.6%.

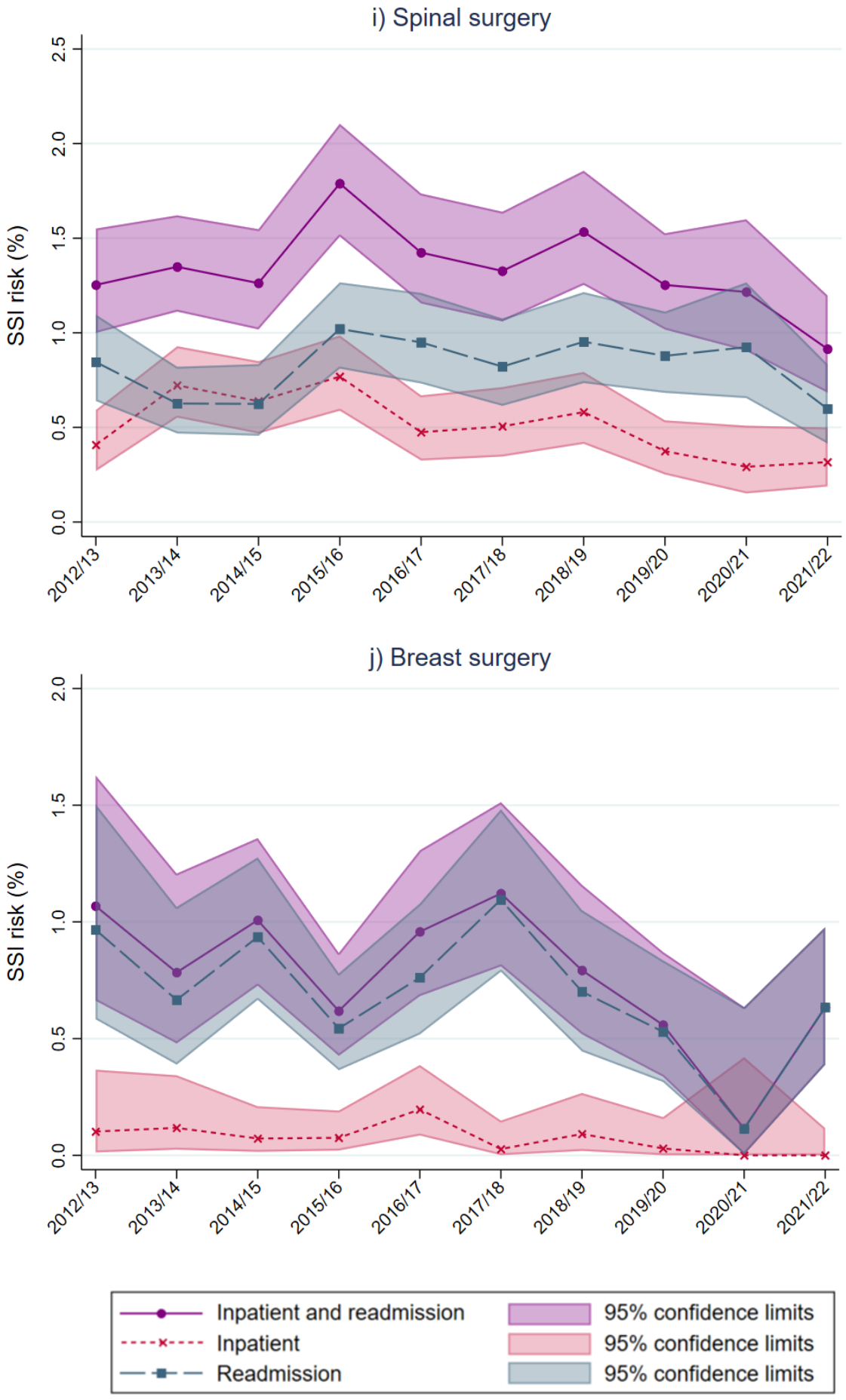
Figures 6a-j: Trends in annual SSI incidence for all surgical categories, NHS hospitals England, April 2012 to March 2022




c) Reduction of long bone fracture
SSI risk (%)
0.0
0.5
1.0
1.5
2.0
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/20
2020/21
2021/22
d) Repair of neck of femur
SSI risk (%)
0.0
0.5
1.0
1.5
2.0
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/20
2020/21
2021/22
Inpatient and readmission
95% confidence limits
Inpatient
95% confidence limits
Readmission
95% confidence limits


e) Coronary artery bypass graft (CABG) surgery
SSI risk (%)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/20
2020/21
2021/22
f) Cardiac (non-CABG) surgery
SSI risk (%)
0.0
0.5
1.0
1.5
2.0
2.5
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/20
2020/21
2021/22
Inpatient and readmission
Inpatient
Readmission
95% confidence limits
95% confidence limits
95% confidence limits


g) Large bowel surgery
SSI risk (%)
0.0
5.0
10.0
15.0
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/20
2020/21
2021/22
h) Small bowel surgery
SSI risk (%)
0.0
5.0
10.0
15.0
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/20
2020/21
2021/22
Inpatient and readmission
Inpatient
Readmission
95% confidence limits
95% confidence limits
95% confidence limits


i) Spinal surgery
SSI risk (%)
0.0
0.5
1.0
1.5
2.0
2.5
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/20
2020/21
2021/22
j) Breast surgery
SSI risk (%)
0.0
0.5
1.0
1.5
2.0
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
2019/20
2020/21
2021/22
Inpatient and readmission
95% confidence limits
Inpatient
95% confidence limits
Readmission
95% confidence limits

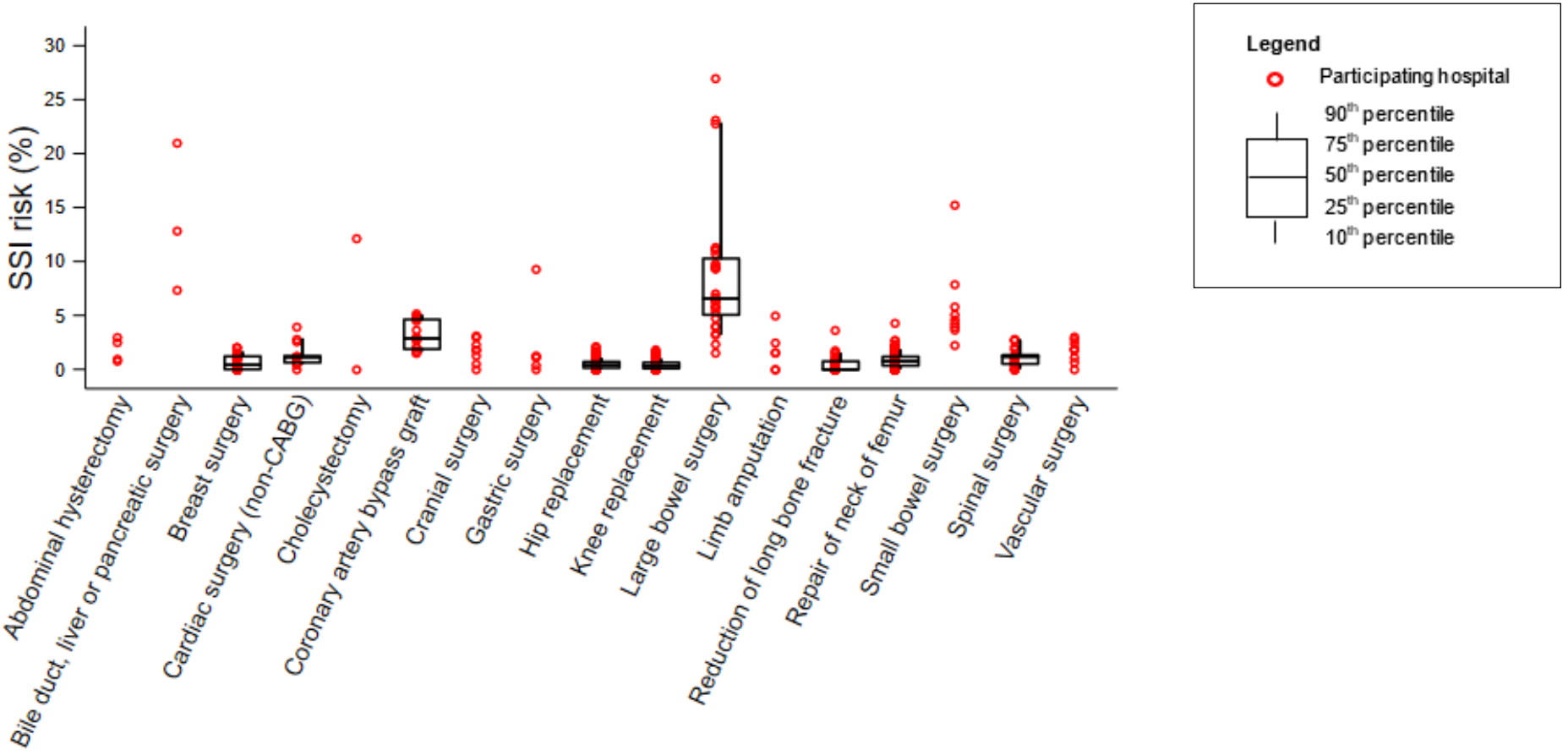
Variation in SSI risk between hospitals

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 (25th to 50th percentile) and an upper quartile (50th to 75th percentile), defining an expected range of results. The 'whiskers', which are used to indicate variability outside the upper and lower quartile, use the 10th and 90th 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.

Similar to previous years, large bowel surgery showed the greatest variability with hospital SSI risk ranging from 1.5% to 27.0%, which could in part be due to variation in emergency surgeries, but may also indicate room for improvement across hospitals in infection prevention, or case ascertainment. Hip replacement, knee replacement and breast surgery showed the least variation, with most hospitals hovering around the median. However, high outlier hospitals can still be identified for these categories.

Of the 9 surgical categories with more than 10 participating hospitals, 4 had a narrower interquartile range (difference between the 25th and 75th percentiles) than the previous financial year, indicating less variation. Of the remaining 5 surgical categories, 4 had a wider interquartile range, and one category remained the same. When the current interquartile range was compared to the previous year, cardiac (non-CABG) surgery had the greatest percentage decrease (42.7% decrease) 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 2017 to March 2022



* Categories with fewer than 10 hospitals participating within this time period are presented as a distribution without a box plot.
† NHS hospitals with less than 95 operations for hip replacement, knee replacement or abdominal hysterectomy are excluded from analysis for that category. NHS hospitals with less than 45 operations for any other category are excluded from analysis for that category.

Outlier assessment

In financial year 2021 to 2022, 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 financial year 2021 to 2022 for orthopaedic categories. The cumulative incidence of SSI per 100 procedures is plotted against the number of procedures for each participating NHS trust or 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 more immediate action.

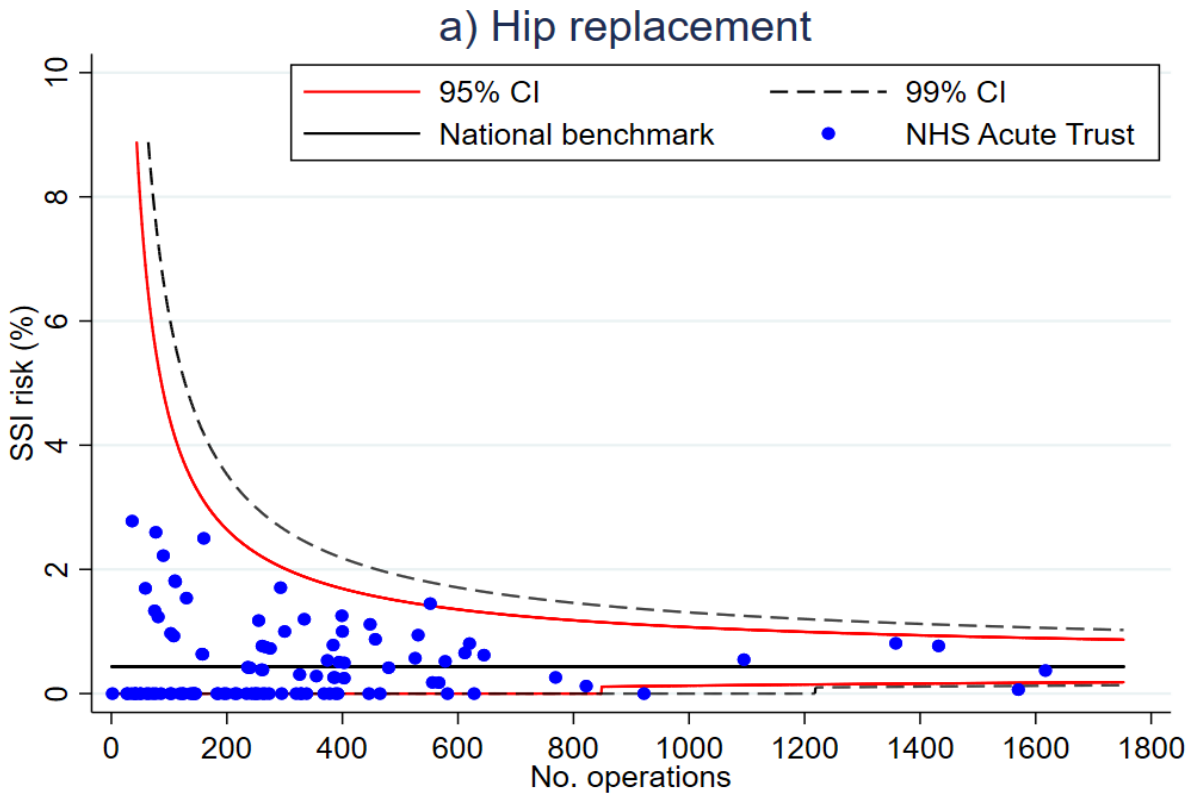
Results showed increased variation across trusts and less consistent grouping around the national benchmark for hip and knee replacement surgery in financial year 2021 to 2022 compared to the previous financial year. Compared to financial year 2019 to 2020, there was also slightly more variation in SSI risk for reduction of long bone fracture and repair of neck of femur surgery.

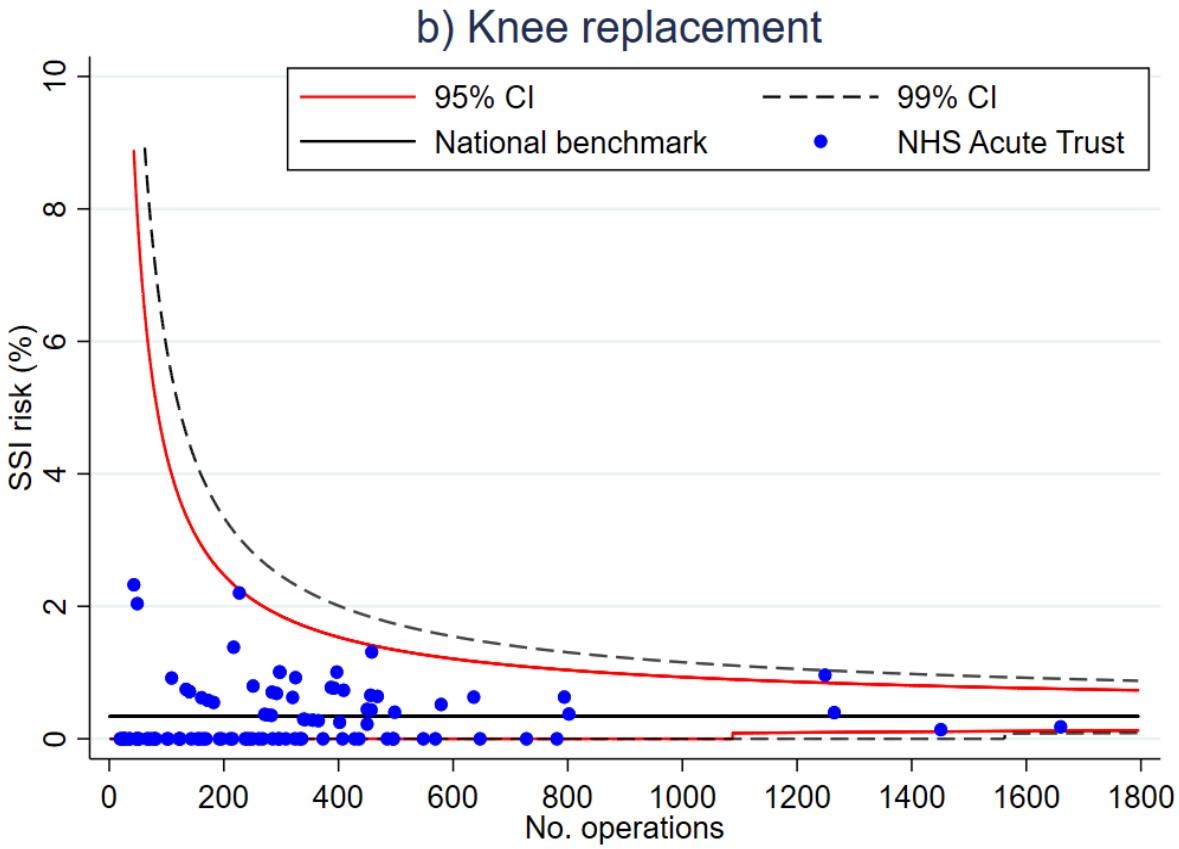
Four NHS acute trusts or treatment centres were identified as statistical high outliers (falling above the 95% upper confidence limits) across the 4 mandatory orthopaedic categories in financial year 2021 to 2022 (one for each category). Five NHS acute trusts or treatment centres were identified as statistical low outliers (falling below the 95% lower confidence limits) in financial year 2021 to 2022 (2 for hip replacement, and 3 for repair of neck of femur). One of the 4 providers notified as high outliers was also a high outlier in the same category last financial year, and one of the 5 the providers deemed a low outlier was also a low outlier in the same category in the last financial year.

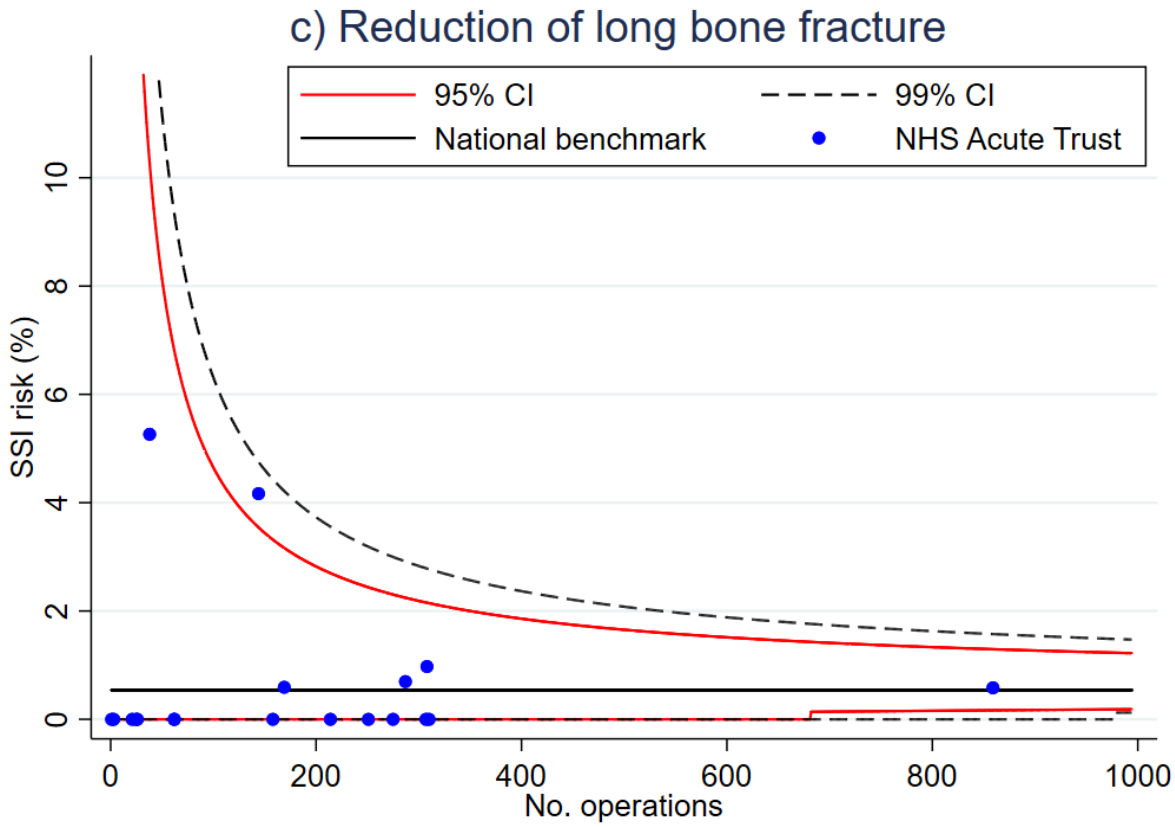
As part of this report, SSI risk results by NHS acute trust (and NHS treatment centres) for the last 2 financial years (2020 to 2021 and 2021 to 2022) are published in separate accompanying tables.

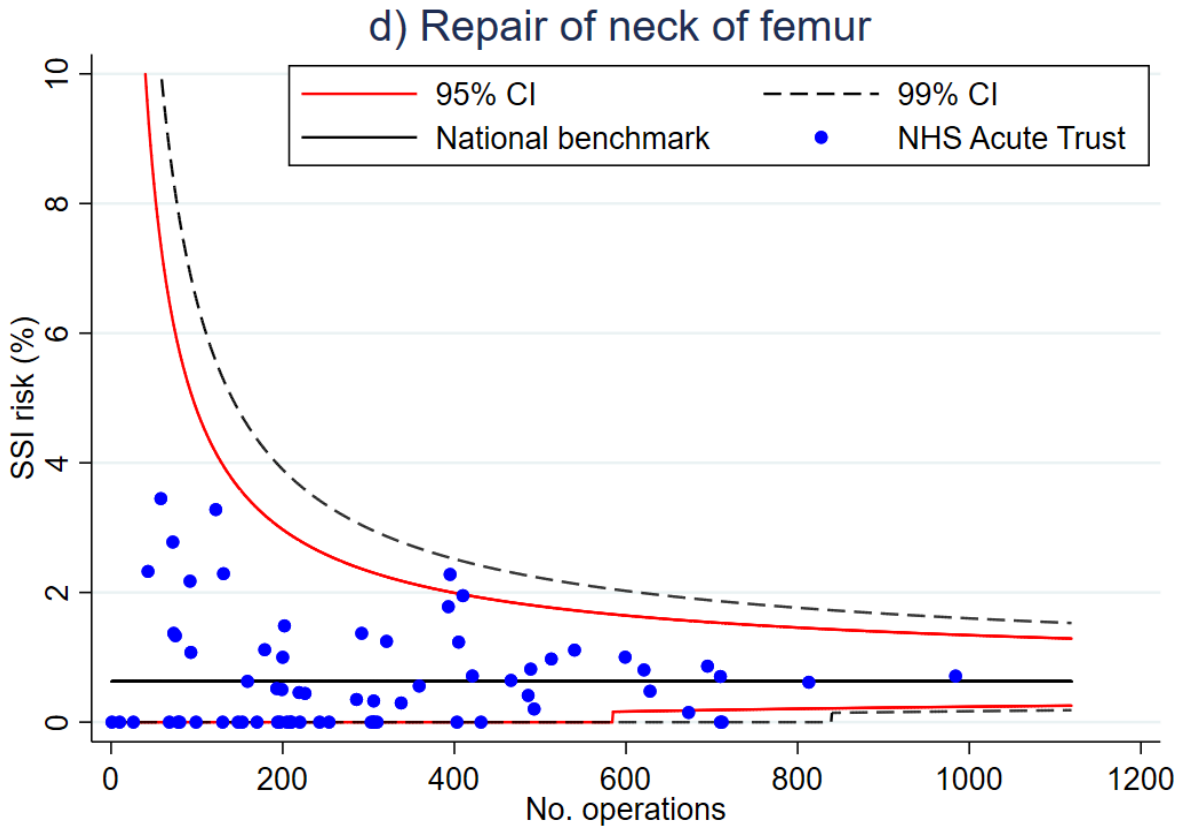
Annual trust-level results for hip and knee replacement surgery are also made available through UKHSA's public reporting tool, Fingertips. The tool also allows users to group results by trust type (namely, teaching, non-teaching, and specialty) or NHS sub-region and compare to a corresponding overall group average.

Figures 8a-d: Distribution of inpatient and readmission SSI risk, NHS acute trusts and treatment centres England, April 2021 to March 2022






c) Reduction of long bone fracture
95% CI
99% CI
National benchmark
NHS Acute Trust
SSI risk (%)
0
2
4
6
8
10
0
200
400
600
800
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
200
400
600
800
1000
1200
No. operations

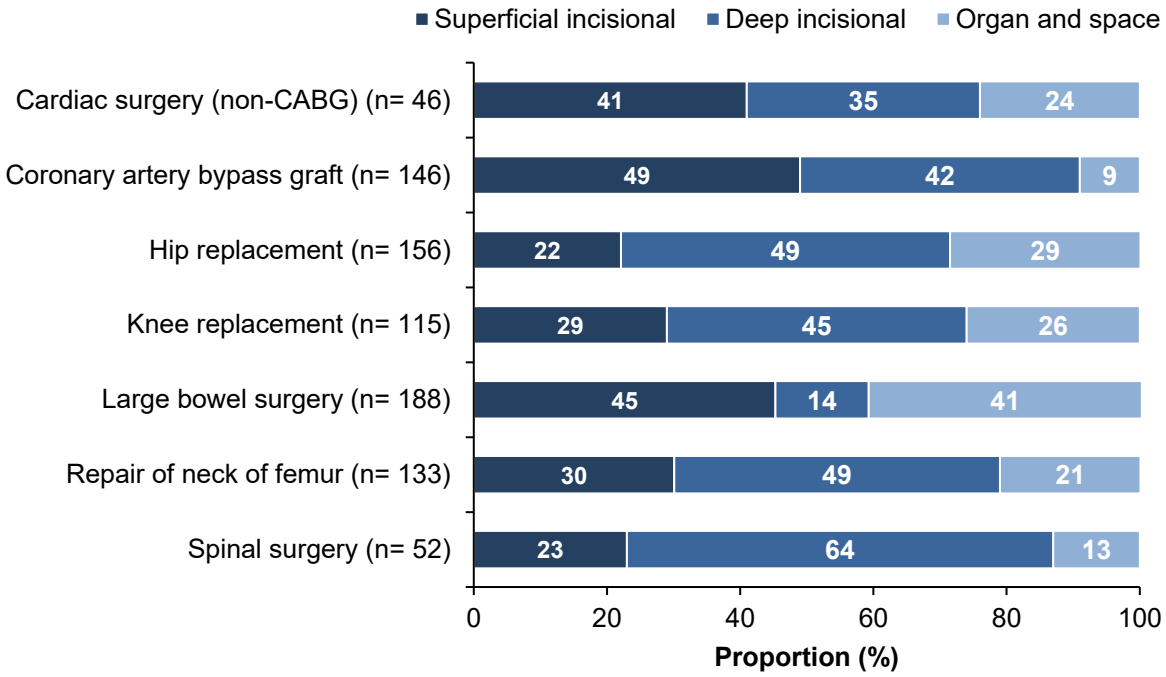
Characteristics of SSIs

Focus of SSI

Figure 9 shows the distribution of SSI types (superficial, deep or organ and space) by surgical category in financial year 2021 to 2022, where the number of inpatient and readmission SSIs per category were ≥45. Type of infection varied by 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 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 and treated earlier during the inpatient stay, and therefore are more likely to be less severe.

In financial year 2021 to 2022, CABG and large bowel surgery continue to report the highest proportions of superficial incisional infections (49.3% and 45.2%, respectively) and both are long stay procedures. Compared to the last time this section was published (financial year 2019 to 2020), the proportion of superficial SSIs following hip replacement surgery increased (from 19.0% to 21.8%) as the proportion of deep incisional SSIs decreased (from 58.8% to 49.3%). Among the 7 categories, the highest proportion of organ or space SSIs was following large bowel surgery (41.0%).

Figure 9: Proportion of SSI type for inpatient and readmission-detected SSIs by surgical category, NHS hospitals England, April 2021 to March 2022



Causative micro-organisms

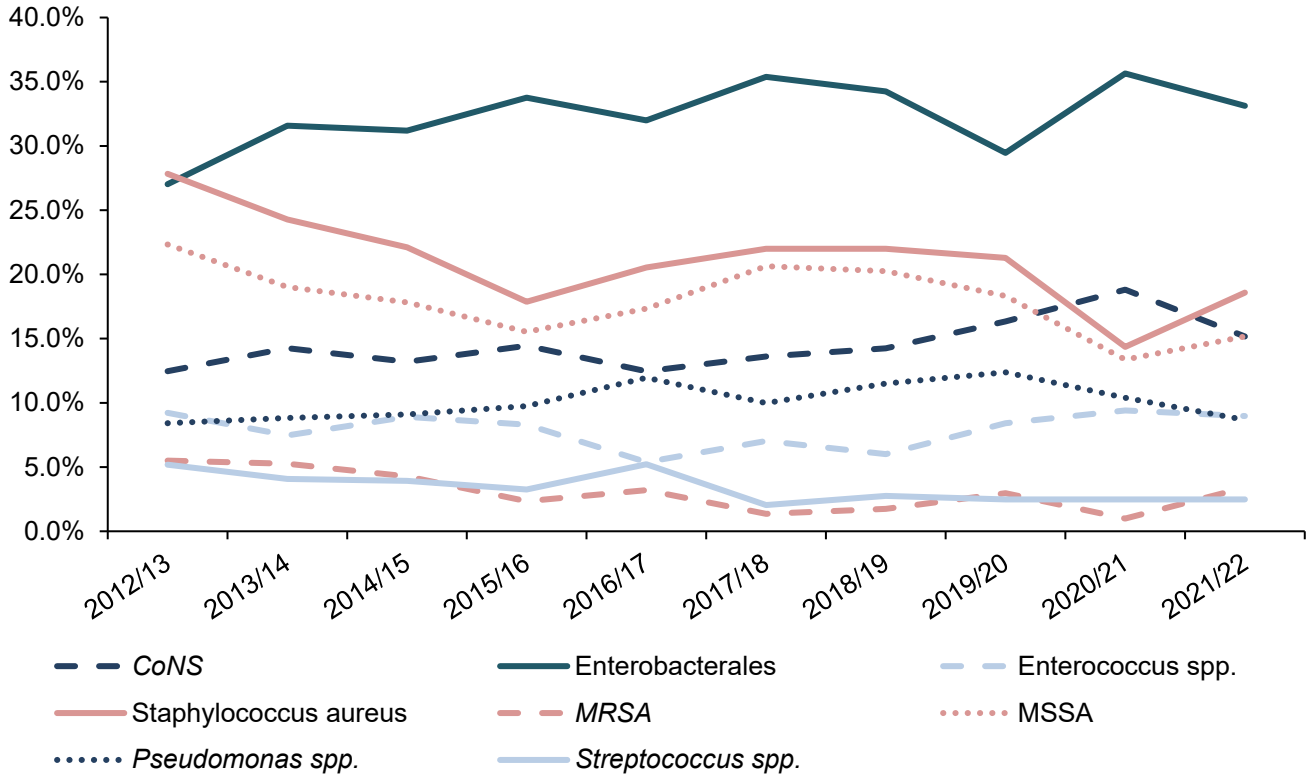
Figure 10a-b shows 10-year trends in microbial aetiology of inpatient and readmission-detected superficial and deep or organ and space SSIs across all surgical categories. During this time period there were 13,704 inpatient and readmission-detected SSIs reported, 69.9% (N=9,579) of which had accompanying microbiological confirmation. This proportion has increased from 64.2% in financial year 2011 to 2012 to 76.8% in 2021 to 2022. According to the UKHSA 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 organism for all SSIs in financial year 2021 to 2022, and showed an increasing 10-year trend for both types of SSI. Enterobacterales were attributed to 33.1% of superficial SSIs and 30.1% of deep incisional or organ and space SSIs. The most common Enterobacterales species was *Escherichia coli*. The second most prevalent causative organism was *Staphylococcus aureus* (*S. aureus*) for both superficial SSIs (18.6%) and deep incisional or organ and space SSIs (19.7%). *S. aureus* increased in financial year 2021 to 2022 compared to the previous financial year for both superficial SSIs (from 14.1% to 18.6%) and deep incisional or organ and space SSIs (17.4% to 19.7%). Despite the increase in *S. aureus* for superficial infections, there is a decreasing 10-year trend, compared to a more stable 10-year trend for deep incisional or organ and space infections.

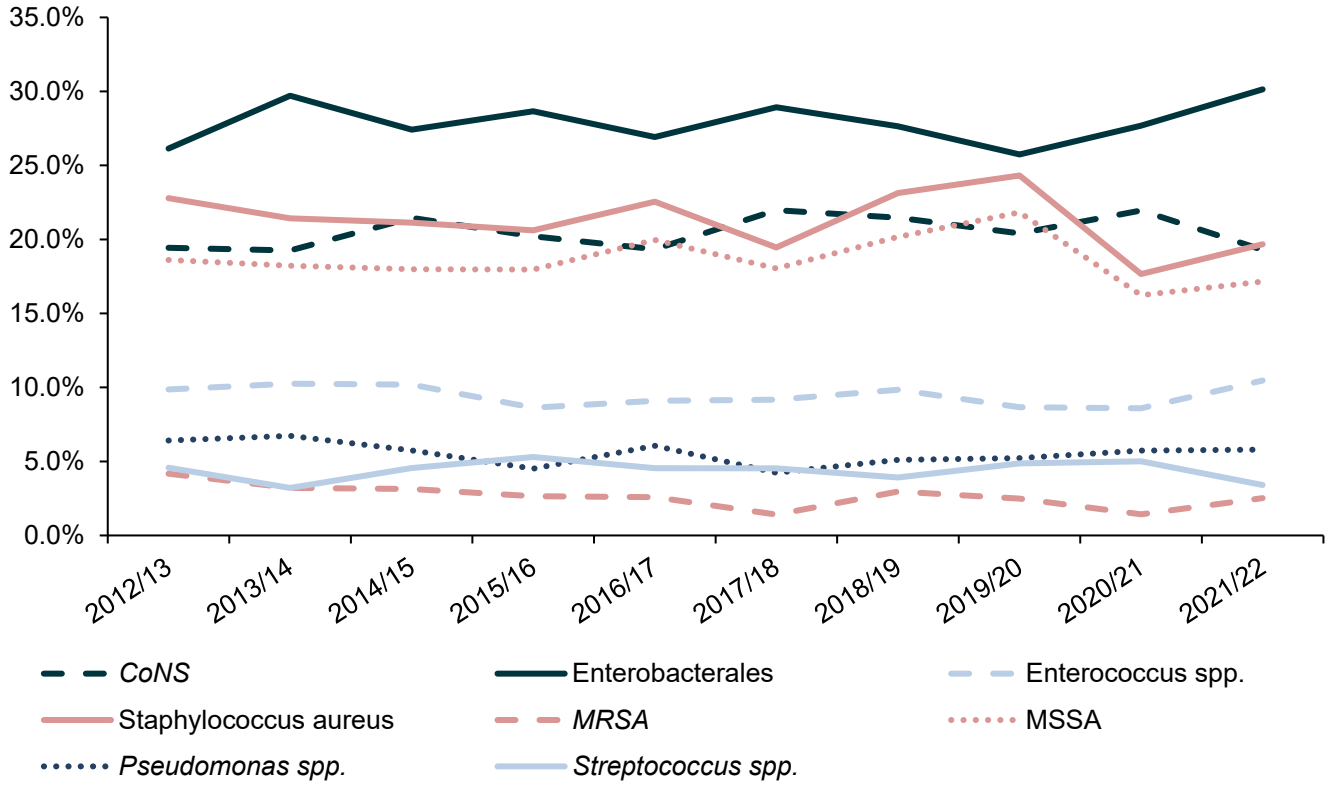
For both deep or organ and space and superficial infections, methicillin-sensitive *S. aureus* (MSSA) represents a much greater proportion of *S. aureus* infections than methicillin-resistant *S. aureus* (MRSA). However, among both types of infections the greatest increase from the previous financial year to the current financial year was for MRSA (from 1.4% to 3.4% for superficial, from 1.4% to 2.3% for deep or organ and space). For MRSA, the proportion in 2021 to 2022 was higher than or similar to pre-pandemic for superficial SSIs (3.4% versus 3.0%) and deep or organ and space (2.3% versus 2.5%), while MSSA remained lower than pre-pandemic (superficial: 15.0% versus 18.3%; deep or organ and space: 17.0% versus 21.8%).

Figure 10. Micro-organisms reported as causing inpatient and readmission SSIs, all surgical categories, NHS hospitals England, April 2012 to March 2022

a) Superficial SSIs



b) Deep or organ and space SSIs



Tables 4a-b provide break down of the distribution of organisms reported as causing inpatient and readmission-detected SSIs by surgical category for superficial and deep or organ and space SSIs. Five years of data were used for these analyses (April 2017 to March 2022) to increase sample sizes.

Among monomicrobial SSIs (single organism reported as causing SSI), MSSA is the dominant causative organism for hip replacement, knee replacement and spinal surgery among both superficial and deep or organ and space SSIs. Coagulase-negative Staphylococci (CoNS) make up almost a quarter of monomicrobial causative organisms associated with deep or organ and space SSIs for 4 of the 6 categories assessed including knee replacement (26.6%), repair of neck of femur (26.6%), hip replacement (24.4%) and CABG (24.5%). Compared to deep or organ and space SSIs, superficial SSIs reported a smaller proportion of CoNS causative microorganisms, except for CABG surgery (28.9%).

Enterobacterales SSIs were most prevalent in large bowel surgery, contributing 55.7% of superficial SSIs and 57.4% of deep or organ and space SSIs. Compared to the last time this section was published (financial year 2019 to 2020), the proportion of SSIs caused by Enterobactales following hip replacement decreased (superficial: 18.3% versus 20.1%; deep or organ and space: 20.3% versus 21.7%). Large bowel surgery and spinal surgery showed the greatest increase in proportion of superficial SSIs caused by Enterobactales (from 48.5% to 55.7% and from 15.9% to 19.0%, respectively).

Polymicrobial SSIs (cases with more than one organism reported as causing SSI) were most common in large bowel surgery. The proportions were greater in deep or organ and space SSIs (58.0%) compared to superficial SSIs (39.0%). Around a third to a half of deep or organ and space polymicrobial infections involved a combination of Gram-positive and Gram-negative organisms across all surgical categories (from 32.4% for spinal surgery to 54.6% for large bowel surgery). Among superficial SSIs, the proportions of combined Gram-positive and Gram-negative polymicrobials was slightly higher (from 39.1% for spinal surgery to 59.3% for hip replacement).

The proportion of polymicrobial SSIs caused by combinations of Gram-negative bacteria was highest for large bowel for superficial SSIs (29.9%) and CABG surgery for deep of organ and space SSIs (21.1%). The remaining categories had a higher proportion of Gram-positive only combinations (from 20.0% for knee replacement to 42.3% for repair of neck of femur). For deep or organ and space SSI, the proportion of Gram-negative polymicrobial infections was lower than superficial SSIs across all surgical categories, except hip replacement (8.1%) and repair neck of femur (10.2%).

The proportion of deep or organ and space SSIs caused by Gram-positive combinations was almost double that for superficial SSIs for knee replacement (39.4% for deep and organ and space SSIs versus 20.0% for superficial SSIs) and around 50% higher for hip replacement (40.9% for deep and organ and space SSIs versus 25.9% for superficial SSIs) and spinal surgery (51.5% for deep and organ and space SSIs versus 34.8% for superficial SSIs).

Table 4a: Micro-organisms reported as causing inpatient and readmission detected SSIs (superficial SSIs), all surgical categories*, NHS hospitals, England, April 2017 to March 2022

		Hip replacement		Knee replacement		Repair of neck of femur		Large bowel		Spinal surgery		Coronary artery bypass graft	
	Reported causative organism	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Monomicrobial	Methicillin-sensitive *S.aureus*	35	37.6	39	54.2	39	41.5	6	3.2	33	52.4	40	20.7
	Methicillin-resistant *S.aureus*	8	8.6	3	4.2	3	3.2	2	1.1	1	1.6	4	2.1
	Coagulase-negative staphylococci	15	16.1	12	16.7	17	18.1	10	5.3	14	22.2	55	28.9
	Enterobacterales	17	18.3	8	11.1	20	21.3	102	55.7	12	19.0	51	26.8
	Pseudomonas	6	6.5	3	4.2	6	6.4	35	18.7	3	4.8	29	15.0
	Streptococcus	4	4.3	1	1.4	0	0.0	5	2.7	0	0.0	0	0.0
	Enterococcus	4	4.3	3	4.2	6	6.4	16	8.6	0	0.0	2	1.0
	Other bacteria	4	4.3	3	4.2	2	2.1	2	1.1	0	0.0	6	3.1
	Fungi including *Candida* spp.	0	0.0	0	0.0	1	1.1	5	2.7	0	0.0	3	1.6
	Total monomicrobial	**93**	**100**	**72**	**100**	**94**	**100**	**183**	**100**	**63**	**100**	**190**	**100**
Polymicrobial	Gram-positive combinations only	7	25.9	5	20.0	11	42.3	4	3.4	8	34.8	12	13.2
	Gram-negative combinations only	1	3.7	3	12.0	2	7.7	35	29.9	5	21.7	19	20.9
	Gram positive and gram-negative combinations	16	59.3	13	52.0	11	42.3	61	52.1	9	39.1	48	52.7
	Other	3	11.1	4	16.0	2	7.7	17	14.5	1	4.3	11	12.2
	Total polymicrobial	**27**	**100**	**25**	**100**	**26**	**100**	**117**	**100**	**23**	**100**	**90**	**100**
	Total cases**	**120**	**200**	**97**	**200**	**120**	**200**	**300**	**200**	**86**	**200**	**280**	**200**

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

Table 4b: Micro-organisms reported as causing inpatient and readmission detected SSIs (deep and organ space SSIs), all surgical categories*, NHS hospitals, England, April 2017 to March 2022

		Hip replacement		Knee replacement		Repair of neck of femur		Large bowel		Spinal surgery		Coronary artery bypass graft	
	Reported causative organism	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Monomicrobial	Methicillin-sensitive *S.aureus*	129	35.3	131	41.1	55	19.0	4	4.3	87	49.7	47	30.3
	Methicillin-resistant *S.aureus*	15	4.1	10	3.1	22	7.6	1	1.1	2	1.1	6	3.9
	Coagulase-negative staphylococci	89	24.4	85	26.6	77	26.6	5	5.3	34	19.4	38	24.5
	Enterobacterales	74	20.3	32	10.0	90	31.0	54	57.4	31	17.7	36	23.2
	Pseudomonas	10	2.7	9	2.8	11	3.8	7	7.4	6	3.4	12	7.7
	Streptococcus	29	7.9	31	9.7	5	1.7	3	3.2	3	1.7		0.0
	Enterococcus	7	1.9	6	1.9	18	6.2	16	17.0	4	2.3	6	3.9
	Other bacteria	10	2.7	14	4.4	12	4.1	1	1.1	8	4.6	7	4.5
	Fungi including *Candida* spp.	2	0.5	1	0.3	0	0.0	3	3.2	0	0.0	3	1.9
	Total monomicrobial	**365**	**100**	**319**	**100**	**290**	**100**	**94**	**100**	**175**	**100**	**155**	**100**
Polymicrobial	Gram-positive combinations only	81	40.9	54	39.4	70	37.4	7	5.4	35	51.5	15	16.9
	Gram-negative combinations only	16	8.1	12	8.8	19	10.2	23	17.7	8	11.8	19	21.3
	Gram positive and gram-negative combinations	96	48.5	59	43.1	83	44.4	71	54.6	22	32.4	43	48.3
	Other	5	2.5	12	8.8	15	8.0	29	22.3	3	4.4	12	13.5
	Total polymicrobial	**198**	**100**	**137**	**100**	**187**	**100**	**130**	**100**	**68**	**100**	**89**	**100**
	Total cases**	**563**	**200**	**456**	**200**	**477**	**200**	**224**	**200**	**243**	**200**	**244**	**200**

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

Patient post discharge questionnaire (PDQ)

Whilst SSIs detected through optional post discharge surveillance are not included in this annual report, in anticipation of the release of an electronic PDQ (ePDQ), we describe trends in uptake of the existing PDQ (12). Figure 11 shows PDQs given and PDQs completed as a percentage of the number of operations, and the proportion of PDQs completed as a percentage of the number of PDQs given (2012 to 2022). The proportion of patients under surveillance given a PDQ indicates the coverage of total operations by PDQ surveillance. This proportion increased from 45.4% in financial year 2012 to 2013 to 53.5% in 2021 to 2022, with no change during the pandemic despite the reduction seen in number of operations.

The proportion of PDQs completed of those given increased from 72.3% in 2012 to 2013 to 80.5% in 2021 to 2022, showing that where PDQs are given there is a high response rate. Given that not all hospitals are utilising PDQs, the overall proportion of operations with a completed PDQ remained below 45% over the past 10 years although showing a steady increased from 32.8% to 43.0%.

Figure 11: Uptake and completion of PDQs as a proportion of all operations and where PDQ given, by financial year, NHS hospitals England, April 2012 to March 2022

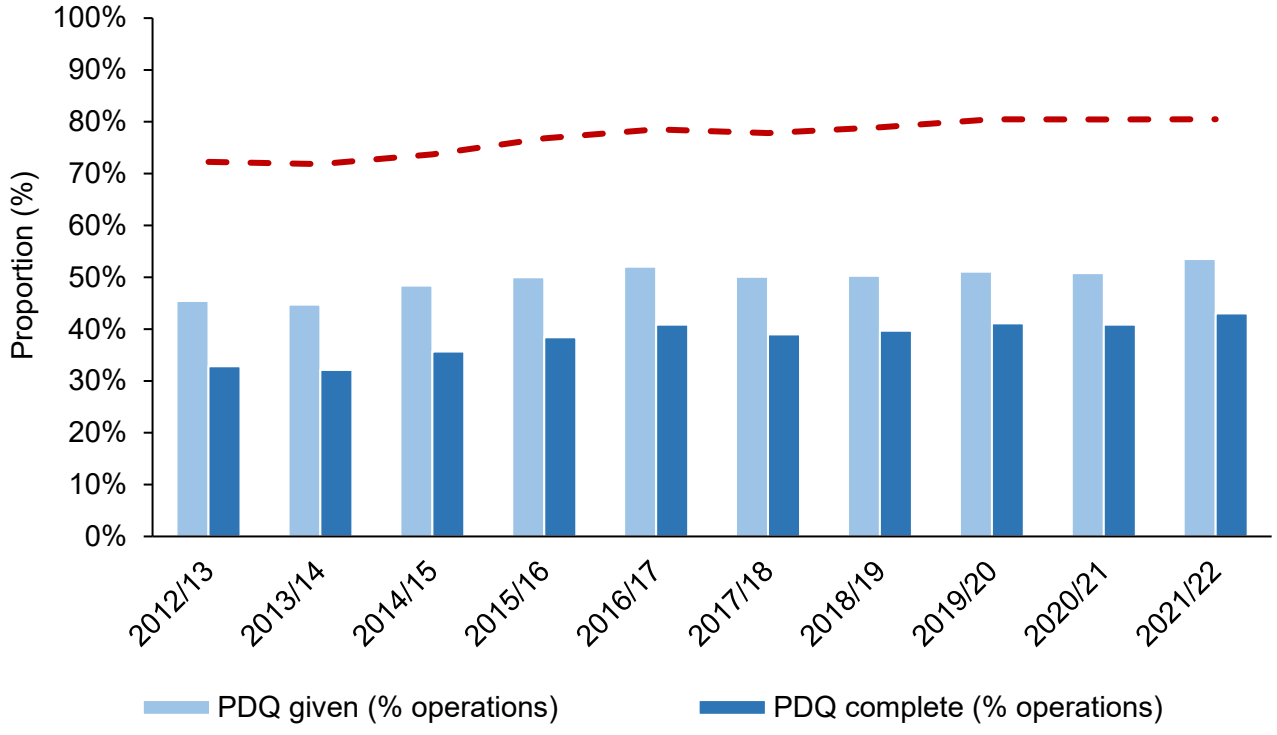
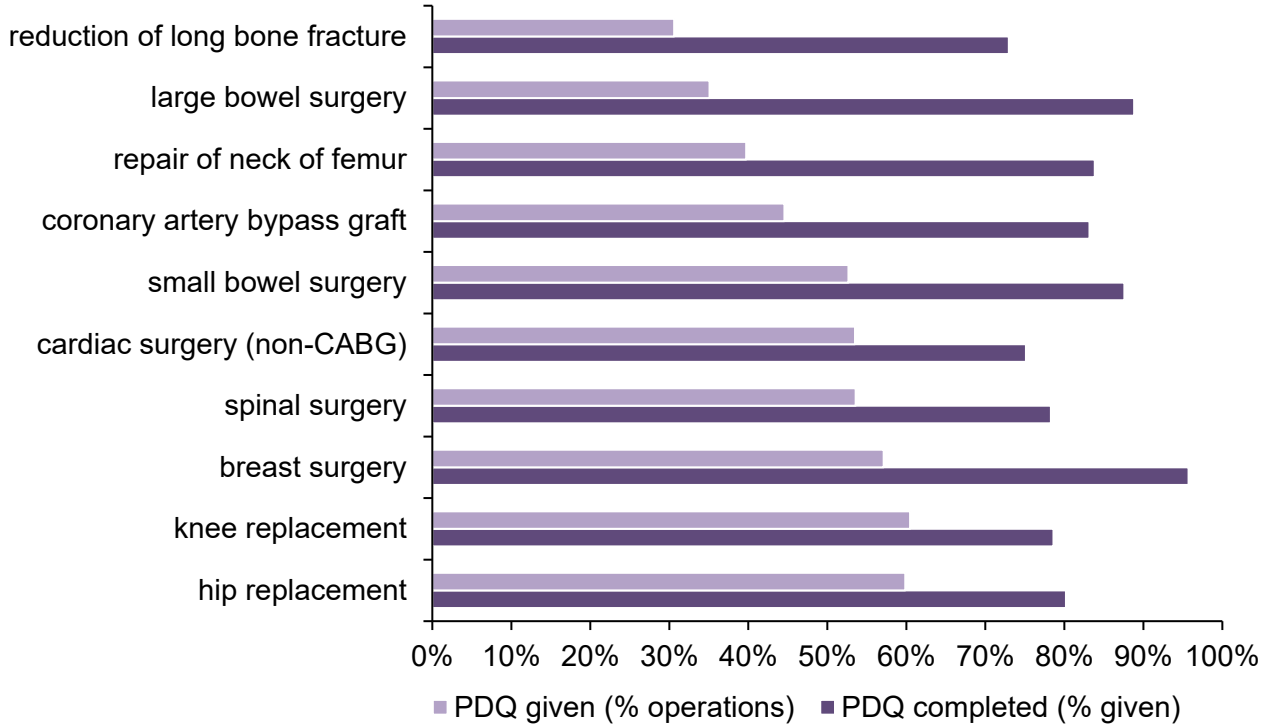


Figure 12 shows the proportion of PDQs given (as a percentage of operations) and PDQs completed (as a percentage of PDQs given) among categories with more than 5 participating hospitals in financial year 2021 to 2022. The proportion of operations with a PDQ given ranged from 30.6% for reduction of long bone fracture to 60.0% for both hip and knee replacement. Categories with lower lengths of stay (median 0 to 3 days) including hip and knee replacement, breast surgery and spinal surgery, had the highest uptake of PDQs. The proportion of PDQs completed (from PDQ given) was above 70% for all categories, highest for breast surgery (95.7%).

Figure 12: Uptake of PDQs as a proportion of all operations and completion of PDQs where PDQ given, by category, NHS hospitals England, April 2021 to March 2022



Discussion

Through partnership working with NHS and independent sector healthcare providers, the UKHSA SSISS has amassed a wealth of information, having accumulated surveillance data for almost 2.5 million operations and 53,000 SSIs since its inception in 1997. In financial year 2021 to 2022, submissions of data for both mandatory and voluntary surgical categories increased compared to the previous financial year. This trend was likely due to an increase in routine surgeries after the reductions due to COVID-19 in financial year 2020 to 2021. Despite the 73.1% increase in procedures, the number of procedures remained 14% lower than pre-pandemic (financial year 2019 to 2020). While participation was closer to pre-pandemic levels, it is still likely to have been affected by the pandemic.

The collection of a full data set for all surgical patients under surveillance during the pandemic has helped us explain SSI trends by providing important context on hospital activity and case mix. Overall, in 2021 to 2022 there were a higher proportion of complex procedures than pre-pandemic (2019 to 2020). Breast surgery was the only category that did not show any increases in complexity compared to the previous year, as surgery duration and length of stay remained the same, while ASA score decreased from 14.6% to 14.2% and multiple procedures decreased from 14.4% to 4.6%. The greatest increase in complexity among specific categories was seen in cranial surgery for multiple procedures, with an increase from 0.8% to 6.4%. Surgery complexity remaining high may be due to elective surgeries still not returning to pre-pandemic levels, alternatively it is possible there may have been deterioration of underlying conditions due to delay, necessitating more complex surgery. However, the lower participation than pre-pandemic may have introduced more variability and mean that some trends or comparisons between the 2 most recent financial years need to be interpreted with caution.

In financial year 2021 to 2022, 10-year trends in the annual inpatient and readmission SSI risk showed that 8 of 10 surgical categories assessed showed a declining trend, including all of the mandatory orthopaedic categories. Despite the overall decreasing trend, 6 of 10 categories assessed showed an increase in SSI risk from financial year 2020 to 2021 to financial year 2021 to 2022. In the most recent 2 financial years, only spinal surgery has shown the same trend (decreasing SSI risk in both years). The fluctuation in trend for most categories assessed may be due to changes in infection prevention control measures during COVID-19, changes to adherence of SSISS protocols, or changes in number of operations submitted meaning more variation in the calculated SSI risks.

Large bowel surgery decreased from 9.9% in financial year 2020 to 2021 to 7.4% in financial year 2021 to 2022, which is the lowest SSI risk in 10 years. There is still considerable inter-hospital variation in SSI risk following large bowel surgery, with 5-year hospital rates ranging from 1.5% to 27.0%. This indicates that there may be room for improvement through review of infection prevention control, sharing of best practice from mentor hospitals and case ascertainment practices. However, there may be differences in the distribution of patient risk

factors between hospitals, or other risk factors such as emergency surgery, which was recorded in 8.0% of large bowel procedures in 2021 to 2022.

Annual trust-level SSI risk funnel plots in financial year 2021 to 2022 showed more variation in the SSI risk across trusts and less consistent grouping around the national benchmark for the mandatory orthopaedic surveillance categories. This trend of more variation is in contrast to the trend seen in the last 2 financial years. Four high outlier notifications were sent out for the mandatory surveillance categories compared to 2 in the previous year. High outliers emphasize the importance of continued surveillance and monitoring as differences in the population at risk and risk factors at the time of surgery may result in periodic increases in infections regardless of a hospital's own prior history and the declining national benchmark.

There were 5 low outlier notifications and one of the trusts was a low outlier in the same category the previous year. 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 delve further into their results through their web-based hospital reports which include risk-stratified data, and review their policies and practices, such as the use of prophylactic antimicrobials.

More than half of the patients undergoing a knee replacement procedure were obese (55.7% in financial year 2020 to 2021). An elevated BMI has been shown to increase the likelihood of developing an SSI (10, 11). However, a 2017 report found that 47% of Clinical Commissioning Groups (CCGs) in the United Kingdom have a BMI threshold in place for funding surgery (13). At this time, the majority of these CCGs apply a threshold of 35 kg/m^2 or more, however 10% set a threshold of 30 kg/m^2 ('obese') and 4% set a threshold of 25 kg/m^2 ('overweight'). In financial year 2020 to 2021, the median patient BMI decreased for half of the surgical categories, which may suggest selective access to elective surgery based on a lower patient BMI, especially for non-urgent surgeries. Completion of BMI has increased from 54% in financial year 2020 to 2021, to 59% in financial year 2021 to 2022. BMI information will be important to consider when assessing high hospital outliers, especially where BMI thresholds continue to be applied by Integrated Care Boards (established July 2022).

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% (14). Given this concern it is important that we continue to monitor the proportion of SSI caused by Gram-negative bacteria such as Enterobacterales. In financial year 2021 to 2022, both superficial SSIs and deep or organ and space SSIs showed an increasing 10-year trend in the proportion of Enterobacterales SSIs, which is a concerning trend and highlights the need for ongoing surveillance.

In financial year 2021 to 2022, the proportion of SSIs caused by *S. aureus* increased for both infection types, with MRSA and MSSA both increasing. While MSSA represented a much greater proportion of *S. aureus* infections, MRSA showed the greatest increase from the

previous financial year to the current financial year (from 1.4% to 3.4% for superficial, from 1.4% to 2.3% for deep or organ and space). While this increase for MRSA brought the proportion to a similar proportion as pre-pandemic, MSSA remained below pre-pandemic levels. Despite this increase, there is a decreasing 10-year trend for superficial SSIs caused by *S. aureus* and a stable trend for deep or organ and space SSIs. 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.

The proportion of PDQs given and the proportion of PDQs completed (as a percentage of the number of operations) both showed an increasing trend, reaching 53.5% and 43.0% respectively in financial year 2019 to 2020. However, the proportion of PDQs completed from the number of PDQs given has remained high for the last 10 years and reached 80.5% in 2021 to 2022, showing that where PDQs are given there is a high response rate. At the category level, the response rate for PDQs completed (from PDQs given) was also high for all categories with more than 5 participating hospitals, with breast surgery showing that 95.7% of all PDQs given were completed.

As the provision and completion of PDQs is not mandatory, SSIs detected through PDQs are not included in our analysis. The PDQ is currently paper-based and therefore comes with an administrative overhead. In spite of this, over 50% of operations were administered a PDQ illustrating the value hospitals place in obtaining more comprehensive estimate of SSI burden. An electronic PDQ (ePDQ) is in beta phase development and this should help increase hospital uptake of PDQ surveillance by easing the administrative burden and increase response rates by patients. This will provide hospitals with a more sensitive SSI measure and allow PDQs to be used for benchmarking and alerting, facilitating early detection of changes warranting intervention.

While this report shows that some trends are returning to pre-pandemic levels (2019 to 2020), the impact of COVID-19 on healthcare is ongoing. We will continue to monitor and assess the contribution of COVID-19 on SSI trends.

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. Ninety-five percent 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 (non-emergency) surgeries, diagnostic procedures and tests in an effort to help the NHS reduce waiting times.

NHSN Risk Index

The Centres for Disease Control and Prevention 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 of SSI for a patient after an 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 one 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 of less than 1 usually means that being exposed to a certain factor or possessing a certain risk factor increases the risk of infection. A risk ratio greater than 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

Table 9. 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

Appendix 2

Table 10. Data completeness for patient and surgical characteristic variables, NHS hospitals England, April 2021 to March 2022

			Patient-related characteristics				Surgery-related characteristics						
Surgical category	**Number of hospitals**	**Number of operations**	**Age**	**Sex**	**BMI***	**ASA score**	**Wound class**	**Operation duration**	**Pre-op stay**	**Elective surgery**	**Trauma surgery***	**Primary indication**	**Antibiotic prophylaxis**
			(%)	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
Abdominal hysterectomy	3	152	100.0	0.0	82.2	94.7	100.0	99.3	100.0	100.0	98.7	-	99.3
Bile duct, liver or pancreatic surgery	1	84	100.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	-	83.3
Breast surgery	15	3152	100.0	100.0	75.2	97.0	100.0	100.0	100.0	100.0	99.6	-	97.8
Cardiac surgery (non-CABG)	8	3233	100.0	100.0	82.9	68.7	100.0	100.0	100.0	100.0	100.0	-	100.0
Cholecystectomy	2	72	100.0	100.0	1.4	97.2	100.0	100.0	100.0	100.0	100.0	-	73.6
Coronary artery bypass graft	11	5403	100.0	100.0	85.5	76.9	100.0	100.0	100.0	100.0	99.9	-	99.9
Cranial surgery	3	1180	100.0	100.0	79.1	88.3	100.0	100.0	100.0	100.0	99.8	-	99.4
Gastric surgery	4	223	100.0	100.0	70.0	100.0	100.0	100.0	100.0	100.0	100.0	-	92.8
Hip replacement	147	35480	100.0	100.0	65.0	98.9	99.7	100.0	100.0	100.0	1.8	98.9	97.8
Knee replacement	138	32787	100.0	100.0	66.8	98.7	99.7	100.0	100.0	100.0	1.8	98.4	97.7

			Patient-related characteristics				Surgery-related characteristics						
Surgical category	**Number of hospitals**	**Number of operations**	**Age**	**Sex**	**BMI***	**ASA score**	**Wound class**	**Operation duration**	**Pre-op stay**	**Elective surgery**	**Trauma surgery***	**Primary indication**	**Antibiotic prophylaxis**
			(%)	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
Large bowel surgery	13	2374	100.0	100.0	73.5	98.3	100.0	100.0	100.0	100.0	98.3	-	97.1
Limb amputation	4	144	100.0	100.0	74.3	95.8	100.0	100.0	100.0	100.0	97.9	-	95.8
Reduction of long bone fracture	23	3519	100.0	100.0	18.8	98.0	100.0	100.0	100.0	100.0	99.5	-	94.5
Repair of neck of femur	85	21144	100.0	100.0	30.5	96.6	99.2	100.0	100.0	100.0	2.0	99.2	97.2
Small bowel surgery	5	505	100.0	100.0	60.2	97.0	100.0	100.0	100.0	100.0	99.6	-	95.0
Spinal surgery	13	5683	100.0	100.0	65.9	99.2	100.0	100.0	100.0	100.0	78.5	-	92.3
Vascular surgery	4	661	100.0	100.0	75.3	98.6	100.0	100.0	100.0	100.0	100.0	-	98.8

* Optional data entry field.

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