Public Health England

Protecting and improving the nation's health

Surveillance of surgical site infections in NHS hospitals in England

April 2018 to March 2019

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Public Health England
Wellington House
133-155 Waterloo Road
London SE1 8UG
Tel: 020 7654 8000
www.gov.uk/phe
Twitter: @PHE_uk
Facebook: www.facebook.com/PublicHealthEngland

Prepared by: The Surgical Site Infection Surveillance Service, Healthcare-Associated Infection & Antimicrobial Resistance Division, National Infection Service, Public Health England

For queries relating to this document, please contact: hcai.amrdepartment@phe.gov.uk

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Authors

Kristine Cooper, Theresa Lamagni, Pauline Harrington, Catherine Wloch and Susan Hopkins.

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Key points

In 2018/19, 201 NHS hospitals and 8 Independent Sector (IS) NHS treatment centres submitted surveillance data for 132,254 surgical procedures to the PHE Surgical Site Infection (SSI) Surveillance Service; across 17 surgical categories 1,183 SSIs were detected during the inpatient stay or on readmission.

106,787 procedures were part of mandatory surveillance of orthopaedics, where all eligible trusts met the surveillance requirements; 25,467 procedures were submitted as part of voluntary surveillance spanning 13 other surgical categories.

The majority of hospitals participating in mandatory surveillance of hip and knee replacement surgery elected to carry out continuous surveillance in 2018/19 (61.0% and 61.5%, respectively).

Seven high outlier notifications were sent out for the mandatory surveillance categories in 2018/19 (4 for knee replacement, 2 for hip replacement and 1 for repair of neck of femur).

Ten-year trends in annual inpatient/readmission SSI risk varied by surgical category with the SSI risk following hip replacement surgery decreasing further to 0.4% in 2018/19, and knee replacement surgery remaining stable at 0.4%.

Spinal surgery has seen the greatest *per cent* increase overall in the annual inpatient/readmission SSI risk, from 0.9% in 2009/10 to 1.5% in 2018/19, while CABG surgery has had the greatest *per cent* decrease overall from 5.7% in 2009/10 to 2.3% in 2018/19; annual inpatient/readmission SSI risk following large bowel surgery increased further reaching 9.0% in 2018/19.

Inter-hospital variation in SSI risk decreased from the previous year for the majority of surgical categories (8 of 11 assessed); large bowel surgery continues to show the greatest variation (interquartile range (IQR) 4.8 in 2018/19) and did not improve from the previous year (IQR 4.2).

National benchmarks for inpatient and readmission-detected SSI have remained relatively stable and ranged from 8.7% for large bowel surgery to <1.0% for hip and knee replacement surgery (April 2014 to March 2019).

Repair of neck of femur surgery had the highest proportion of SSI classified as deep incisional or organ/space (72.0%), followed closely by hip replacement surgery at 71.0%.

Enterobacterales continued to make up the largest proportion of causative organisms across all surgical categories in 2018/19 (30.0%) but did not increase from 2017/18; the proportion varies by category.

Surgical Site Infection (SSI) Surveillance Service

Introduction

This report summarises the 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 were mandated by the Department of Health 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 2009 to 31 March 2019, with a focus on the latest financial year (2018/19).

Methods

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 attend a one-day training course at 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 90th percentile ('high outliers') or below the 10th 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 PHE 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 methods are recommended, especially for short-stay procedures, but remain

optional. They comprise: a) systematic review of patients attending outpatient clinics or seen at home by clinical staff trained to apply the case definitions and b) wound healing questionnaires completed by patients 30 days after their operation [4]. Data derived from these optional methods are not currently included in the national benchmarks or used for outlier assessment but provide a sensitive measure of an individual hospital's infection risk to inform local assessment of trends.

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 to increase specificity, 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 other European member states and publishes comparative analyses including trends. These provide an opportunity to examine variation in the SSI incidence between European countries and to improve understanding of how these infections may be prevented. Inter-country variation can however be due to differences in surveillance methodology and/or risk factors [7].

Analyses presented in this report

Surveillance data for surgical procedures for a 10-year period, between 1 April 2009 and 31 March 2019, were extracted on 11 November 2019 for this report. For procedures performed in the last few months of the 2018/19 financial year and subject to a one-year follow-up (prosthetic implant surgery), late onset infections occurring after data extraction will not be captured, although these constitute very small numbers [8].

SSIs included in this report are based on cases detected during the inpatient stay or on readmission to hospital. For benchmarking purposes, the last 5 years of data were used (1 April 2014 to 31 March 2019). Pooled 5-year data were also used where the number of observations for the current financial year were too low to calculate meaningful

results or analyses were restricted to categories that met the minimum volume thresholds.

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.

Funnel plots were produced to compare SSI risk across NHS trusts 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). IS NHS treatment centres are also included in these plots. An additional supplement to this report contains 2017/18 and 2018/19 SSI risk results by NHS trust or treatment centre:

www.gov.uk/government/publications/surgical-site-infections-ssi-surveillance-nhs-hospitals-in-england

Data for the previous financial year (2017/18) includes updates reflecting any late onset infections reported since publication of the last annual report.

Surgical Site Infection Surveillance Service overview

Hospital participation and surgical volumes

Overall, 201 NHS hospitals representing 138 NHS trusts and an additional 8 IS NHS treatment centres participated in the SSISS in 2018/19. Surveillance data were submitted for 132,254 procedures. Of these, 106,787 were orthopaedic procedures submitted as part of mandatory surveillance and 25,467 procedures submitted as part of voluntary surveillance spanning 13 other surgical categories. The number of operations submitted for mandatory orthopaedic surveillance remained relatively stable compared to 2017/18 (1% increase). The number of operations submitted for voluntary surveillance decreased from 2017/18 (10%), but 5 more hospitals participated in any voluntary surveillance in 2018/19.

Mandatory surveillance of hip and knee replacement surgery remain the categories with the highest volume of operations and number of participating hospitals (159 and 156 hospitals in 2018/19, respectively). Participation across voluntary surgical categories varied, with large bowel (19 hospitals), breast (17 hospitals) and spinal surgery (15 hospitals) having the highest hospital participation in 2018/19. Variation was similar to that reported in 2017/18, although hospital participation decreased in vascular surgery with 5 fewer hospitals (5 vs 10) and limb amputation surveillance with 4 fewer hospitals (3 vs 7).

Figure 1: Annual participation in the SSISS, voluntary and mandatory surveillance, NHS hospitals England, April 2009 to March 2019

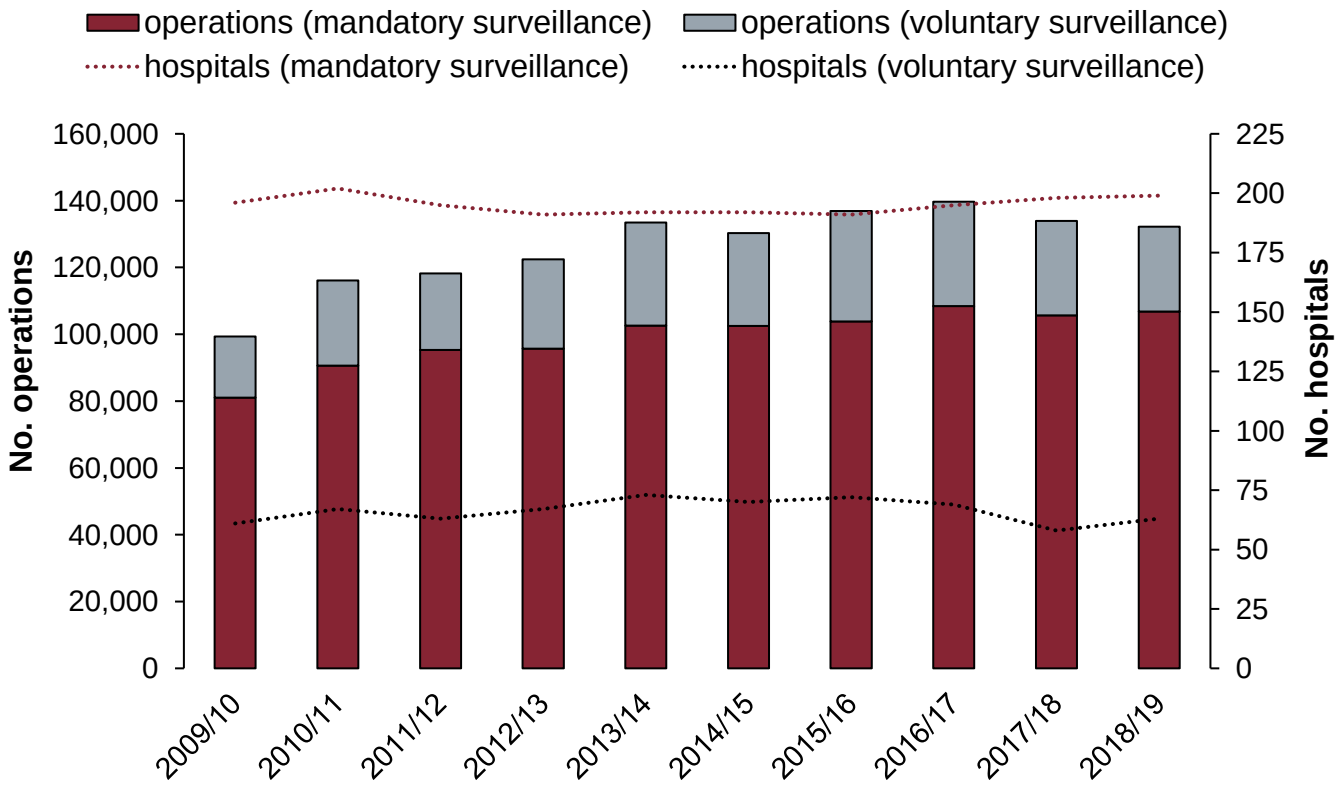
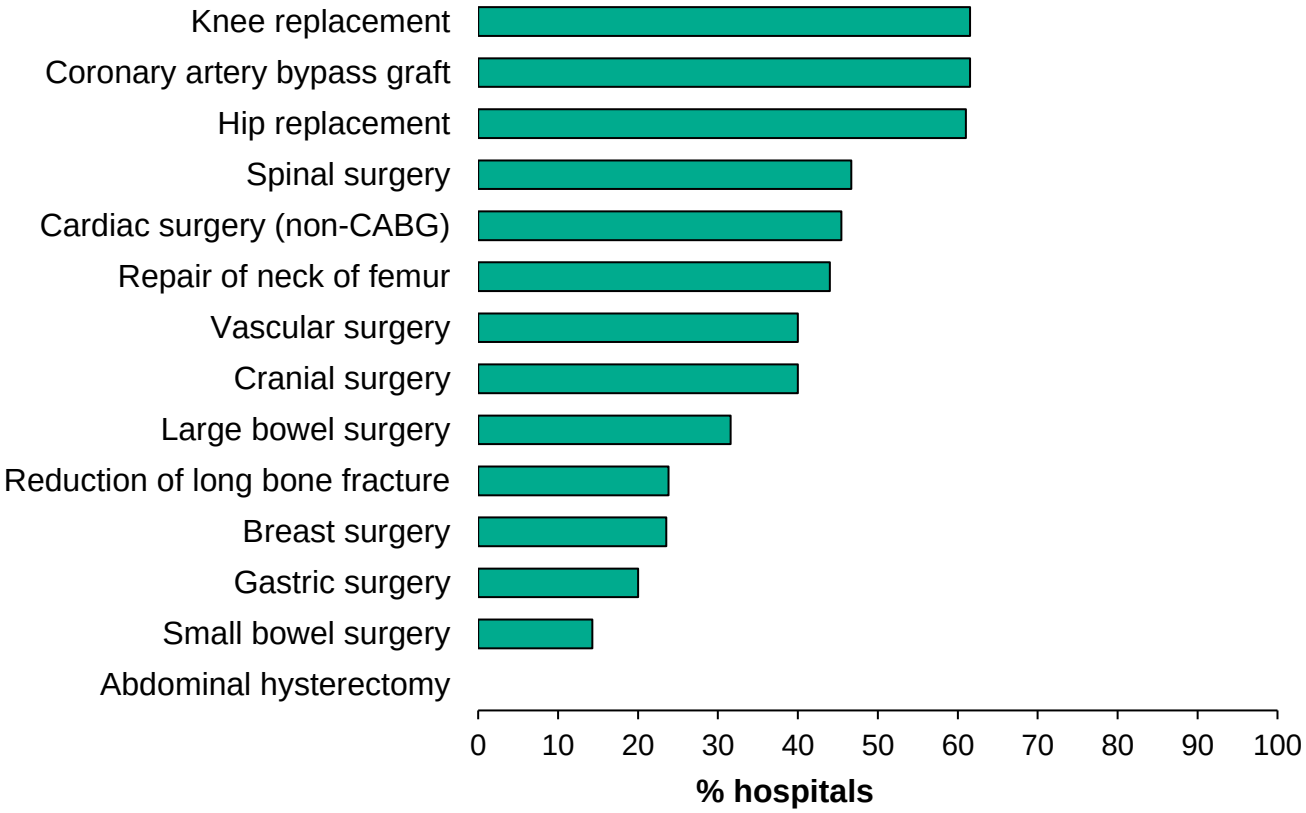


Figure 2 shows the proportion of hospitals carrying out continuous surveillance during 2018/19 by surgical category. Three SSISS surgical categories with <5 participating hospitals (cholecystectomy, limb amputation and bile duct, liver or pancreatic surgery) were excluded.

Knee replacement surgery and coronary artery bypass graft (CABG) surgery had the highest proportion of hospitals carrying out continuous surveillance in 2018/19 (both 61.5%). 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 (61.0% and 61.5%, respectively). Only 6% of trusts undertaking orthopaedic surgery undertook the minimum requirement of surveillance in one category in one quarter.

Figure 2: Proportion of hospitals undertaking continuous surveillance by surgical category, NHS hospitals England, April 2018 to March 2019

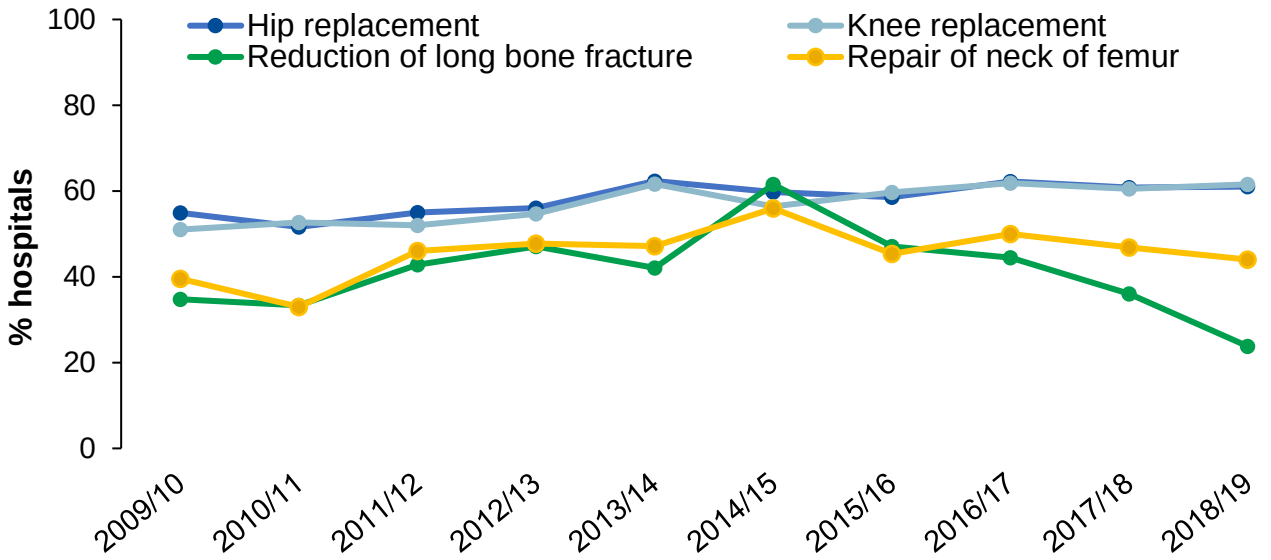


Note
Where there is no bar there were no hospitals carrying out continuous surveillance within the given period.

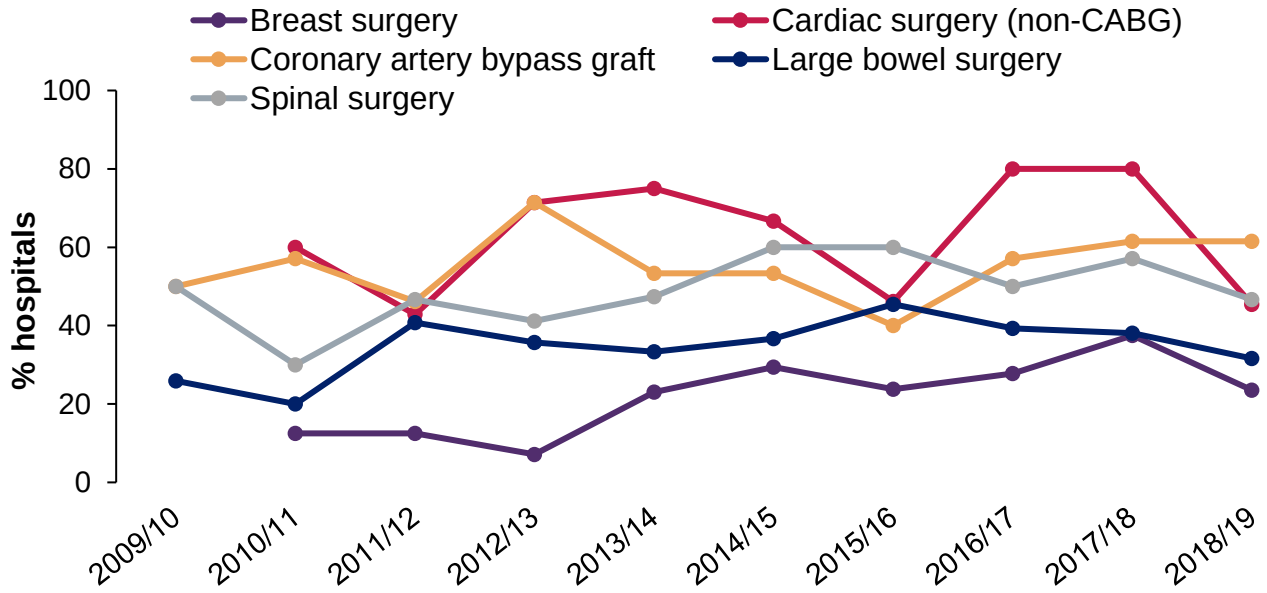
Figures 3a-b show 10-year trends in the proportion of hospitals carrying out continuous surveillance for the mandatory orthopaedic categories and 5 voluntary categories where there were at least 10 or more participating hospitals in 2018/19. The proportion of hospitals carrying out continuous surveillance for the hip and knee replacement categories has shown an overall increase from 2009/10 (54.9% to 61.0% for hip; 51.0% to 61.5% for knee). This is in contrast to reduction of long bone fracture surveillance, where the number of participating hospitals has remained relatively stable over the last 10 years but the proportion of hospitals who submit continuous surveillance data has continued to steadily decrease (23.8% in 2018/19) since its peak at 61.5% in 2014/15. For the voluntary categories, proportions of hospitals carrying out continuous surveillance fluctuated, possibly reflecting lower and more variable annual hospital participation. Large bowel and breast surgery have consistently had a lower proportion of hospitals carrying out continuous surveillance over time compared to both cardiac modules and spinal surgery, which have been undertaken continuously in 40.0% or more of hospitals since 2011/12. Continuous surveillance for CABG reached the highest at 80.0% of hospitals in 2016/17 and 2017/18.

Figure 3: Trends in the proportion of hospitals undertaking continuous surveillance, NHS hospitals England, April 2009 to March 2019

a) mandatory surveillance categories



b) voluntary surveillance categories



Patient and surgical characteristics

Table 1 shows the percentage of all submitted records for 2018/19 with complete information for key patient and surgical characteristics, indicating that a valid response has been provided. Data completion is important to help hospitals better understand their results, particularly for hospitals whose SSI risk is significantly higher than the national benchmark as a means to identify factors which might be contributing to this increased risk. As such, the majority of these data elements are mandated for

collection. However, for a number of fields “unknown” or “missing” is an available response option (see *Appendix* for more details).

Data completeness remained high (≥95%) for most required data elements in 2018/19. The exclusion of “unknown” or “missing” response options led to some variation for the American Society of Anesthesiologists’ (ASA) score which ranged from 75.2% for cardiac surgery (non-CABG) to 100% for cholecystectomy and limb amputation, and the administration of antibiotic prophylaxis which ranged from 85.1% for breast surgery to 100% for cholecystectomy. ASA score is 1 of 3 risk factors used to classify operations by NHSN risk index (see glossary) for risk-stratified SSI incidence results. The proportion of records with valid body mass index (BMI) information, calculated using optional height and weight data fields, was 64% in 2018/19. The number of surgical categories with BMI data available for ≥50% of submitted procedures continued to increase to 14 in 2018/19 (12 in 2017/18). Similar to previous reports, cardiac surgeries (CABG and non-CABG) have the highest BMI completion rates (87.5% and 89.7% in 2018/19). Substantially lower BMI completion rates are seen for cholecystectomy, repair of neck of femur and reduction of long bone fracture surgery (30.0%, 32.3% and 34.5%, respectively).

Table 2 shows the distribution of key patient and surgical characteristics. The median age varied by surgical category and remained highest for repair of neck of femur (85 years) and lowest for abdominal hysterectomy (52 years). Categories with the highest proportion of paediatric (<18 years) data submitted in 2018/19 were small bowel (10% of procedures), spinal and cardiac (non-CABG) surgery (both 8%). The highest proportion of patients with a submitted ASA score ≥3 continued to be seen in cardiac surgery (CABG 95.2% and non-CABG 93.0%) followed closely by limb amputation procedures (90.4%). The proportion of operations with a wound classified as contaminated or dirty is low (<8%) for most surgeries outside of bowel (40.4% for small bowel and 20.2% for large bowel in 2018/19).

Among categories with BMI data completion rates of 50% or more, knee replacement and abdominal hysterectomy had the highest proportion of obese (BMI ≥ 30kg/m^2) patients (55.5% and 40.3%, respectively). The proportion of obese patients undergoing knee replacement surgery has remained between 55% to 56% for the last 5 years. At the national level, the distribution of patient BMI for hip/knee replacement in 2018/19 was similar to 2009/10 with a median patient BMI for knee replacement of 30.4 kg/m^2 in 2009/10 (IQR=27.1-34.2 kg/m^2) and 30.8 kg/m^2 in 2018/19 (IQR=27.3-34.6 kg/m^2). Although variation in patient BMI exists across hospitals, in 2018/19, 20% or more of patients undergoing hip replacement at every hospital were classed as obese; for knee replacement surgery at least 35% or more of patients at each hospital were obese.

Those surveillance categories with the highest proportion of operations performed on an emergency basis (defined as procedures that are immediate, unplanned and life-saving

or those that are performed immediately after resuscitation) were limb amputation (12.0%), cranial surgery (9.0%) and bowel surgeries (7.1% large bowel and 6.9% small bowel).

For patients undergoing hip and knee replacement, information is collected on the primary indication for surgery. Figures 4a-b show that the vast majority of hip and knee replacements are performed due to osteoarthritis, particularly for knee replacement surgery (92.0%). Revision was the second most common reason for a hip or knee replacement (9.0% and 5.8%, respectively). The proportion of revision surgeries being performed decreased since 2009/10 for hip replacement (11.4% to 9.0% in 2018/19), with slight decreases for knee (6.1% to 5.8% in 2018/19).

Table 1: Data completeness for patient and surgery-related characteristics by surgical category, NHS hospitals England, April 2018 to March 2019

Surgical category	No. participating hospitals	No. operations	Patient-related characteristics				Surgery-related characteristics						
			Age (%)	Sex (%)	BMI* (%)	ASA score (%)	Wound class (%)	Operation duration (%)	Pre-op stay (%)	Elective surgery (%)	Trauma surgery* (%)	Primary indication (%)	Antibiotic prophylaxis (%)
Abdominal hysterectomy	8	393	100	100	64.4	94.4	100	100	100	100	99.2	-	87.8
Bile duct, liver or pancreatic surgery	2	133	100	100	71.4	96.2	100	100	100	100	100	-	99.2
Breast surgery	17	3,280	100	99.9	60.4	89.6	100	100	100	100	99.9	-	85.1
Cardiac surgery (non-CABG)	11	3,870	100	100	89.7	75.2	100	100	100	100	99.6	-	99.6
Cholecystectomy	1	30	100	100	30.0	100	100	100	100	100	100	-	100
Coronary artery bypass graft	13	5,985	100	100	87.5	79.9	100	100	100	100	99.9	-	99.8
Cranial surgery	5	977	100	100	87.0	83.3	100	100	100	100	99.2	-	91.9
Gastric surgery	5	257	100	100	68.3	82.1	100	100	100	100	99.6	-	95.3
Hip replacement	159	42,352	100	100	66.3	98.0	100	100	100	100	-	98.4	98.2
Knee replacement	156	45,400	100	100	69.6	98.1	99.9	100	100	100	-	98.6	98.2
Large bowel surgery	19	2,330	100	100	70.4	96.1	100	100	100	100	99.9	-	95.8
Limb amputation	3	83	100	100	75.9	100	100	100	100	100	100	-	98.8
Reduction of long bone fracture	21	2,355	100	100	34.5	95.7	99.8	100	100	100	97.2	-	98.0
Repair of neck of femur	75	16,680	100	100	32.3	97.5	100	100	100	100	-	99.7	97.2
Small bowel surgery	7	550	100	100	69.6	91.1	100	100	100	100	99.8	-	96.5
Spinal surgery	15	6,720	100	100	61.3	92.6	99.3	100	100	100	77.1	-	90.2
Vascular surgery	5	859	100	100	74.5	98.3	100	100	100	100	100	-	99.4

*indicates an optional data entry field

Table 2: Patient and surgery-related characteristics by surgical category*, NHS hospitals England, April 2018 to March 2019

Surgical category	Patient-related characteristics				Surgery-related characteristics							
	Median age, IQR (years)	Male (%)	BMI ≥ 30 kg/m^2 (%)	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	52 (46-65)	-	40.3	18.9	0.0	119 (90-151)	2 (1-4)	1.3	0.3	11.7	2.9	0.0
Bile duct, liver or pancreatic surgery	65 (54-72)	54.1	24.2	46.9	6.0	300 (204-430)	8 (6-18)	13.5	0.0	24.1	1.5	3.0
Breast surgery	58 (48-70)	2.9	29.8	12.2	0.2	73 (52-103)	0 (0-1)	0.3	0.2	7.8	24.9	11.8
Cardiac surgery (non-CABG)	67 (54-75)	65.3	29.0	93.0	0.0	238 (190-299)	9 (7-16)	25.9	1.5	43.2	0.5	89.2
Cholecystectomy	64 (58-70)	53.3	44.4	33.3	0.0	383 (245-460)	9 (6-19)	**	0.0	70.0	0.0	**
Coronary artery bypass graft	68 (60-75)	82.2	32.7	95.2	0.0	236 (200-276)	9 (6-14)	39.1	0.9	26.6	1.2	71.0
Cranial surgery	58 (44-70)	54.9	28.3	38.8	1.7	116 (61-190)	6 (3-12)	22.6	9.0	0.5	2.7	48.4
Gastric surgery	62 (49-71)	58.0	29.8	40.8	3.1	175 (123-348)	7 (2-10)	5.8	0.4	9.7	1.2	0.8
Hip replacement	71 (63-78)	39.8	38.1	27.3	0.1	83 (65-105)	3 (2-5)	3.8	0.2	-	0.6	100
Knee replacement	71 (63-77)	42.8	55.5	25.9	0.1	78 (62-97)	3 (2-5)	0.6	0.1	-	0.4	100
Large bowel surgery	68 (56-77)	52.7	24.8	45.1	20.2	170 (126-230)	8 (5-14)	15.4	7.1	13.3	1.6	2.6
Limb amputation	67 (55-76)	66.3	19.0	90.4	7.2	62 (40-85)	28 (13-36)	65.1	12.0	0.0	72.0	0.0
Reduction of long bone fracture	59 (37-77)	44.4	20.4	35.7	7.0	90 (63-127)	6 (2-13)	27.8	2.3	5.3	0.7	99.7
Repair of neck of femur	85 (78-90)	30.2	10.0	77.3	0.0	66 (51-86)	13 (8-21)	26.7	1.5	-	2.3	100
Small bowel surgery	57 (37-70)	56.0	20.7	50.7	40.4	138 (85-213)	10 (6-22)	29.3	6.9	28.9	0.6	1.6
Spinal surgery	56 (42-70)	46.1	37.5	24.6	0.3	121 (82-181)	3 (1-7)	10.1	1.6	0.6	8.1	47.1
Vascular surgery	73 (66-80)	74.0	26.3	82.9	0.1	192 (137-278)	4 (2-9)	17.3	4.7	4.7	8.7	72.2

*results for surgical categories with <5 participating hospitals should be interpreted with caution
**suppressed due to small numbers (no. operations <5)

Figure 4a: Primary indication for hip replacement surgery, NHS hospitals England, April 2018 to March 2019 (N=41,680)

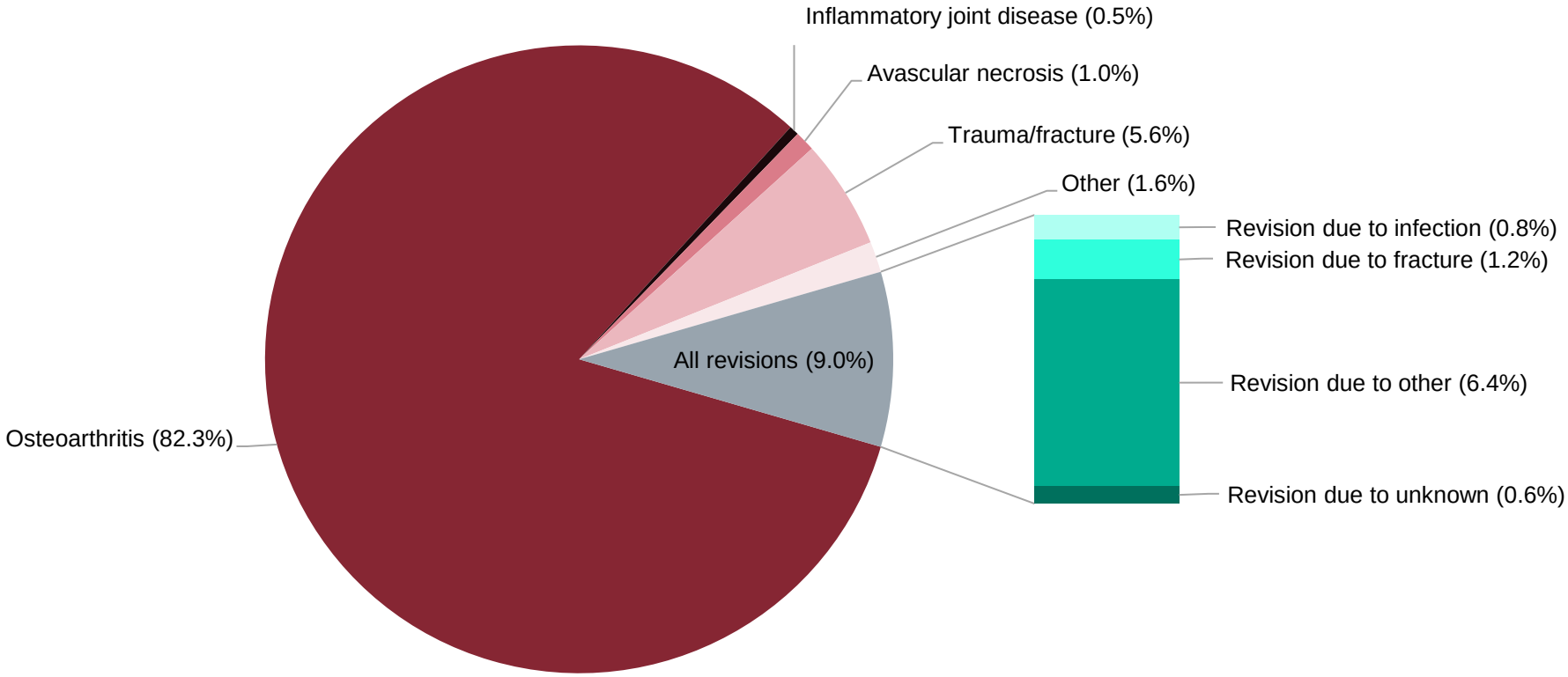
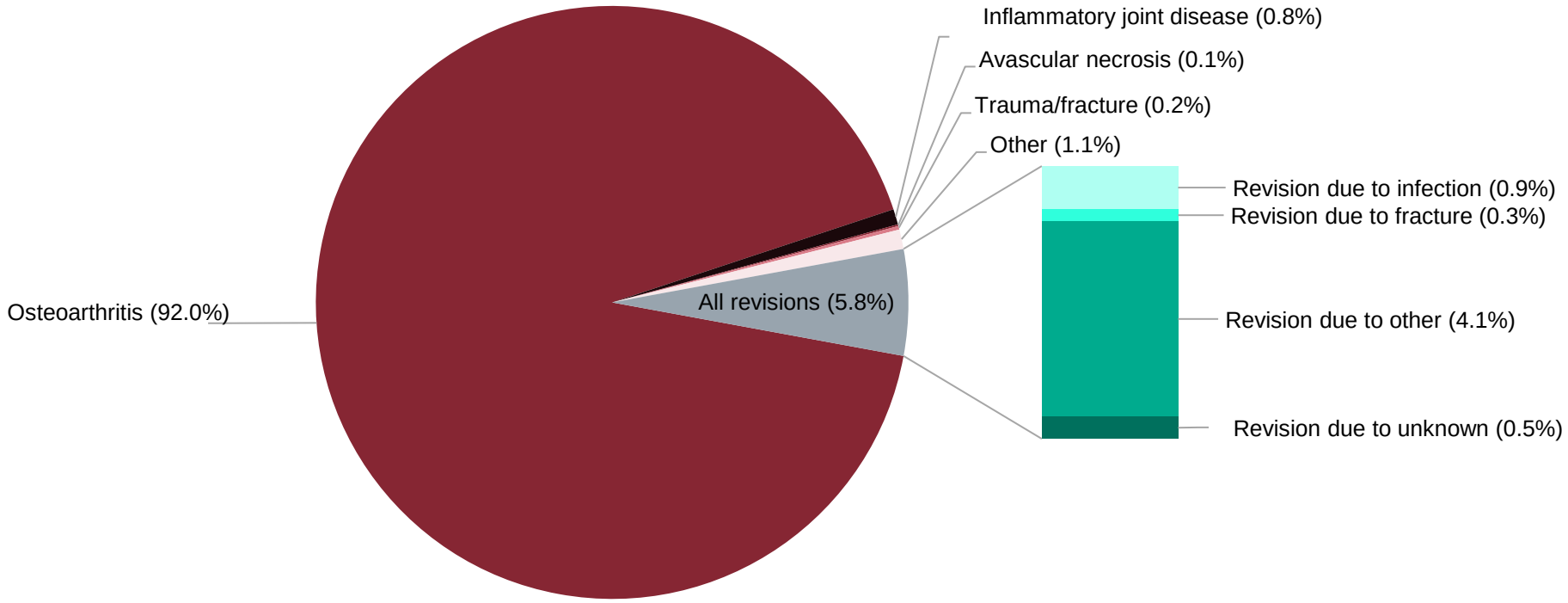


Figure 4b: Primary indication for knee replacement surgery, NHS hospitals England, April 2018 to March 2019 (N=44,755)



Assessing SSI risk

Inpatient and readmission SSI risk

Table 3 presents the cumulative SSI incidence (risk) and incidence density by surgical category. Five years of data (April 2014 to March 2019) 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 large bowel surgery at 8.7%, indicative of the high bacterial load at this surgical site. The lowest SSI risk seen is for hip and knee replacement surgery (both 0.5%). The national benchmark for hip replacement continued to decrease by 0.1% this financial year, while knee replacement remained stable. The national benchmark for CABG surgery has steadily decreased over the last 3 years (3.8% April 2012 to March 2017 to 3.0% April 2014 to March 2019).

For short hospital 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 8.4 per 1,000 inpatient days for bile duct, liver or pancreatic surgery. Large bowel surgery had the second highest risk by incidence density (7.1 per 1,000 inpatient days) followed closely by cholecystectomy (6.9 per 1,000).

Table 3: Cumulative inpatient and readmission SSI incidence by surgical category, NHS hospitals England, April 2014 to March 2019

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	15	2,571	44	1.7	(1.2-2.3)	11	14	1.6	(0.9-2.7)
Bile duct, liver or pancreatic surgery	6	1,640	125	7.6	(6.4-9.0)	8	115	8.4	(6.9-10.1)
Breast surgery	35	20,601	182	0.9	(0.8-1.0)	17	19	0.8	(0.5-1.2)
Cardiac surgery (non-CABG)	16	17,606	235	1.3	(1.2-1.5)	14	157	0.7	(0.6-0.9)
Cholecystectomy	8	1,658	42	2.5	(1.8-3.4)	6	23	6.9	(4.4-10.4)
Coronary artery bypass graft	21	28,630	850	3.0	(2.8-3.2)	15	471	1.8	(1.6-1.9)
Cranial surgery	10	7,647	132	1.7	(1.4-2.0)	20	46	0.7	(0.5-0.9)
Gastric surgery	10	2,083	47	2.3	(1.7-3.0)	8	40	2.7	(1.9-3.6)
Hip replacement	188	202,950	1,098	0.5	(0.5-0.6)	19	328	0.3	(0.3-0.3)
Knee replacement	177	218,409	1,081	0.5	(0.5-0.5)	21	234	0.2	(0.2-0.3)
Large bowel surgery	46	17,546	1,520	8.7	(8.3-9.1)	8	1,291	7.1	(6.7-7.5)
Limb amputation	11	1,675	39	2.3	(1.7-3.2)	13	28	1.3	(0.9-2.0)
Reduction of long bone fracture	34	12,002	122	1.0	(0.8-1.2)	17	71	0.7	(0.5-0.8)
Repair of neck of femur	107	93,786	942	1.0	(0.9-1.1)	16	641	0.4	(0.4-0.4)
Small bowel surgery	20	4,043	261	6.5	(5.7-7.3)	8	223	4.9	(4.2-5.5)
Spinal surgery	24	34,938	515	1.5	(1.4-1.6)	14	210	1.0	(0.8-1.1)
Vascular surgery	15	5,310	135	2.5	(2.1-3.0)	14	64	1.8	(1.4-2.2)

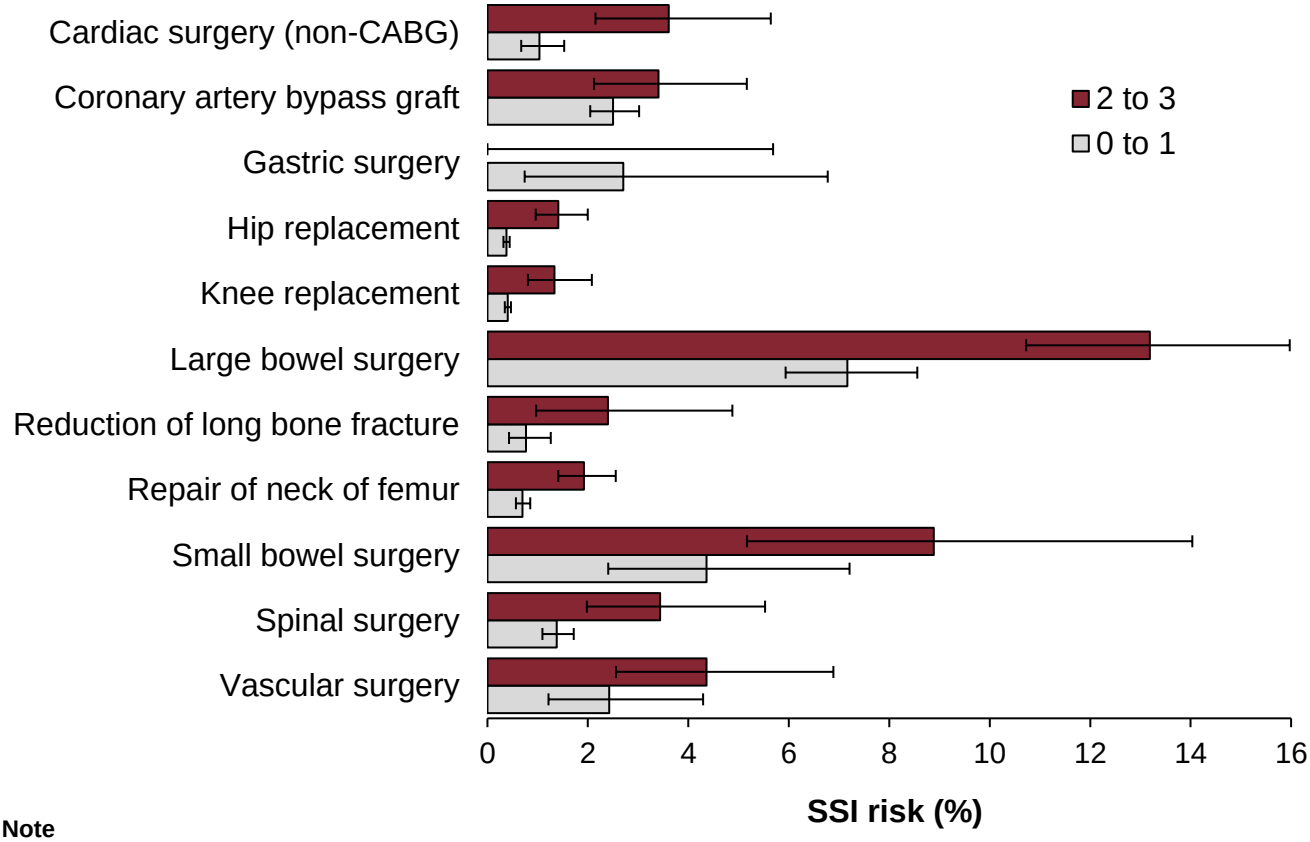
*1 record excluded due to missing date inpatient surveillance discontinued

Risk factors for SSI

Key patient and surgery-related characteristics are captured through the SSI surveillance programme. Participants are encouraged to look at the breakdown of their hospital results by NHSN risk index to account for potentially important differences in patient population. The NHSN risk index assigns a score of 1 for the presence of the following risk factors: ASA score of 3 or higher, operation duration >75th percentile as defined by 'T-time', and a contaminated or dirty wound. Figure 5 shows the 2018/19 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 (gastric surgery). Categories with larger volumes of surgery showed the difference in infection between high and low risk operations to be significant (i.e. hip and knee replacement, cardiac (non-CABG), large bowel, repair of neck of femur and spinal surgery).

Only surgical categories where patient risk factor groups had sufficient volumes were analysed (≥95 procedures for abdominal hysterectomy, hip/knee replacement; ≥45 procedures for all other categories).

Figure 5: Inpatient and readmission SSI incidence by NHSN risk index, NHS hospitals England, April 2018 to March 2019



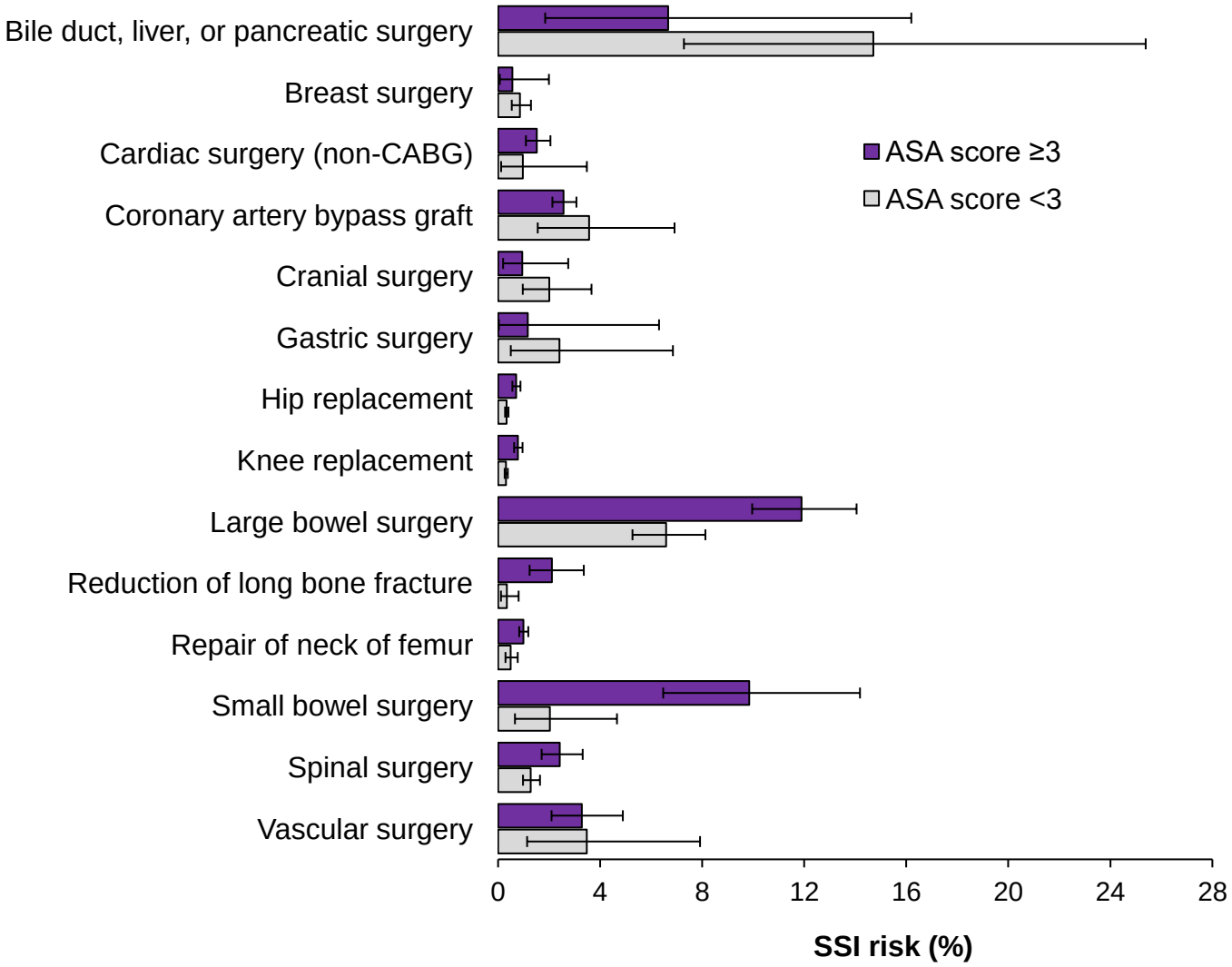
Note
For gastric surgery where there is no bar signifying SSI risk among the high risk operations, there were no numerator (SSI) cases but the denominator (number of operations) for that risk group met the minimum volume threshold.

Figure 6 shows the SSI incidence (or risk) stratified by the individual key risk factors that make up the NHSN risk index, as well as patient obesity. Just over half of surgical categories presented in Figure 6a showed that patients with an ASA score ≥3 were at an increased risk of infection (8 of 14). The impact of ASA score on SSI risk may not have been as apparent in categories that have a disproportionately high number of patients with an ASA score ≥3 (CABG 95.2%) or a disproportionately low number (breast at 12.2%). The proportion of procedures with a contaminated or dirty wound classification is very low for the majority of surgical categories (≤3% for 12 of 17) limiting the categories in which we can analyse this factor. For both bowel surgeries and reduction of long bone fracture, SSI risk was higher in operations with a contaminated/dirty wound compared to a clean or clean-contaminated wound operation, reaching statistical significance for large bowel surgery. An operation duration greater than expected (>'T time' or 75th percentile) also increased a patient's risk of SSI across the majority of surgical categories (11 of 15). BMI analysis was restricted to hospitals' surveillance quarters with 70% or higher completion. Only two of the presented surgical categories, cranial and vascular surgery, did not show a higher SSI risk among patients who were obese (≥30 kg/m^2) in comparison to those who were not. The difference in SSI risk was statistically significant for large bowel surgery, where obese patients were twice as likely as non-obese patients to be at risk of SSI following surgery.

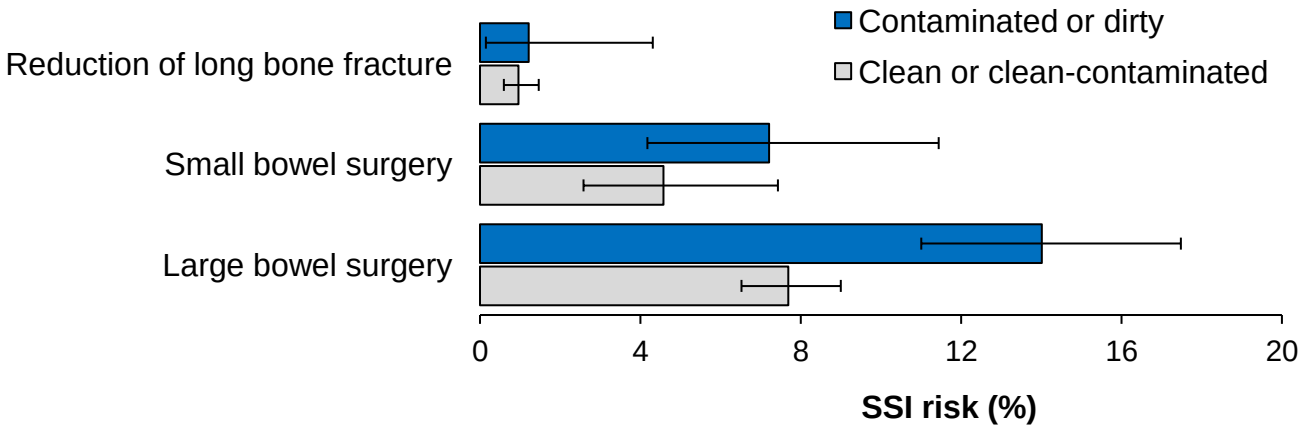
Table 4 shows SSI risk by the primary indication for hip replacement and knee replacement surgery. For both, revision procedures carried a much higher SSI risk than primary procedures (3.6 times higher for hip and 3.0 times higher for knee).

Figures 6a-d: Inpatient and readmission SSI incidence by risk factor (ASA score, wound contamination class, duration of operation and BMI), NHS hospitals England, April 2018 to March 2019

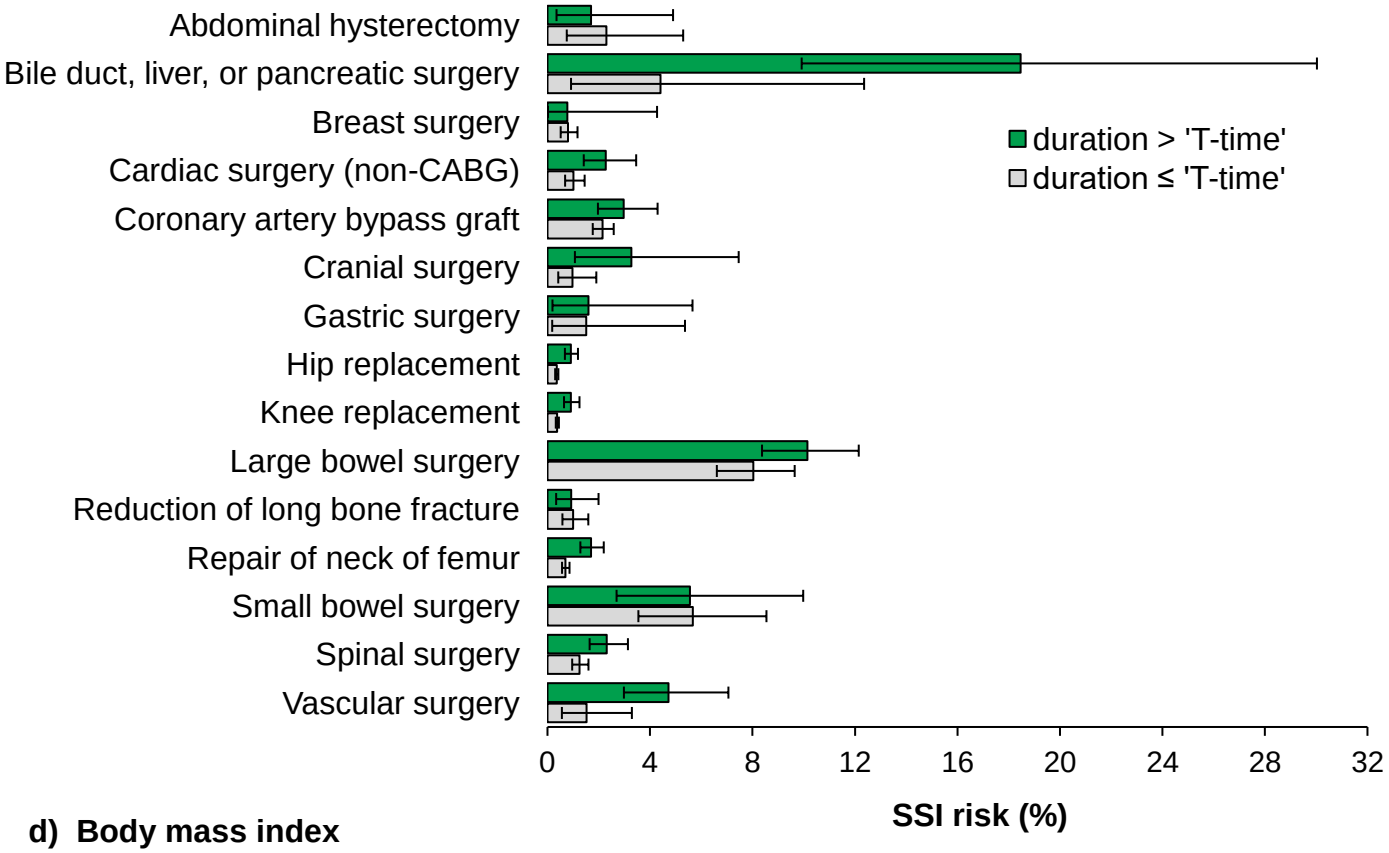
a) ASA score



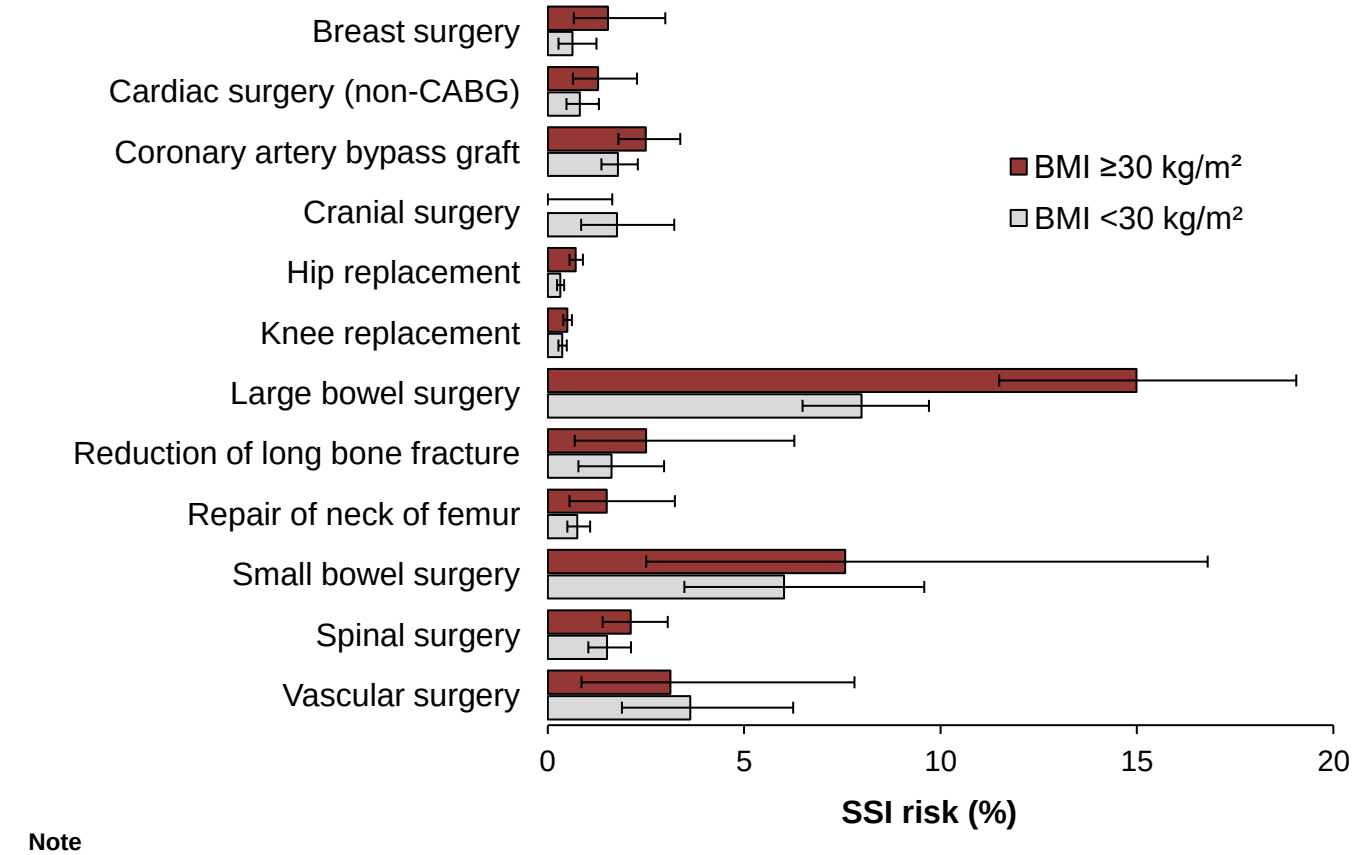
b) Wound contamination class



c) Duration of operation



d) Body mass index



Note
For cranial surgery where there is no bar signifying SSI risk among the obese patient group, there were no numerator (SSI) cases but the denominator (number of operations) for that risk group met the minimum volume threshold.

Table 4: Inpatient and readmission SSI incidence by primary indication for joint replacement surgeries, NHS hospitals England, April 2018 to March 2019

		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	34,282	117	0.3	(0.3-0.4)	41,185	151	0.4	(0.3-0.4)
	Inflammatory joint disease	206	1	0.5	(0.0-2.7)	378	5	1.3	(0.4-3.1)
	Avascular necrosis	434	1	0.2	(0.0-1.3)	41	0	0.0	(0.0-8.6)
	Trauma/fracture	2,349	9	0.4	(0.2-0.7)	87	2	2.3	(0.3-8.1)
	Other	658	7	1.1	(0.4-2.2)	477	3	0.6	(0.1-1.8)
	All	**37,929**	**135**	**0.4**	**(0.2-0.4)**	**42,168**	**161**	**0.4**	**(0.3-0.4)**
Revision	Infection	322	8	2.5	(1.1-4.8)	408	9	2.2	(1.0-4.1)
	Fracture	513	9	1.8	(0.8-3.3)	116	3	2.6	(0.5-7.4)
	Other	2,688	27	1.0	(0.7-1.5)	1,853	17	0.9	(0.5-1.5)
	Unknown	228	4	1.8	(0.5-4.4)	210	1	0.5	(0.0-2.6)
	All	**3,751**	**48**	**1.3**	**(0.9-1.7)**	**2,587**	**30**	**1.2**	**(0.8-1.7)**

Note
SSI incidence estimates calculated for primary indication surgery groups with <100 procedures should be interpreted with caution.

Trends in SSI risk

Figure 7 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. In 2018/19 the incidence for hip replacement decreased slightly (0.1%) again to 0.4% (Figure 7a) and remained the same for knee replacement at 0.4% (Figure 7b). For both hip and knee replacement, historical declines from 2009/10 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 5 days in 2009/10 compared to 3 days in 2018/19). However, in 2017/18 there was a noted decrease in incidence of readmission SSIs for both hip and knee with a further decrease for hip in 2018/19.

The trend for the inpatient/readmission SSI risk following reduction of long bone fracture has shown greater variability over the years (Figure 7c). After a peak in 2014/15 at 1.4%, the rate showed a decreasing trend and remained at 0.8% for 2016/17 and 2017/18, but then increased again to 1.0% in 2018/19. In contrast, repair of neck of femur (Figure 7d) has seen a continuous decline in the SSI incidence since 2009/10, from 1.6% to 0.9% in 2018/19.

Of the gastrointestinal categories, large and small bowel surgery (Figures 7e-f), the SSI risk following large bowel surgery further increased in 2018/19 reaching 9.0%, the same level seen in 2009/10. In contrast, a decrease was seen from 2017/18 for small bowel surgery, reaching 5.6% in 2018/19. However, there was no improvement seen overall for small bowel surgery as this was the same risk reported in 2009/10.

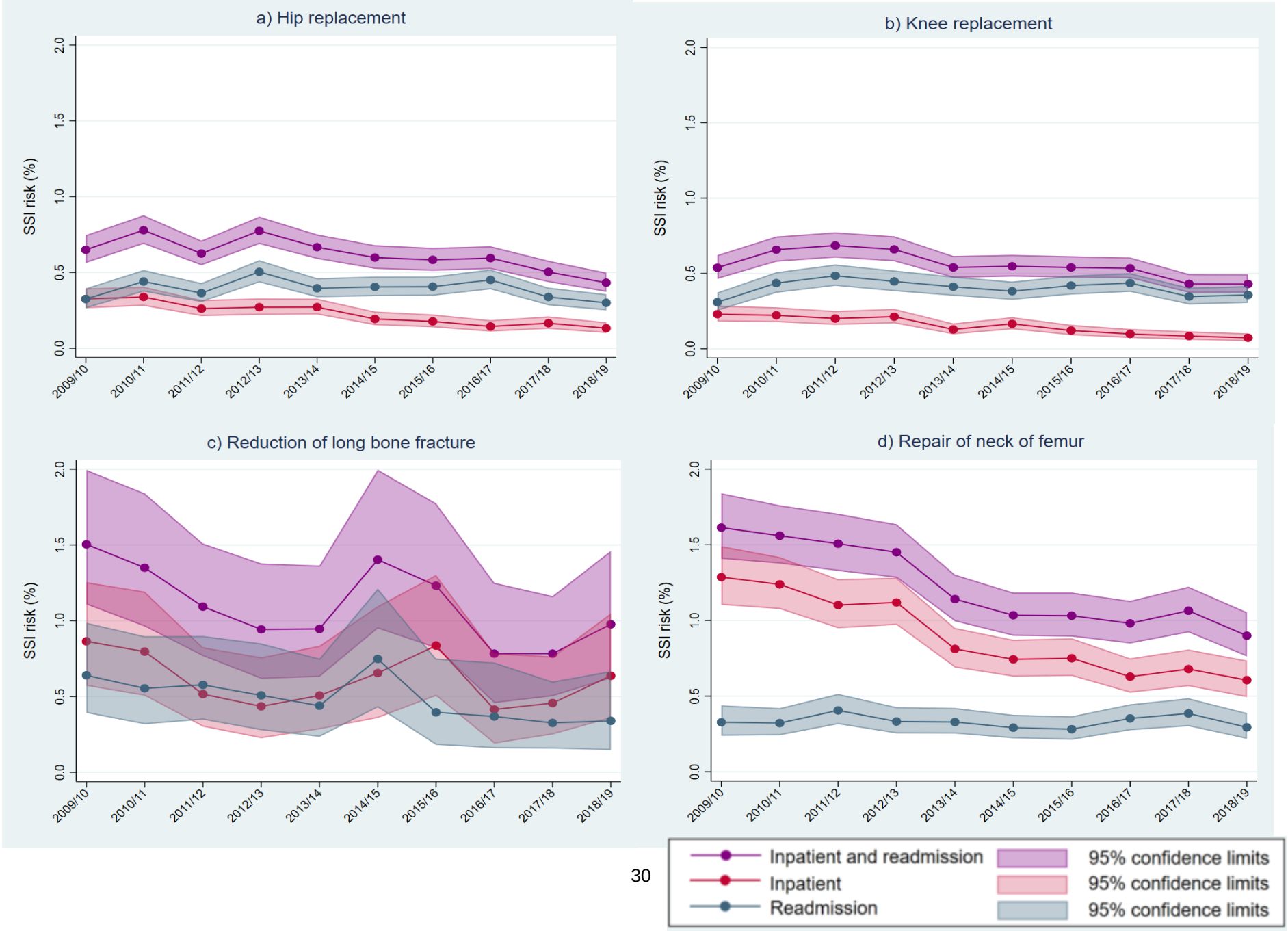
CABG (Figure 7h) reported the greatest *per cent* decrease in SSI risk from 2009/10; despite a peak in 2016/17 at 3.8%, there has been a steadily decreasing trend again over the last 2 years, reaching 2.3% in 2018/19. This included infections at vein harvesting sites and the sternum. The greatest annual percentage increase in inpatient/readmission SSI risk was for vascular surgery (Figure 7j), from 2.1% in 2017/18 to 3.3% in 2018/19.

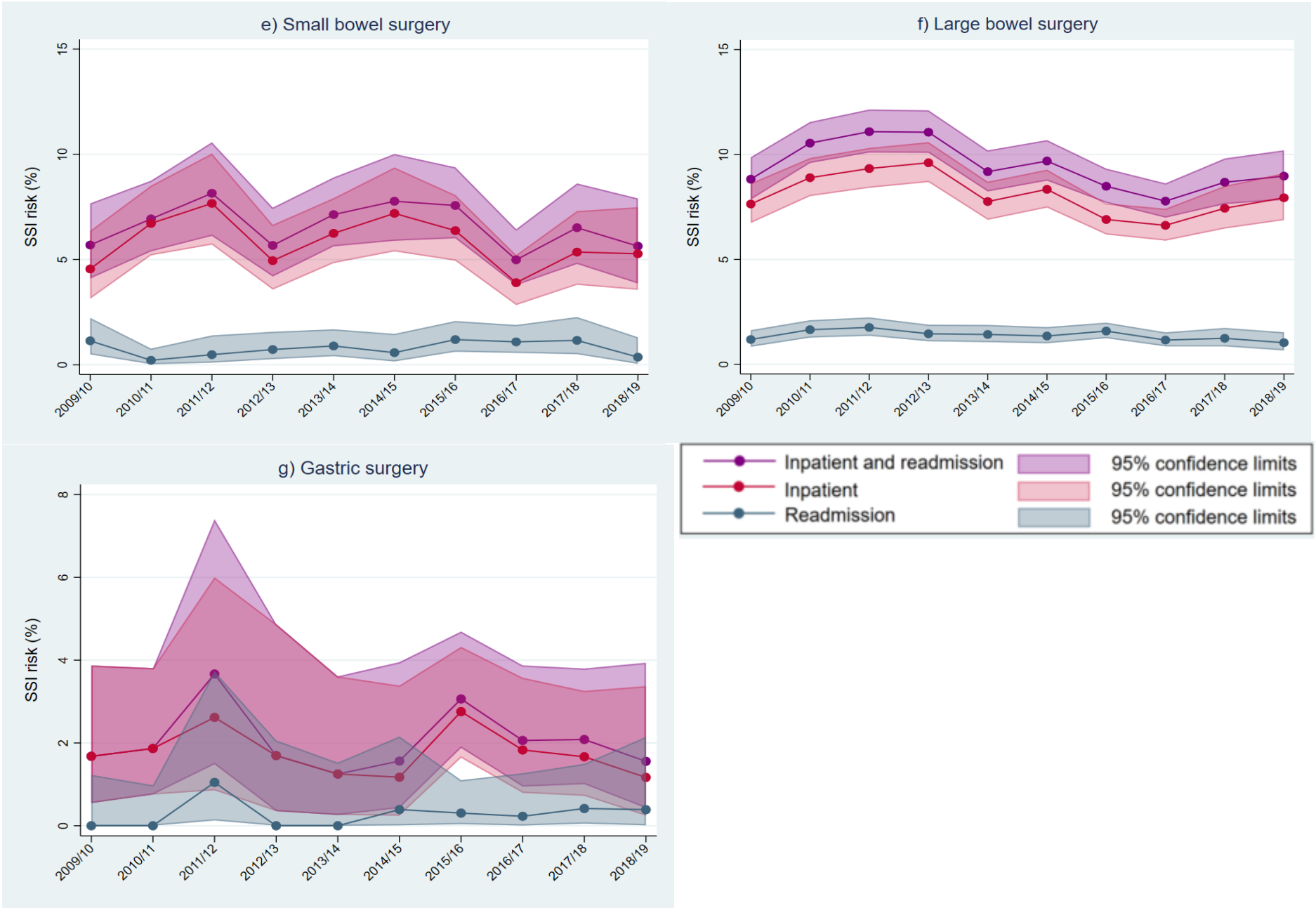
Spinal surgery (Figure 7l) reported the greatest *per cent* increase in SSI risk from 2009/10; after the declines noted in the previous 2 years, the risk increased in 2018/19 to 1.5%.

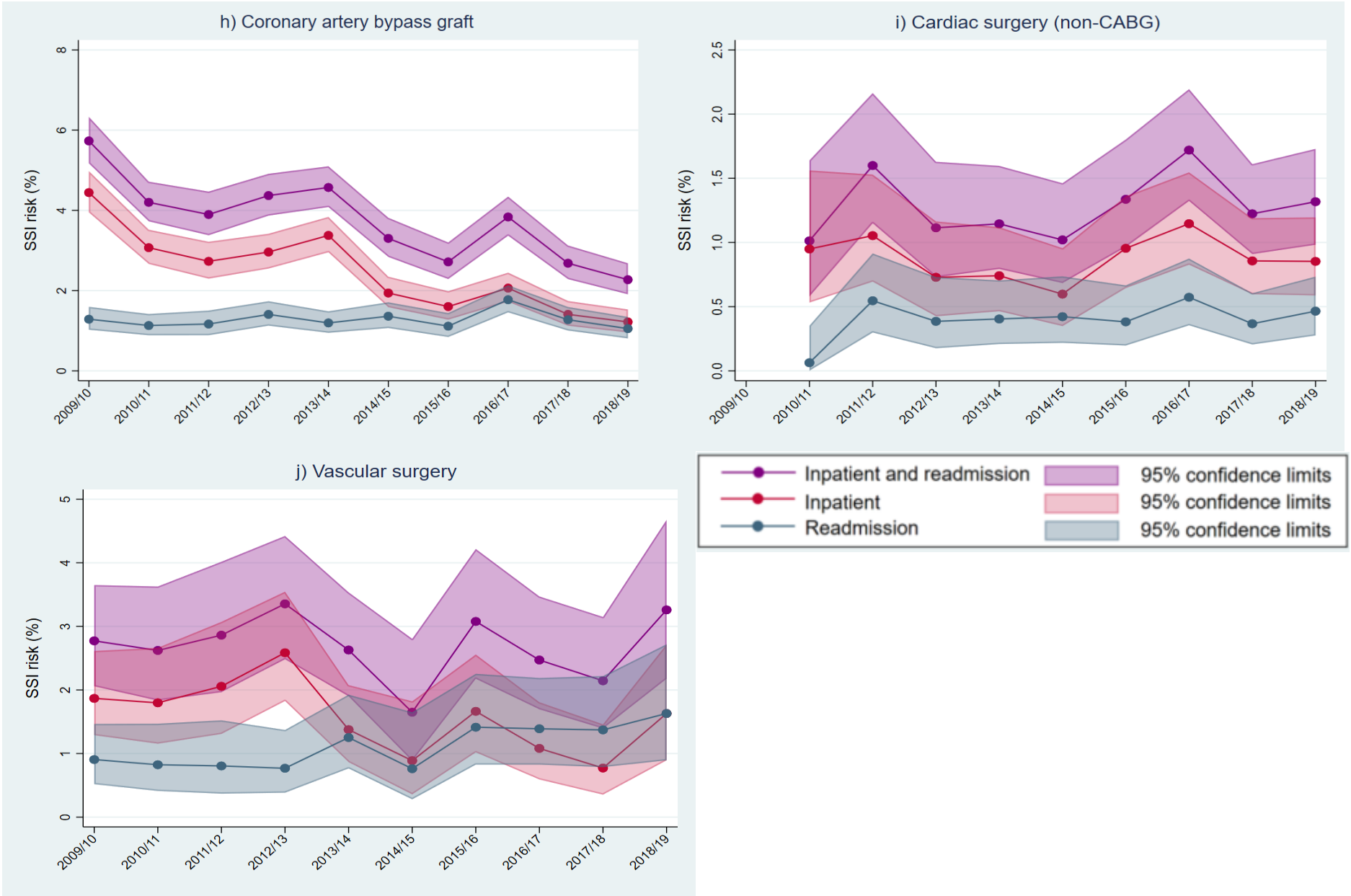
Overall, the SSI risk following breast surgery (Figure 7n) in 2018/19 (0.8%) was lower than that reported in 2010/11 (1.2%). SSI risk for cranial surgery (Figure 7m) in 2018/19 (1.3%) was higher than that reported in 2010/11 (0.9%) despite a decrease (0.7%) in the last year. From the start of surveillance in 2010/11, SSI risk in both categories fluctuated, with no clear trend apparent.

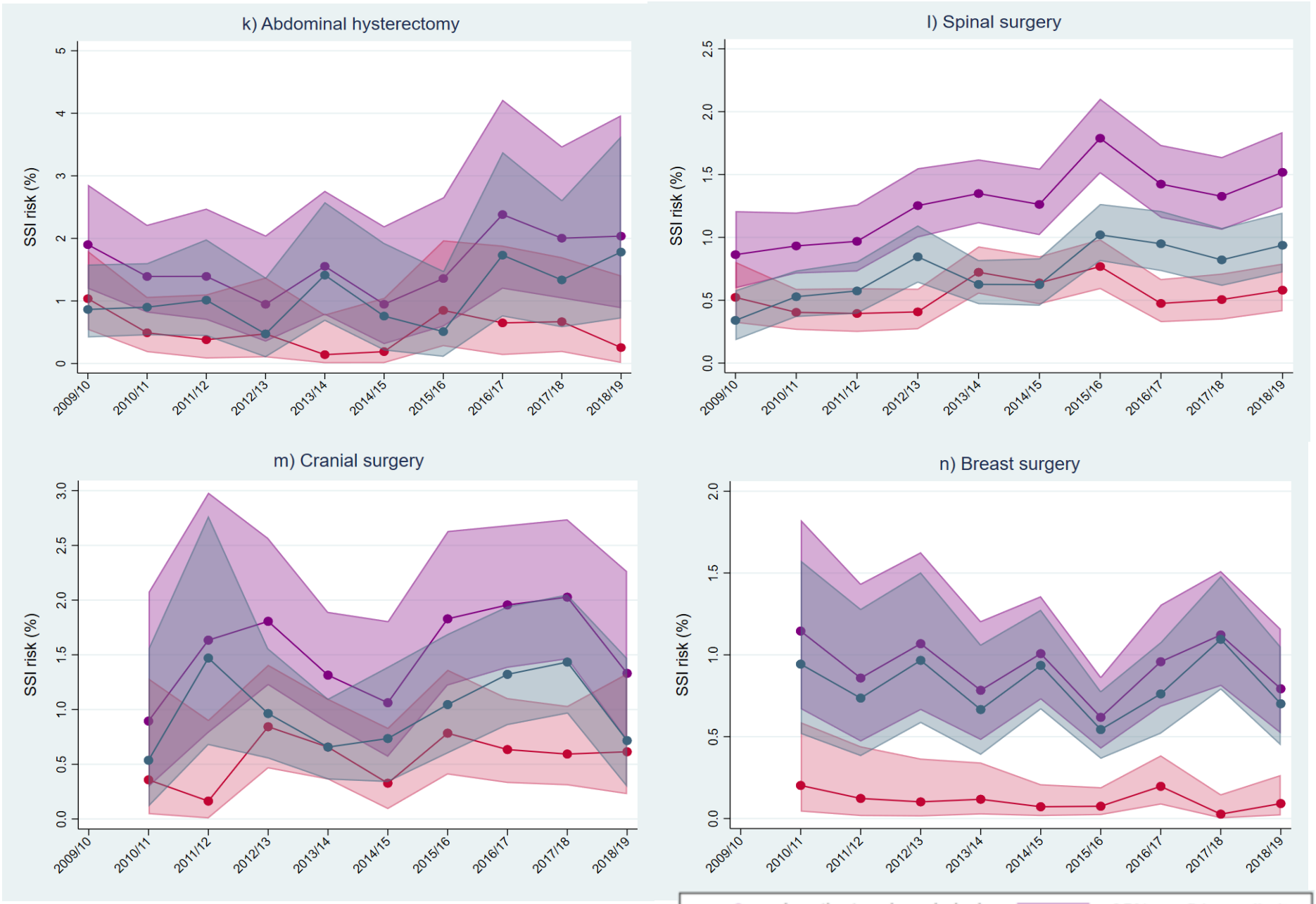
Among the remaining surgical categories, there were no sustained trends of note.

Figures 7a-n: Trends in annual SSI incidence for all surgical categories, NHS hospitals England, April 2009 to March 2019




e) Small bowel surgery
f) Large bowel surgery
g) Gastric surgery
SSI risk (%)
0
5
10
15
0
2
4
6
8
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
Inpatient and readmission
Inpatient
Readmission
95% confidence limits
95% confidence limits
95% confidence limits


h) Coronary artery bypass graft
SSI risk (%)
0
2
4
6
8
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
i) Cardiac surgery (non-CABG)
SSI risk (%)
0.0
0.5
1.0
1.5
2.0
2.5
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
j) Vascular surgery
SSI risk (%)
0
1
2
3
4
5
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
Inpatient and readmission
Inpatient
Readmission
95% confidence limits
95% confidence limits
95% confidence limits

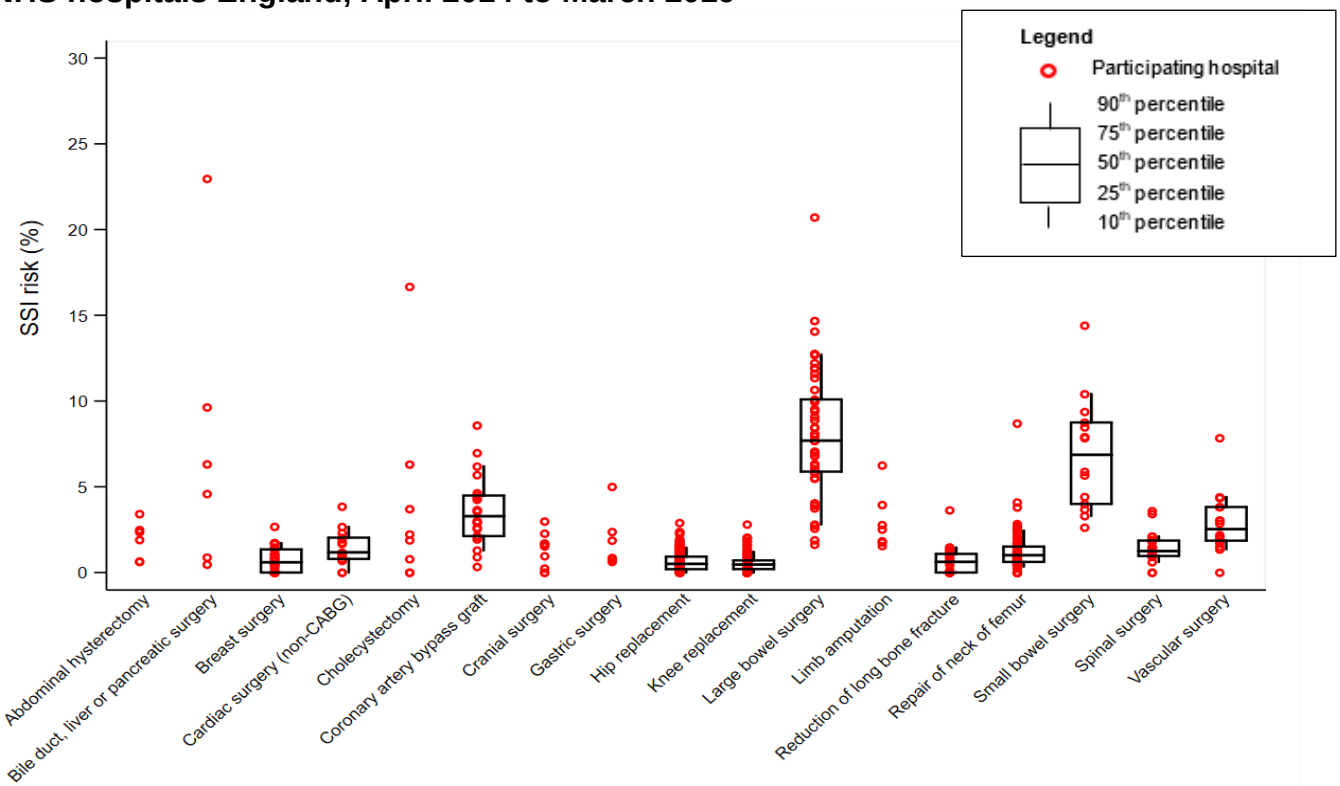

k) Abdominal hysterectomy
l) Spinal surgery
m) Cranial surgery
n) Breast surgery
SSI risk (%)
2009/10
2010/11
2011/12
2012/13
2013/14
2014/15
2015/16
2016/17
2017/18
2018/19
Inpatient and readmission
Inpatient
Readmission
95% confidence limits
95% confidence limits
95% confidence limits

Variation in SSI risk between hospitals

Figure 8 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. Each red dot represents a participating hospital. Hospitals with <95 operations for hip/knee replacement and abdominal hysterectomy were excluded. For all other surgical categories, a threshold of 45 or more operations was used.

Large bowel surgery continues to show the greatest variability, with hospital SSI risk ranging from 0.3% to 24.9%, indicating that there may be room for improvement across hospitals in both infection reduction and case ascertainment. Hip and knee replacement show the least variation, with the majority of 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 2013 to March 2018) but 8 of the 11 surgical categories with presented box plots had a slightly narrower interquartile range (difference between the 25th and 75th percentiles). The spread in small bowel surgery and repair of neck of femur decreased the most, measured by the *per cent* change in the interquartile range from the previous year (29% and 28%, respectively).

Figure 8: Distribution of inpatient and readmission SSI risk by surgical category*, NHS hospitals England, April 2014 to March 2019



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

Outlier assessment

In 2018/19, all NHS trusts performing orthopaedic surgery met the mandatory requirements for participation in the SSISS. For these 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 9a-d show funnel plots displaying variation in the SSI risk among trusts in 2018/19 for orthopaedic categories. The cumulative incidence of SSI per 100 procedures is plotted against the number of procedures for each participating NHS acute trust. 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.

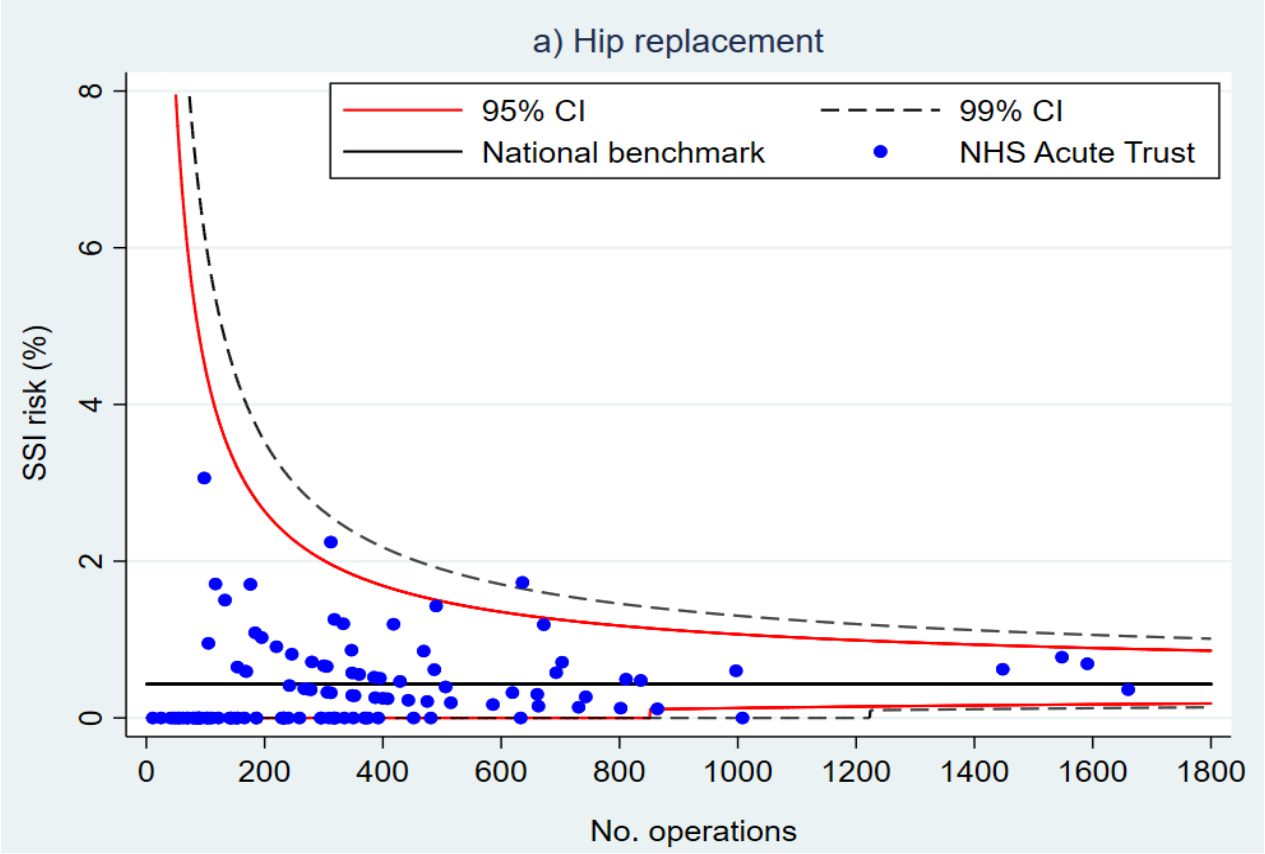
Results for 2018/19 continue to show less variation and more consistent grouping around the national benchmark for hip and knee replacement surgery. Reduction of long bone fracture and repair of neck of femur show a greater spread in the SSI risk across trusts, however there are far fewer trusts submitting surveillance data for reduction of long bone fracture.

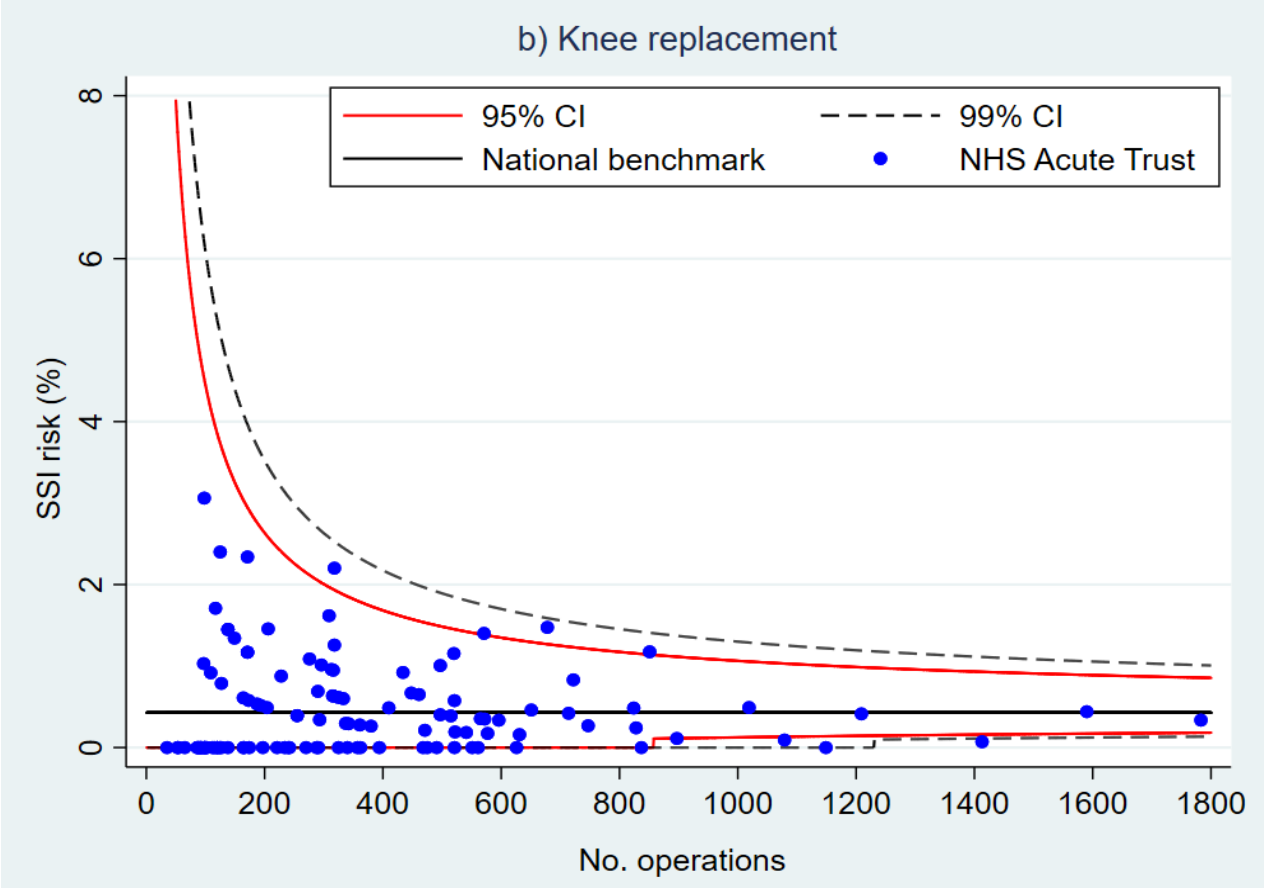
Five NHS acute trusts or treatment centres were identified as statistical high outliers (falling above the 95% upper confidence limits) across the 4 mandatory orthopaedic categories in 2018/19. One trust was a high outlier for 3 categories (hip/knee replacement and repair of neck of femur). The remaining 4 were high outliers for one orthopaedic category (3 for knee replacement, 1 for hip replacement). Six NHS acute trusts or treatment centres were identified as statistical low outliers (falling below the 95% lower confidence limits). One trust was a low outlier for 3 categories (hip/knee replacement and repair of neck of femur). Two of the providers notified as high outliers had a previous history of being an outlier in the same category within the last 3 years. Three of the providers notified as low outliers had a previous history of being a low outlier, although one was for a different orthopaedic category.

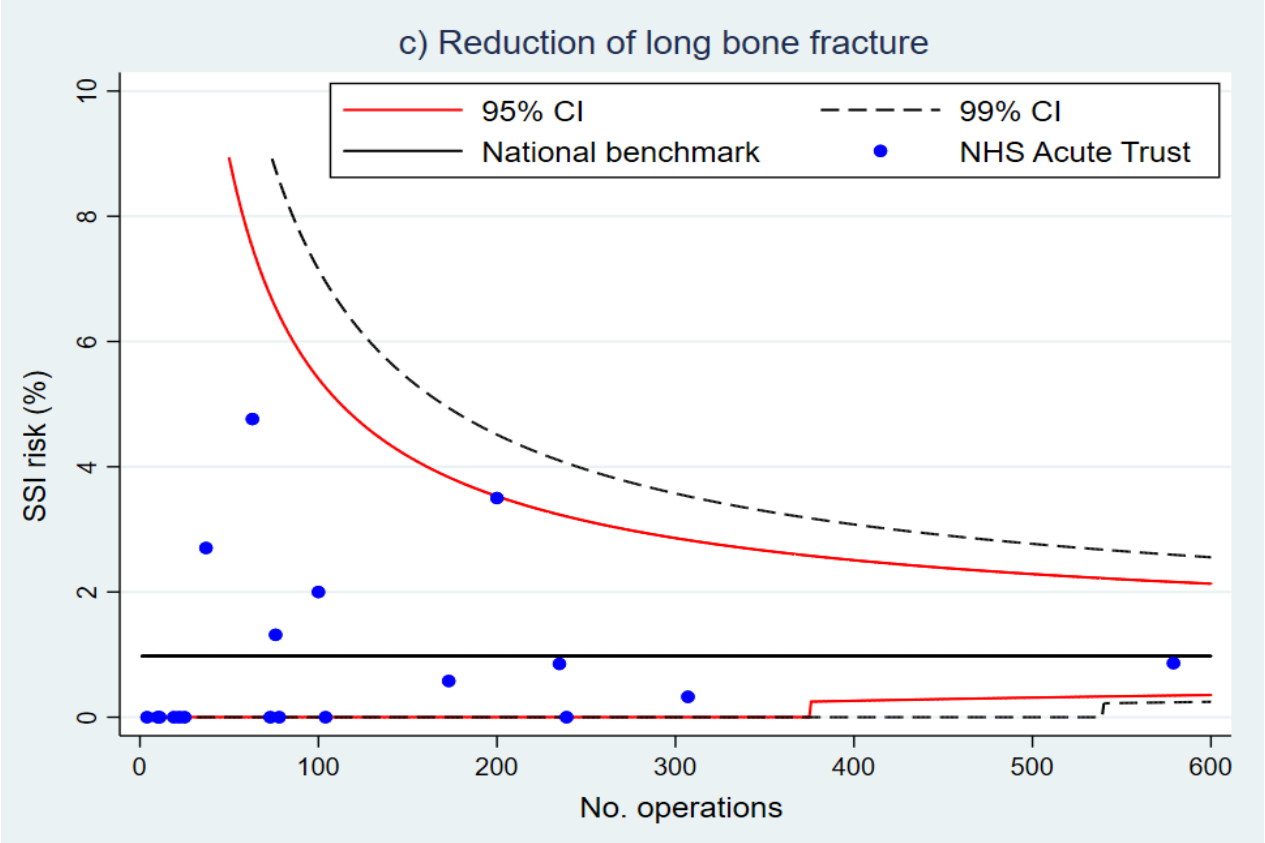
As part of this report, SSI risk results by NHS acute trust (and NHS treatment centre) for 2018/19, as well as 2017/18 updates to reflect the full one-year follow-up period for surgeries with implants, are published in separate accompanying tables here: www.gov.uk/government/publications/surgical-site-infections-ssi-surveillance-nhs-hospitals-in-england

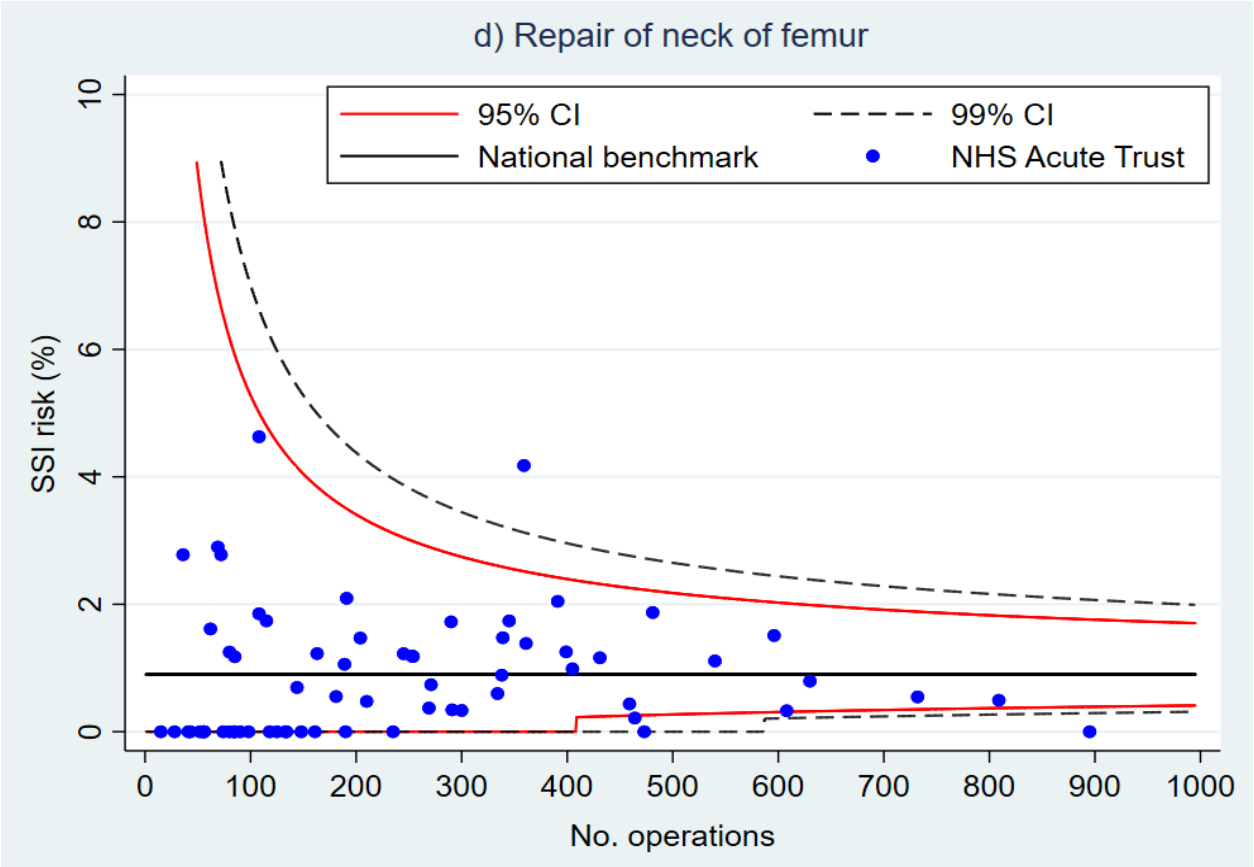
Annual trust-level results for hip and knee replacement surgery are also made available through PHE's public reporting tool, Fingertips at fingertips.phe.org.uk/profile/amr-local-indicators. The tool also allows users to group results by trust type (i.e. teaching, non-teaching, and specialty) or NHS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

Figures 9a-d: Distribution of inpatient and readmission SSI risk, NHS acute trusts and treatment centres England, April 2018 to March 2019






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
No. operations

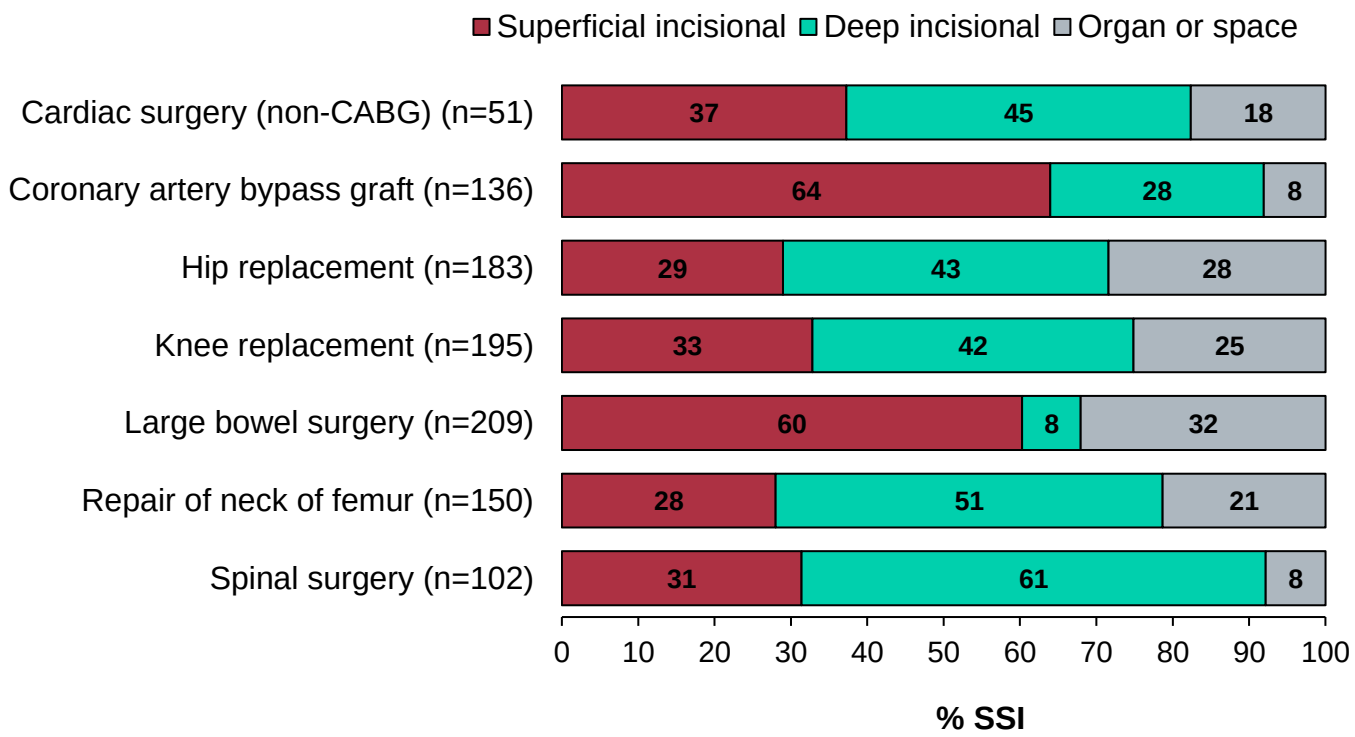

d) Repair of neck of femur
95% CI
99% CI
National benchmark
NHS Acute Trust
SSI risk (%)
0
2
4
6
8
10
0
100
200
300
400
500
600
700
800
900
1000
No. operations

Characteristics of SSIs

Focus of SSI

The distribution of SSI type for the 1,183 inpatient and readmission-detected SSIs reported in 2018/19 is shown by category in Figure 10 (where inpatient and readmission SSIs was ≥50). The proportion of SSIs classified as deep incisional or organ/space varied by surgical category, ranging from 36.0% for CABG to 71.0% for hip replacement and 72.0% for repair of neck of femur surgery. Differences in proportions may be affected by the variation in duration of hospital stay. Surgical categories with a shorter duration in hospital see relatively more readmission-detected SSIs, which in turn increases the proportion of more serious wound complications. However, despite being a procedure with a long inpatient stay (median length of stay 13 days), repair of neck of femur surgery had the lowest proportion of superficial incisional SSIs. Other long stay procedures such as large bowel surgery and CABG reported the highest proportion of superficial incisional SSIs (60.3% and 64.0%, respectively).

Figure 10: Distribution of SSI type for inpatient and readmission-detected cases by surgical category, NHS hospitals England, April 2018 to March 2019



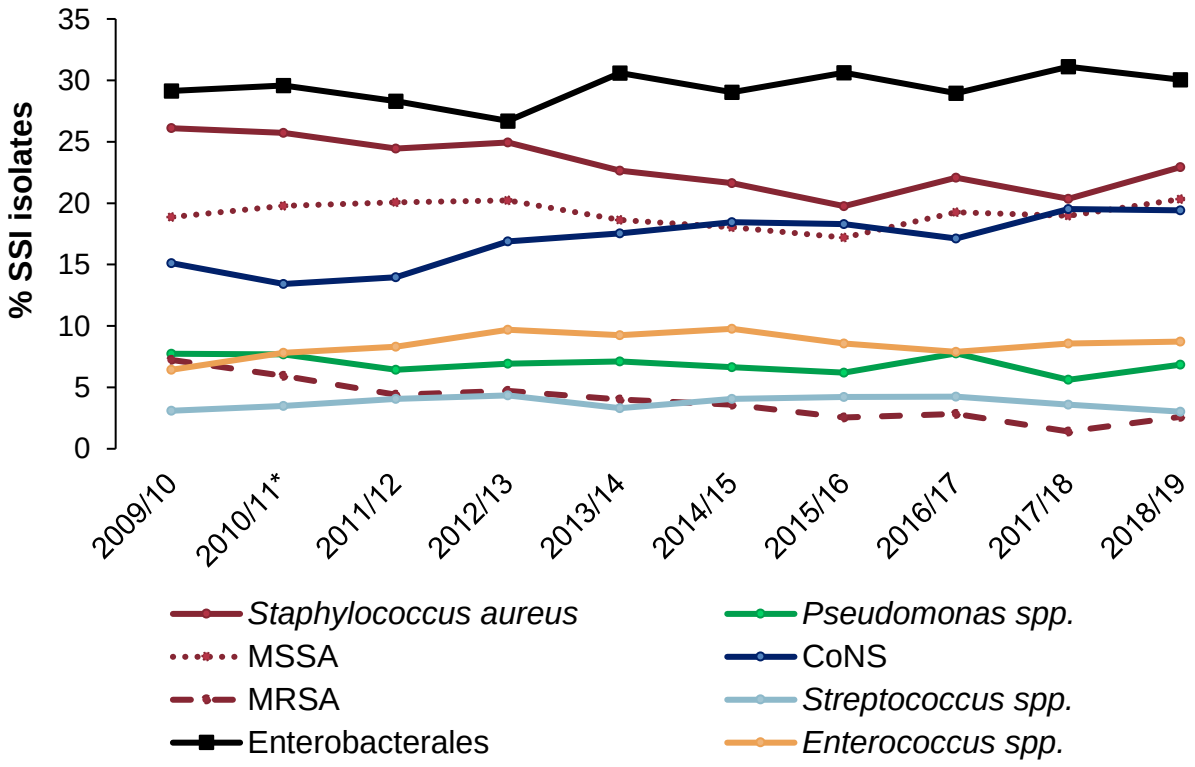
Causative organisms

Figure 11 looks at 10-year trends in microbial aetiology of inpatient and readmission-detected SSIs across all surgical categories. During this time period there were 15,839 inpatient and readmission-detected SSIs reported, 68% (N=10,740) of which had accompanying microbiology data. According to the PHE SSISS case definitions, positive microbiology is not essential to meet the SSI case definition.

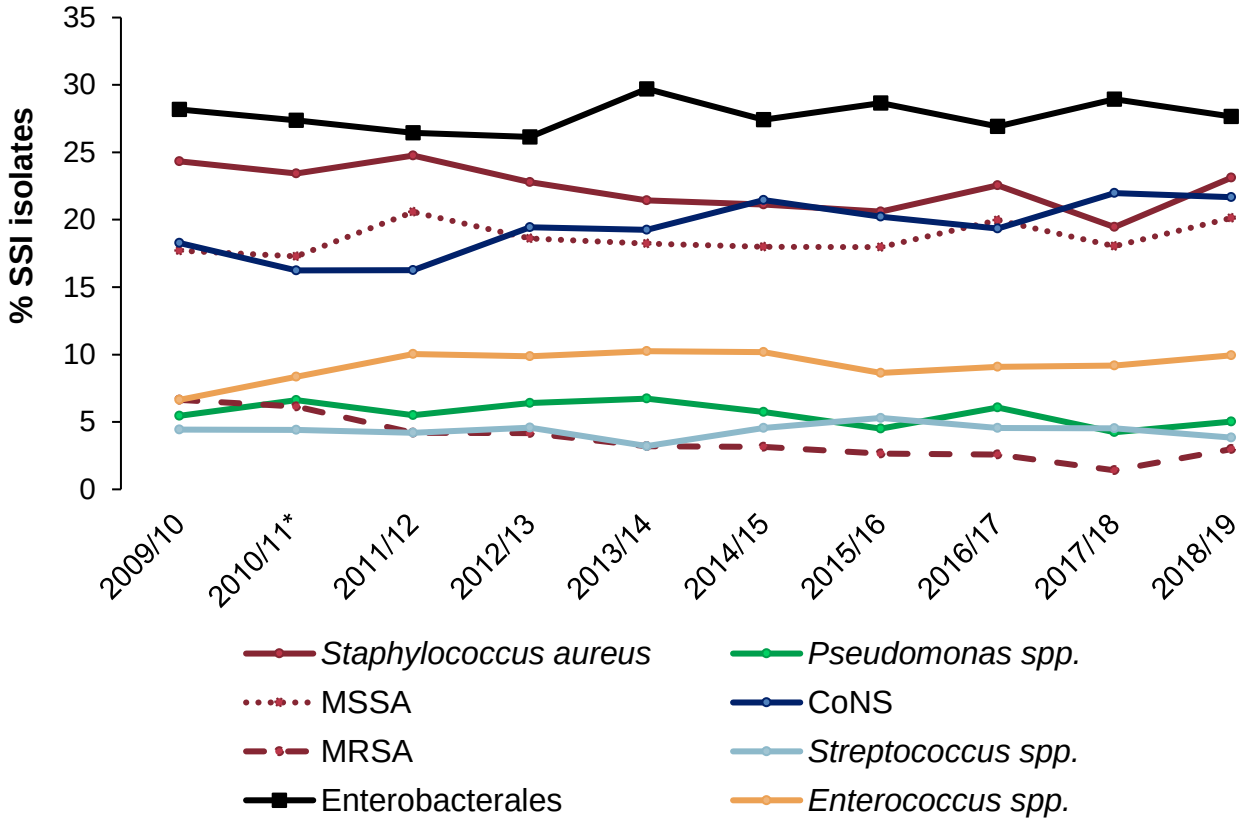
Enterobacterales (formerly Enterobacteriaceae) remain the most prevalent causative organisms at 30.0% in 2018/19. The 3 most prevalent species making up this group were *Escherichia coli* (30.2%), coliforms (19.6%) and *Proteus mirabilis* (13.3%). *Staphylococcus aureus* has shown the greatest relative decline (26.1% in 2009/10 to 22.9% in 2018/19) over the 10 years, however in 2018/19 the proportion of *S. aureus* increased from the previous year, similar to the slight peak seen in 2016/17 (22.1%). Both the methicillin-resistant *S. aureus* (MRSA) and methicillin-sensitive form increased by 1.0% from 2017/18 to 2018/19. Coagulase-negative staphylococci (CoNS) remained stable at 19.4% in 2018/19 but has had the greatest *per cent* increase from 2009/10, followed by *Enterococcus* spp. (8.7% in 2018/19). When restricted to deep or organ/space SSI only, the species distribution showed a similar picture, however CoNS and *Enterococcus* spp. made up a higher proportion of cases (21.7% and 9.9% in 2018/19, respectively).

Figure 11. Micro-organisms reported as causing inpatient and readmission-detected SSIs, all surgical categories, NHS hospitals England, April 2009 to March 2019

a) all SSIs



b) deep incisional or organ/space SSIs only



*cranial, breast, cardiac (non-CABG) surgery added to the surveillance programme in 2010/11

Table 5 breaks down the distribution of organisms reported as causing inpatient and readmission-detected SSIs by surgical category. Five years of data were used for these analyses (April 2014 to March 2019) to ensure sufficient volumes. Table 5a provides the distribution for all types of SSIs and Table 5b looks specifically at deep or organ/space infections. Surgical categories included in this analysis had ≥100 cases with available microbiology information. Spinal surgery had the highest proportion of SSI cases with accompanying microbiology (86%) and large bowel surgery the lowest (55%). Over 80% of hip replacement and repair of neck of femur surgery SSIs had microbiology.

Among monomicrobial SSIs (1 organism reported as causing SSI), MSSA remained the dominant causative organism for hip replacement, knee replacement, repair of neck of femur and spinal surgery (29.4%, 40.0%, 29.6% and 43.2% respectively). SSIs caused by Enterobacterales were most prevalent in large bowel surgery (52.1%), as well as CABG (29.5%), the later including infections at donor vein sites. CoNS micro-organisms, which are associated with implants, were highest in spinal surgery (25.1%), followed closely by CABG (24.8%), hip replacement (24.7%) and knee replacement (23.7%). Similar distributions of pathogens are seen in monomicrobial SSIs causing deep and organ/space SSIs (Table 5b). Of note, as reported last year, the proportion of MSSA isolates within deep surgical site infections was lower for large bowel surgery (2.5% vs 4.0%) while the proportion due to Enterobacterales was higher (56.9% vs

52.1%). For repair of neck of femur surgery, the proportion of MSSA was also lower in deep or organ/space monomicrobial SSIs (25.4% vs 29.6%) while the proportion of CoNS causative pathogens was higher (20.7% vs 17.1%).

Polymicrobial SSIs (cases with more than 1 organism reported as causing SSI) were most frequent in large bowel surgery at 40% of cases and lowest in knee replacement surgery at 25%, reflecting the level of wound contamination inherent to these procedures. Around half of polymicrobial infections involved a combination of Gram-positive and Gram-negative organisms. This was observed across surgical categories (ranging from 41.4% for knee replacement to 51.0% for large bowel surgery), with the exception of spinal surgery (29.9%).

The proportion of polymicrobial SSIs caused by combinations of Gram-negative bacteria was highest for large bowel and CABG surgery (23.7% and 20.7%, respectively). The remaining categories had a higher proportion of Gram-positive only combinations (ranging from 31.7% for repair of neck of femur to 53.5% for spinal surgery). The proportion of deep and organ/space SSIs due to Gram-negative polymicrobial infections was slightly lower than for all SSIs combined across all surgical categories, except CABG (20.7% ‘all SSI’ vs 23.6% ‘deep and organ/space SSI’). In contrast, compared to all SSIs, the proportion of deep and organ/space SSIs caused by Gram-positive combinations was slightly higher for the majority of surgeries, especially spinal (60.0% ‘deep and organ/space SSI’ vs 53.5% ‘all SSI’). Proportions for CABG and large bowel surgery remained relatively similar.

Table 5: Micro-organisms reported as causing inpatient and readmission-detected SSIs by surgical category, NHS hospitals England, April 2014 to March 2019

a) all SSIs

		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*	183	29.4	238	40.0	149	29.6	20	4.0	136	43.2	86	21.3
	Methicillin-resistant *S. aureus*	26	4.2	25	4.2	42	8.3	9	1.8	7	2.2	14	3.5
	Coagulase-negative staphylococci	154	24.7	141	23.7	86	17.1	14	2.8	79	25.1	100	24.8
	Enterobacterales	137	22.0	64	10.8	134	26.6	262	52.1	56	17.8	119	29.5
	Pseudomonas	24	3.9	21	3.5	25	5.0	56	11.1	11	3.5	47	11.7
	Streptococcus	40	6.4	44	7.4	13	2.6	19	3.8	7	2.2	4	1.0
	Enterococcus	29	4.7	22	3.7	30	6.0	37	7.4	4	1.3	8	2.0
	Other bacteria	28	4.5	39	6.6	22	4.4	67	13.3	14	4.4	23	5.7
	Fungi including *Candida* spp.	2	0.3	1	0.2	3	0.6	19	3.8	1	0.3	2	0.5
	Total monomicrobial	**623**	**100**	**595**	**100**	**504**	**100**	**503**	**100**	**315**	**100**	**403**	**100**
Polymicrobial	Gram-positive combinations only	121	43.8	80	39.4	84	31.7	12	3.6	68	53.5	54	22.8
	Gram-negative combinations only	25	9.1	21	10.3	33	12.5	80	23.7	17	13.4	49	20.7
	Gram-positive and Gram-negative combinations	121	43.8	84	41.4	120	45.3	172	51.0	38	29.9	110	46.4
	Other	9	3.3	18	8.9	28	10.6	73	21.7	4	3.1	24	10.1
	Total polymicrobial	**276**	**100**	**203**	**100**	**265**	**100**	**337**	**100**	**127**	**100**	**237**	**100**
	Total cases*	**899**	**100**	**798**	**100**	**769**	**100**	**840**	**100**	**442**	**100**	**640**	**100**

b) deep incisional or organ/space 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*	138	29.1	188	39.3	92	25.4	4	2.5	100	43.7	41	23.7
	Methicillin-resistant *S. aureus*	21	4.4	17	3.6	27	7.5	3	1.9	7	3.1	7	4.0
	Coagulase-negative staphylococci	123	25.9	117	24.5	75	20.7	6	3.8	53	23.1	38	22.0
	Enterobacterales	107	22.5	51	10.7	101	27.9	91	56.9	41	17.9	56	32.4
	Pseudomonas	9	1.9	15	3.1	15	4.1	7	4.4	7	3.1	16	9.2
	Streptococcus	36	7.6	39	8.2	9	2.5	5	3.1	6	2.6	2	1.2
	Enterococcus	20	4.2	17	3.6	24	6.6	15	9.4	4	1.7	5	2.9
	Other bacteria	19	4.0	33	6.9	17	4.7	24	15.0	10	4.4	8	4.6
	Fungi including *Candida* spp.	2	0.4	1	0.2	2	0.6	5	3.1	1	0.4	0	0.0
	Total monomicrobial	**475**	**100**	**478**	**100**	**362**	**100**	**160**	**100**	**229**	**100**	**173**	**100**
Polymicrobial	Gram-positive combinations only	106	45.7	72	44.7	73	33.8	5	3.2	54	60.0	33	22.9
	Gram-negative combinations only	20	8.6	14	8.7	24	11.1	34	21.7	11	12.2	34	23.6
	Gram-positive and Gram-negative combinations	99	42.7	65	40.4	100	46.3	80	51.0	22	24.4	61	42.4
	Other	7	3.0	10	6.2	19	8.8	38	24.2	3	3.3	16	11.1
	Total polymicrobial	**232**	**100**	**161**	**100**	**216**	**100**	**157**	**100**	**90**	**100**	**144**	**100**
	Total cases*	**707**	**100**	**639**	**100**	**578**	**100**	**317**	**100**	**319**	**100**	**317**	**100**

*total cases are specific to this analysis and refers only 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 were submitted by hospitals and reflect their own perspectives and learning over the past year from carrying out surveillance or undertaking new quality improvement initiatives at the local level.

Protecting patients from surgical site infection: core temperature monitoring vs peripheral temperature monitoring

This initiative was undertaken at Northampton General Hospital NHS Trust to compare patient temperature recordings from a zero-heat flux deep forehead core temperature monitoring system with peripheral temporal thermometers for patients whose theatre journey was over an hour. NICE (2016) *Clinical Guideline 65 Hypothermia: Prevention in Adults Having Surgery* states to monitor patient temperatures in theatres, maintain above 36.0°C, and to not use indirect estimates of core temperature, such as temporal infrared thermometers.

Following informed consent to participate, 13 patients were followed through theatre. Their core and peripheral temperatures were recorded at 30-minute intervals, from the anaesthetic room, through theatres, to the recovery room.

61.5% (n=8) of the patients audited maintained normothermia during their theatre journey. However, the remaining 38.5% (n=5) patients' core temperatures dropped below 36°C, requiring active warming using forced air warming blankets and/or warmed intravenous fluids. None of these patients were detected in the peripheral readings, only the core temperature readings.

This evidence-based safety initiative is important as hypothermia increases risk of surgical site infection three-fold. The outcomes were presented to Consultant Anaesthetists who supported it and we launched core temperature monitoring in July 2019 to protect surgical patients from infection.

Holly Slyne, Natalie Clews and Gill Jones

Infection Prevention and Control Team
Northampton General Hospital NHS Trust

Using a multidisciplinary approach to reduce the incidence of SSIs

Sheffield Teaching Hospitals NHS Foundation Trust has a dedicated surgical site infection surveillance (SSIS) team conducting continuous surveillance in hip and knee replacement categories. The Trust provides one of the largest orthopaedic services in England and as such performs a significant number of revision surgeries as well as primary arthroplasty surgery.

Historically the Trust has been a high outlier in these categories in part due to the complex case mix, peaking at 2.5% inpatient/readmission SSI risk in the knee category in Jul-Sep 2015 and 2.7% SSI risk in the hip category Apr-Jun 2016.

A multidisciplinary approach to reduce SSIs has been developed working with the Musculo-Skeletal (MSK) Care Group, leading to initiatives including:

- 'bug busters' steering group
- pre-operative decolonisation
- root cause analysis for each confirmed SSI case
- the provision of specific dressings' rooms
- written patient information, offering clear and concise advice for all stages of care
- audit
- staff/patient education

These approaches have seen the infection rates reduce dramatically. In the last year (July 2018 to June 2019) we have only been a high outlier once in the knee category and our hip category has been equal to or below the national average.

The MSK Care Group have taken ownership of these changes supported by the comprehensive data collection provided by the SSIS team. This work will continue to provide the best possible surgical outcome for patients.

Sarah Egginton, Deborah Adams, Debbie Carr, Debra Crossland, Heather Goddard and Lyndsey Packham

Infection Prevention and Control Team
Sheffield Teaching Hospitals NHS Foundation Trust

Introduction of a revolutionary electronic surgical wound documentation proforma to aid expansion of a Trust's already successful SSI surveillance programme

Guy's & St Thomas' NHS Foundation has run a successful surgical site infection (SSI) surveillance (SSIS) programme from 2009 to date using PHE recommended surveillance methodology. In order to keep up with an increasing focus and attention on SSI in the era of heightened focus on antimicrobial resistance and antimicrobial stewardship; our team built a successful business case for electronic (e-Noting®) surgical wound documentation to facilitate the expansion of our surveillance programme.

We liaised with various stakeholders, including IT leads, finance department leads, SSIS committee, senior leadership and other identified individuals to put forward the patient benefits of our proposed patient safety initiative. We explored alternative funding arrangements from the organisation's digital hub team. This team prioritises IT implementation for projects with evidenced financial value. By working together with SSI local champions, our SSIS team successfully introduced electronic surgical wound documentation from October 2018, initially to 11 participating surgical specialties. Six new specialties were recently recruited into our credible and sustainable SSI surveillance programme run by frontline staff. We envisage covering all surgical specialties by April 2020. Additionally, an SSI module was developed to support staff.

We successfully built a credible SSI business case through determination, passion and persistence to facilitate the introduction of a revolutionary patient safety initiative that facilitated expansion. We will soon be utilising the e-Noting® surgical wound documentation tool to undertake post discharge surveillance for all specialties.

Lillian Chiwera, William Newsholme and Neil Wigglesworth

Directorate of Infection
Guy's & St Thomas' NHS Foundation Trust

Discussion

Summary

In 2018/19 a total of 201 NHS hospitals and 8 IS NHS treatment centres submitted surveillance data for 132,254 surgical procedures, for which 1,183 inpatient and readmission-detected SSIs were reported. To date, PHE SSISS has accumulated surveillance data for over 2 million operations and 50,000 SSIs since its inception in 1997, representing a wealth of information for guiding infection prevention and control efforts and answering important research questions to support the reduction of surgical site infections and minimize the burden they place on the health care system and impact on patients.

Ten-year trends in the annual SSI incidence evidence continuous decreasing trends for most of the mandatory orthopaedic categories, supporting the pivotal role surveillance plays in preventing infection [9]. In 2018/19, the inpatient and readmission SSI risk following hip replacement surgery continued to decrease from 2017/18 by 0.1% to 0.4%. The inpatient and readmission SSI risk following knee replacement surgery remained the same in 2018/19 at 0.4% and aligned with other European country estimates reported in 2017 (0.5%) [10]. SSI risk following reduction of long bone fracture surgery has also decreased overall in the last 10 years (1.5% inpatient/readmission in 2009/10 to 1.0% inpatient/readmission in 2018/19) despite some intermittent peaks and a recent 0.2% increase in 2018/19. Trends varied among other non-orthopaedic surgical categories. In 2018/19 the SSI risk following large bowel surgery continued to increase to 9.0% (same as reported in 2009/10) after a trough in 2014/15 to 2016/17. Inpatient and readmission SSI risk following spinal surgery has increased from 0.9% in 2009/10 to 1.5% in 2018/19. In contrast, inpatient and readmission SSI risk following CABG has greatly decreased from 5.7% in 2009/10 to 2.3% in 2018/19. Whether these changes reflect changes in case mix in NHS hospitals remains unclear and warrants further investigation.

Large bowel surgery continues to show the greatest inter-hospital variation in SSI. Initiatives to share best practice among hospitals within this surgical category may help reduce infection rates. The majority of surgical categories (8 of 11 with sufficient data to calculate the 25th and 75th national percentiles) showed a narrowing of the interquartile range compared to the previous year indicating a reduction in the variability of risk across hospitals over time.

Less variation in results for hip and knee replacement was further evidenced in the annual trust-level SSI risk funnel plots. In 2017/18 there was a low number of annual orthopaedic outliers and 4 high outlier notifications were sent. In 2018/19, despite still seeing this more consistent grouping of hospitals around the national benchmark, 7 high

outlier notifications were sent (4 for knee, 2 for hip and 1 for repair of neck of femur). The trust-level reported SSI risk for each outlier was higher than the corresponding national benchmark for that category reported back in 2009/10 (0.6% for knee, 0.8% for hip and 1.7% for repair of neck of femur). Less than half of the outlier trusts had a previous history of being an outlier in the last 3 years. 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 declining national benchmark. This emphasizes the importance of continued surveillance and monitoring.

As the reported inpatient and readmission SSI risk used in both annual trust and quarterly hospital outlier assessments is unadjusted for differences in the patient population and important risk factors, hospitals flagged in our quarterly high outlier notifications are encouraged to explore their results through their web-based hospital reports which include risk-stratified data. As illustrated in the Hospital Perspectives section, outlier notifications encourage hospitals to assess their results and act when necessary. In 2018/19 the Service carried out 2 hospital visits and 3 in-depth epidemiological analyses for high outlier trusts who requested our support, in an effort to identify opportunities for improvement, as well as putting a number of hospitals in touch with ‘mentor’ hospitals.

Based on available BMI information, half of all patients undergoing a knee replacement procedure in 2018/19 were considered to be obese. An elevated BMI has been shown to increase the likelihood of developing an SSI [11,12]. Changes in the distribution of patient BMI for hip and knee replacement were assessed in response to a 2017 report which found that 47% of Clinical Commissioning Groups (CCGs) in the United Kingdom have a BMI threshold in place for funding surgery [13]. The majority of these CCGs have applied 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’). While we found no evidence of impact on surveillance data for hip and knee replacement as a result of these CCG thresholds, we may see an impact in the ensuing years. Encouragingly, completion of BMI within the surveillance system has been steadily improving (41% in 2009/10 to 64% in 2018/19).

Enterobacterales remain the most prevalent causative pathogens across all surgical categories at 30.0%. Given the concern of increasing trends in resistance in Gram-negative infections and the UK 5-year national action plan of halving healthcare-associated Gram-negative bloodstream infection (BSI) [14], the high proportion of SSI caused by Gram-negative bacteria remains a concern. The proportion of SSI caused by Enterobacterales however, remained stable in 2018/19 and was slightly lower than that reported in 2017/18. The proportion of CoNS-attributed SSIs has been gradually increasing since 2009/10 but remained stable at 19.4% in 2018/19. Despite a significant reduction in 10-year trends in *Staphylococcus aureus*-caused infections, attributed largely to falls in MRSA due to enhanced infection control initiatives (i.e. pre-admission

screening and decolonisation of carriers), the proportion of *S. aureus* caused SSI reported in 2018/19 (22.9%) increased from 20.4% in 2017/18. Capture of microbial aetiology continues to play a key role in prevention of SSI through optimising choice of antibiotic prophylaxis in surgery.

Total number of procedures submitted in 2018/19 was similar to that reported in 2017/18, but continual decreases were seen in submissions to the voluntary surgical categories (10% decrease). National benchmarking is enhanced with greater representation of hospitals performing similar operations across the country. Future digital transformations will help to reduce some of the data collection burden and allow hospitals to prioritise surveillance in areas not as well monitored as those under the national mandate. Hospitals should be encouraged and supported in utilising existing tools aimed at reducing data collection burden, in particular data import functionality. In 2018/19, only 16% of hospitals took advantage of the CSV import feature in our data collection tool.

Future directions

The redesign of the hospital web-based data collection and reporting system has been a high priority for the year and its launch is projected for Spring 2020. Several new features will be available, aimed at reducing data entry time for users through expanded file upload services, bulk submission, streamlined communications and automated prompts. The new system will also include category-specific reconciliation to improve timeliness of reports for different teams, an interactive dashboard and new customisable reports. The SSISS team will be working with hospitals to evaluate these changes and their impact on the data collection burden.

The development of the electronic version of the patient post-discharge questionnaire (ePDQ) has proceeded to the beta phase of digital development. This will align with the digital transformation of the web system and help improve completeness and uptake of the post-discharge questionnaire and reduce time needed to contact patients through automated text/email reminders. Increasing systematic post-discharge surveillance will provide more comprehensive and sensitive SSI risk measures and allow us to use this data for national benchmarking.

Finally, PHE is currently undertaking a strategic review of the surveillance programme by an assembled Task and Finish Group. An initial meeting was held in October 2019 and over the course of the next year, gathered experts in the field will discuss the strategic alignment of the service within available resourcing and develop recommendations on the future direction of the service.

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 (i.e. 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.

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.

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Appendix

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