Health Protection Agency

Third Report of the Mandatory Surveillance of Surgical Site Infection in Orthopaedic Surgery

April 2004 to March 2007

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Contents

Mandatory surveillance of surgical site infection in orthopaedic surgery

Report of data collected between April 2004 and March 2007

Key Points

- 150 NHS Trusts in England participated in the third year (2006/07) of mandatory surveillance of orthopaedic surgical site infection, contributing data on 60,951 orthopaedic procedures, mostly hip and knee prostheses. Six Trusts did not participate.
- Participation is mandatory for at least one surveillance period (three months); almost 40% of Trusts undertook continuous surveillance throughout the third year in at least one category of orthopaedic procedure.
- Rates of SSI have decreased between the second (2005/06) and third year (2006/07) in three out of the four mandatory orthopaedic categories, demonstrating a continued decrease since the mandatory surveillance began.
- Rates of SSI are highest in hip hemiarthroplasty. This is partly explained by patients undergoing these procedures being at greater risk of infection and having a longer post-operative stay in hospital, increasing the chance that SSIs will be detected.
- Rates of SSI increase with the number of risk factors present in the patient.
- Most of the SSIs reported affected the superficial layers of the wound, but approximately a quarter involved the deeper tissues.
- *S.aureus* is recognised as a major cause of SSIs and accounted for 45% of all surgical site infections over the three years of the mandatory surveillance. 62% were methicillin resistant (MRSA), nearly a third of all SSIs (28%) being caused by MRSA.
- Eight Trusts had higher than expected rates of infection in the third year, three of these being high outliers in more than one category of procedure. These Trusts are investigating possible causes for their higher rates.
- A small number of Trusts have unusually low rates of SSI, which might reflect high standards of clinical practice, short post-operative hospital stays or under-reporting of infection. As part of the feedback from the SSI surveillance service throughout the course of the year, these Trusts are already aware that their rates are low and have been asked to confirm that the SSI surveillance protocol is being followed.
- The length of post-operative stay in hospital decreased from 7 days in 2004/05 to 6 days in 2006/07 for both hip and knee prosthesis surgery. In hip hemiarthroplasty the median length of post-operative stay has remained stable at 14 days. The decreasing length of post-operative stay means that the surveillance is increasingly likely to underestimate the true rate of SSI, affecting the interpretation of changes in rates over time.

1. Introduction

This report contains data collected by NHS Trusts in England during the first three years of the mandatory surveillance of surgical site infection (SSI) in orthopaedic surgery. A programme for surveillance of SSI was established by the then Public Health Laboratory Service and Department of Health in 1997[1]. Surveillance of SSI in orthopaedic surgery became mandatory in April 2004[2].

1.1 Requirements of the mandatory surveillance of SSI in orthopaedic surgery

All NHS Trusts where orthopaedic surgical procedures are performed are required to carry out a minimum of three months' surveillance in at least one of the following four orthopaedic categories[3]:

- Hip (prosthesis) replacement
- Knee (prosthesis) replacement
- Hip hemiarthroplasty
- Open reduction of long bone fracture

Some Trusts include more than one acute hospital and may have chosen to collect data at one hospital only. Some Trusts, in particular paediatric specialist hospitals, only carry out procedures in the open reduction of long bone fracture category and the throughput was too small to enable them to participate in the surveillance.

1.2 Surveillance methods

Surgical site infections are defined as infections related to a surgical procedure that affect the surgical wound or deeper tissues handled during the procedure. SSI cannot be reliably identified from laboratory data alone as the diagnosis depends on the presence of signs and symptoms of infection in the wound. The surveillance to detect SSI therefore requires active monitoring of patients from the time of their operation until they are discharged from hospital.

The SSI Surveillance Service is focused on categories of surgical procedure, with each category containing a defined set of similar procedures. All patients undergoing a procedure in the chosen category during the selected surveillance period are included in the surveillance. A basic set of demographic data (e.g. age, sex of the patient), together with some details about the operation itself (e.g. duration of operation) are collected for each eligible procedure. These patients are followed up throughout their hospital stay to discover whether they develop an infection of their surgical wound that meet the criteria for an SSI. Currently there is no requirement to continue surveillance once the patient has been discharged from hospital and SSI that develop after the patient has been discharged from hospital are not included in these rates.

Trusts should adhere to the standard method of collecting and reporting data described in the SSI surveillance protocol to ensure that, as far as possible, data collected in different Trusts are comparable. They are required to participate in the surveillance for minimum three-month periods, although they can choose to collect data for more than one period.

1.3 Using the data to inform practice

A key aim of the surveillance is to encourage Trusts to use the data to evaluate local practice and institute changes where the results indicate this may be necessary. At the end of each surveillance period, participating Trusts receive an individual report that contains their results compared to the data aggregated from all participating hospitals. They use these data to monitor local practice and initiate further investigation and action should the results indicate untoward rates of infection. Some additional analyses are undertaken by the Surgical Site Infection Surveillance Service (SSISS) for those Trusts with a rate of SSI in the highest ten percent and these Trusts are contacted to ensure that they are aware of their high rates.

1.4 Analyses presented in this report

This report contains data contributed by NHS Trusts in the third year of the mandatory surveillance and, where appropriate, compares these results with data combined from all three years. Individual Trust results are available on the HPA website at:

http://www.hpa.org.uk/infections/topics_az/surgical_site_infection/default.htm

2. Rates of surgical site infection in orthopaedic surgery

2.1 Participation in the surveillance between April 2004 and March 2007

Table 1 shows SSI data collected by NHS Trusts that have participated in the surveillance in the third year and over the three years since the mandatory surveillance commenced in April 2004. Six Trusts failed to participate in the third year of surveillance. The number of procedures included in the surveillance has increased each year, with data on a total of 60,951 orthopaedic procedures contributed in the third year. Most Trusts chose to undertake surveillance in the categories for total hip and knee prosthesis.

Table 1: Participation in mandatory surveillance of SSI in orthopaedics: 2006/07 (Year 3) & April 2004/March 2007 (all 3 years combined)

Category	Total no. Trusts*		No of procedures		No. SSI		% Infected	
	Year 3	All years	Year 3	All years	Year 3	All years	Year 3	All years
Total	**150**	**156**	**60951**	**155228**	**557**	**1748**	**0.91**	**1.13**
Hip prosthesis	116	135	25397	63208	181	582	0.71	0.92
Hip hemiarthroplasty	72	98	6709	18433	211	660	3.15	3.58
Knee prosthesis	100	128	25167	63858	96	327	0.38	0.51
ORLBF**	26	40	3678	9729	69	179	1.88	1.84

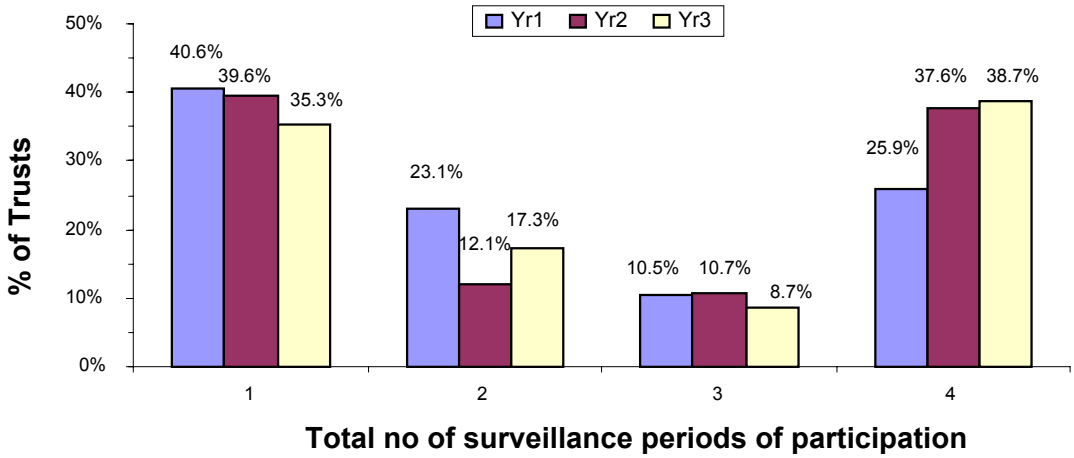
*The number of NHS Trusts in this report has been updated to reflect organisational changes during 2006/07 and may therefore differ from those cited in previous reports.

**ORLBF = Open reduction of long bone fracture

The throughput of surgical procedures in each category varied by Trust and just over four fifths of Trusts had less than 100 procedures for a particular surgical category per quarter. This is an important consideration when comparing rates for individual Trusts, as the volume of data may be relatively small resulting in imprecise rates. Since Trusts are required to participate for a minimum of one surveillance period (three months), the number of procedures included in the mandatory surveillance by each Trust also depends on how many surveillance periods were undertaken.

Figure 1 illustrates the proportion of Trusts that participated in one or more surveillance periods. In 2006-07, 65% of participating Trusts provided data for two or more surveillance periods and almost two fifths (39%) are undertaking continuous surveillance throughout the year in at least one of the orthopaedic categories. The proportion of Trusts undertaking continuous surveillance has been growing over the 3 years, whilst that for Trusts only participating for one period is falling.

Figure 1: Number of quarterly surveillance periods undertaken by NHS Trusts per year



Note: A surveillance period comprises three calendar months

2.2 Incidence of SSI

The percentage of operations that resulted in SSI (cumulative incidence) in the post-operative in-patient period for each category of surgical procedure is shown in tables 2 to 5, and in figures 2 and 3. Rates of SSI are higher in hip hemiarthroplasty, which is most commonly undertaken to repair fractures to the neck of femur. This is partially explained by risk factors in these patients, who are older (table 6) and more likely to have underlying illness that affects their vulnerability to infection[4]. In addition, these more vulnerable patients tend to stay longer in hospital post-operatively, thus increasing the likelihood that SSI will be identified, as the surveillance currently only detects SSI that develop during admission. To allow for differences in length of post-operative stay it is possible to calculate a rate of SSI that uses the number of post-operative days of follow-up as the denominator rather than the number of operations. This rate is called an *incidence density* and is expressed as the number of SSIs that occur per 1000 post-operative days of follow-up (Figure 3). If the length of post-operative follow-up is taken into account, the difference in risk of SSI between total hip prosthesis and hip hemiarthroplasty is reduced (Figure 3).

The risk of SSI has significantly decreased between the first and third year of the mandatory surveillance in three categories (hip prosthesis, knee prosthesis and hip hemiarthroplasty) ($p<0.01$) (Figure 2). This reduction could be partly explained by a decrease in the number of SSIs detected because of a shorter average length of post-operative stay. The median length of post-operative stay for patients undergoing elective hip and knee replacement decreased from 7 days in 2004/5, to 6 days in 2006/7, although it has remained at 14 days for hip hemiarthroplasty. Using the incidence density rate of SSI to partially account for the differences in length of postoperative stay, decreases in rates between year 1 and year 3 occurred in the same three categories and were still statistically significant ($p<0.04$).

Figure 2: Rate of SSI per 100 operations (cumulative incidence) by category of procedure and year

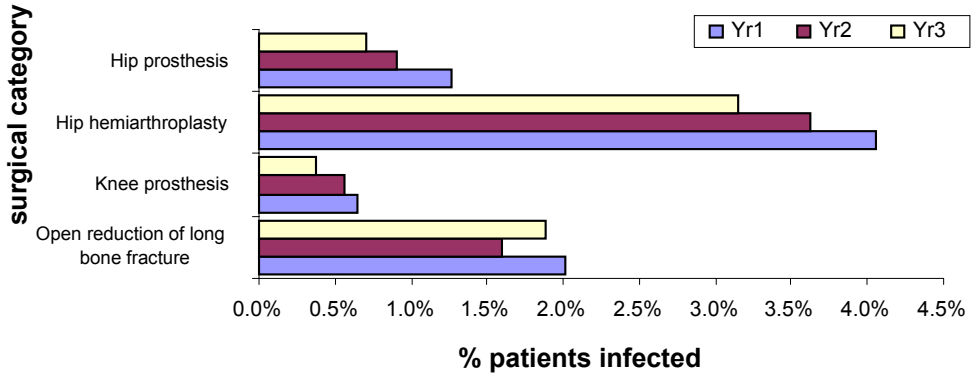
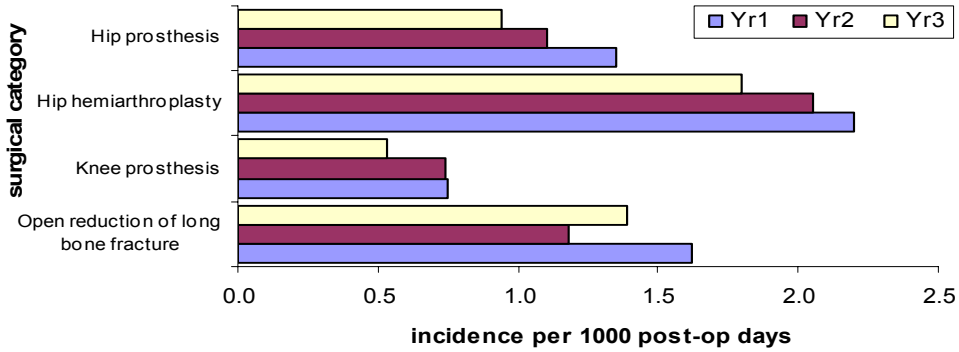


Figure 3: Incidence density of in-hospital SSI per 1000 post-operative in-patient days by category of procedure and year

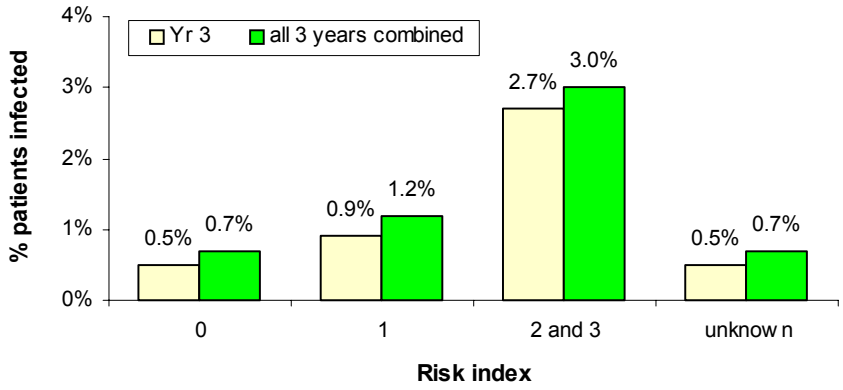


2.3 Incidence of SSI by risk group

The risk of developing SSI following a surgical procedure is affected by factors related to the general health of the patient, the type of operation and the procedure itself. The risk index is used to measure variation in these major risk factors and comprises: wound class of contaminated or dirty (indicating the likely microbial contamination of the wound); an American Society of Anesthesiologists' (ASA) physical status classification of three or more (indicating the patient has a severe underlying systemic disease); and duration of operation greater than the time at the 75th percentile (based on US National Nosocomial Infection Surveillance system and English SSISS data[5]) indicating a more complex procedure and increased opportunity for microbial contamination of the wound. Each operation is allocated a score of between 0 and 3 depending on how many of the three risk factors are present. Those with all three risk factors are at greatest risk of developing SSI.

Tables 2 to 5 show the cumulative incidence of SSI by category of surgical procedure and risk index group for year 3, and for the three years combined. The incidence of SSI increases with the number of risk factors present, although the number of operations in the higher risk index groups is small and the estimates correspondingly imprecise. Where data for one or more of the risk factors included in the index has not been provided, a risk score cannot be calculated. The rates of SSI are lowest in knee prosthesis and table 4 shows that fewer of these patients have underlying risk factors for infection[6], whilst patients undergoing hip hemiarthroplasty or open reduction of long bone fracture are more likely to have risk factors that increase their risk of developing an SSI (tables 3 and 5).

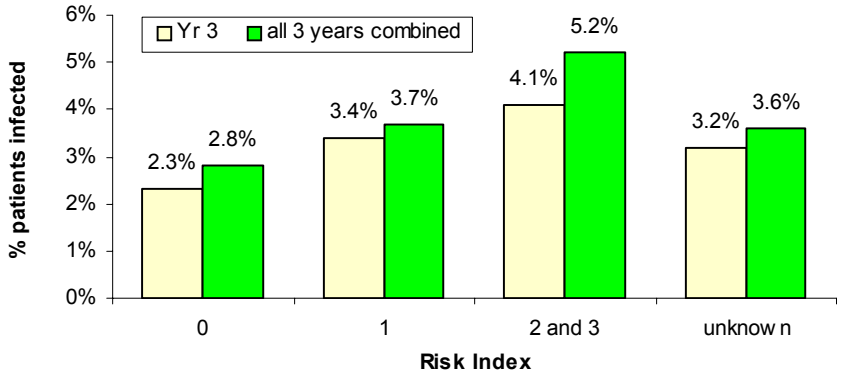
Table 2: Cumulative incidence of SSI in hip prosthesis by risk index for year 3 (2006/07) and all three years combined (2004/05 – 2006/07)



Year 3 data

Risk index category	Number of Trusts	Number of operations	Number of SSI	Cumulative rate (%)
0	116	12900	69	0.5
1	116	6295	59	0.9
2 and 3	102	1078	29	2.7
unknown	104	5124	24	0.5
All	**116**	**25397**	**181**	**0.7**

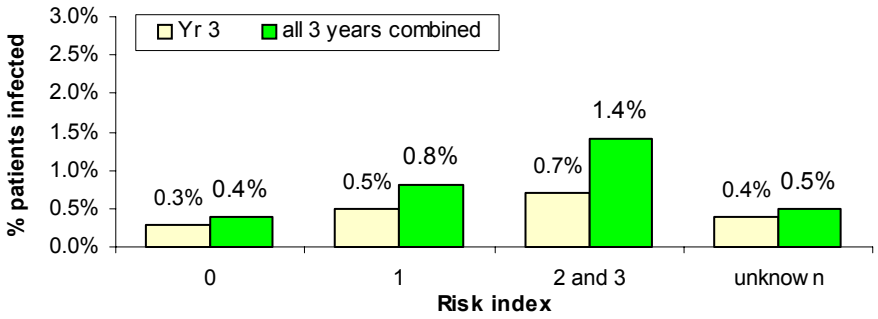
Table 3: Cumulative incidence of SSI in total hip hemiarthroplasty by risk index for year 3 (2006/07) and all three years combined (2004/05 – 2006/07)



Year 3 data

Risk index category	Number of Trusts	Number of operations	Number of SSI	Cumulative rate (%)
0	72	1596	37	2.3
1	72	3171	107	3.4
2 and 3	59	511	21	4.1
unknown	62	1431	46	3.2
All	**72**	**6709**	**211**	**3.1**

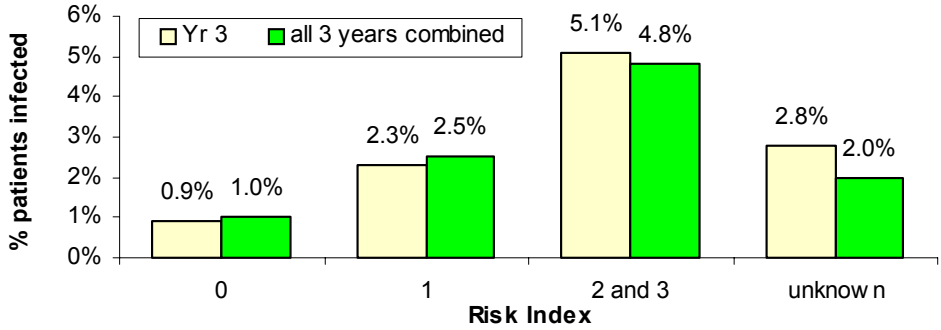
Table 4: Cumulative incidence of SSI in knee prosthesis by risk index for year 3 (2006/07) and all three years combined (2004/05 – 2006/07)



Year 3 data

Risk index category	Number of Trusts	Number of operations	Number of SSI	Cumulative rate (%)
0	100	13872	42	0.3
1	100	5619	28	0.5
2 and 3	84	572	4	0.7
unknown	91	5104	22	0.4
All	**100**	**25167**	**96**	**0.4**

Table 5: Cumulative incidence of SSI in open reduction of long bone fracture by risk index for year 3 (2006-07) and all three years combined (2004/05 – 2006/07)



Year 3 data

Risk index category	Number of Trusts	Number of operations	Number of SSI	Cumulative rate (%)
0	25	1581	15	0.9
1	25	1330	30	2.3
2 and 3	21	117	6	5.1
unknown	24	650	18	2.8
All	**26**	**3678**	**69**	**1.9**

2.4 Incidence of SSI by age group

The age group of patients undergoing surgery is shown in table 6. The median age for patients undergoing hip hemiarthroplasty is 14 years greater than those undergoing total hip prosthesis. Using combined data from all three years, the risk of SSI increases significantly for each additional year of patient age in all surgical categories ($p<0.04$) (not shown). When SSIs are stratified into five age groups, there is a gradient in the risk of SSI for each surgical category, with the oldest age group having a significantly higher risk of SSI than the youngest age group for hip prosthesis (risk ratio 3.2, $p<0.001$) and open reduction of long bone surgery (risk ratio 6.2, $p<0.001$). Some of the increased risk may be explained by older patients staying in hospital longer, thus increasing the possibility that a SSI will be detected.

Table 6: Distribution of age and rate of SSI by category of procedure, April 2004 to March 2007

Type of Procedure	Age group (years)															Median age
	<45			45-64			65-74			75-84			>84			
	SSI	Ops.	Rate (%)	SSI	Ops.	Rate (%)	SSI	ops	Rate (%)	SSI	Ops.	Rate (%)	SSI	Ops.	Rate (%)	
Hip prosthesis	12	2413	0.5	116	18559	0.6	176	22106	0.8	223	16805	1.3	53	3304	1.6	70
Hip hemiarthroplasty	0	18	0.0	17	601	2.8	73	2227	3.3	272	7860	3.5	297	7726	3.8	84
Knee prosthesis	2	637	0.3	56	16973	0.3	124	24467	0.5	120	19149	0.6	25	2604	1.0	71
Open reduction of long bone fracture	12	2273	0.5	13	1631	0.8	16	1087	1.5	58	2305	2.5	80	2433	3.3	74

3. Characteristics of the surgical site infections

SSI are categorised into those that affect the superficial tissues (skin and subcutaneous) of the incision, and those that affect the deeper tissues (deep incisional) or joint itself. In the data combined from all three years, most infections reported are superficial, but approximately a quarter affected the deeper tissues or joint for hip and knee prosthesis, and open reduction of long bone fracture. A third of SSI affected the deeper tissues or joint in hip hemiarthroplasty (table 7).

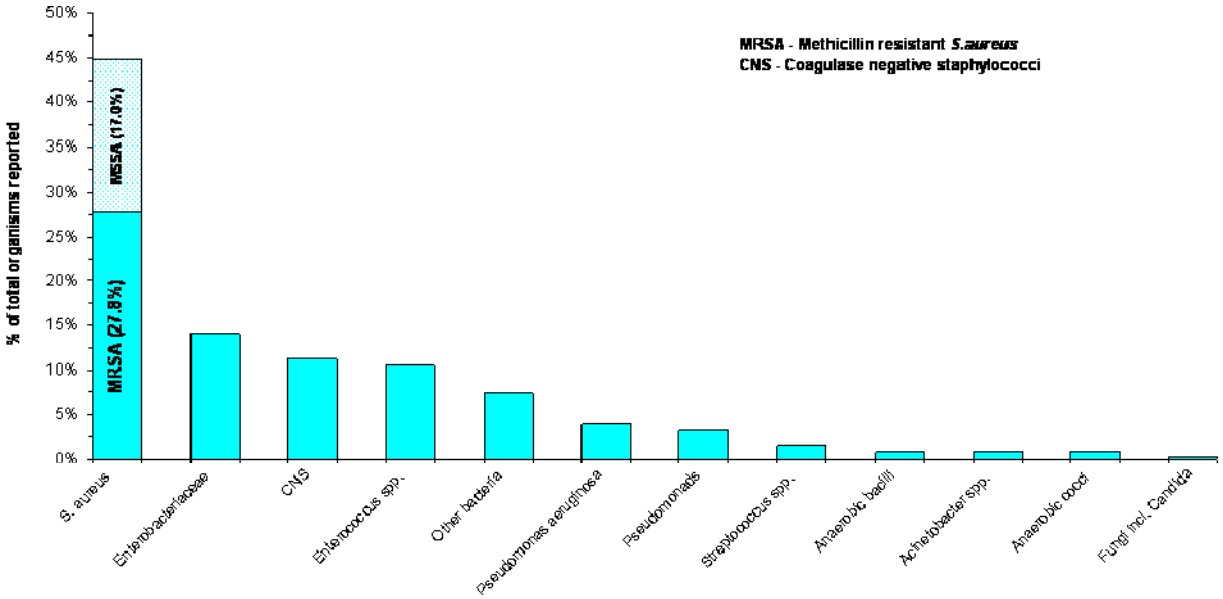
Table 7: Type of surgical site infection by category of procedure, April 2006 to March 2007 (Year 3) and April 2004 to March 2007 (all 3 years combined)

Category of procedure	Type of SSI							
	Superficial				Deep or joint			
	Year 3		All years		Year 3		All years	
	No.	%	No.	%	No.	%	No.	%
Hip prosthesis	135	74.6	430	73.9	46	25.4	152	26.1
Hip hemiarthroplasty	150	71.1	461	69.8	61	28.9	199	30.2
Knee prosthesis	81	84.4	252	77.3	15	15.6	74	22.7
ORLBF	52	75.4	140	78.2	17	24.6	39	21.8

ORLBF = Open reduction of long bone fracture

Data on the micro-organisms causing SSIs were available in 82% of infections for the three years of the mandatory surveillance. The main causative organisms are illustrated in figure 6. S. *aureus* was the most common micro-organism reported, accounting for 45% of all SSIs. Methicillin-resistant *Staphylococcus aureus* (MRSA) was reported as a causative micro-organism in 28% of all SSIs. Of all S.*aureus* reported, 62% were MRSA. This pattern was similar to that reported in the previous two years of mandatory surveillance in orthopaedic surgery.

Figure 4: Micro-organisms reported as causing SSI (all orthopaedic categories) – three years combined (April 2004 to March 2007)



4. Variation in rates of SSI between Trusts

When making comparisons between Trusts it is important to take into account the precision of the estimated rate of SSI. The greater the number of procedures on which the rate is based, the more precise the estimate. The plots shown in figures 5 to 8 are based on data from April 2006 to March 2007. They show the total rate of SSI (cumulative incidence) at each participating Trust plotted against the number of procedures on which the rate is based. The dashed (blue) lines represents the 95% control limits (95% CL) and the solid (red) lines the 99% control limits. The probability that rates above the high 95% control limit or below the low 95% control limit have occurred by chance is low (less than 0.05%).[7] However, these results should be interpreted with caution as no adjustment has been made for the case-mix of patients or other risk factors that may affect the rates. They should be treated as triggers for further investigation.

In the third year of surveillance (2006/07), a few Trusts had rates on or above the 95% CL for each of the following categories: hip prosthesis, knee prosthesis and hip hemiarthroplasty. No Trust had a rate above the 95% CL in open reduction of long bone fracture category. In hip prosthesis, there were three Trusts with rates on or above the 95% CL, of which one was also a high outlier in the previous year (2005/06). There were three Trusts that were high outliers in knee prosthesis although none of these had been high outliers in the previous year. In hip hemiarthroplasty, six Trusts were high outliers in the third year, none of which had been high outliers in the previous year. A few Trusts were outliers in more than one category - one Trust was a high outlier in all the three categories, one Trust was an outlier in both knee prosthesis and hip hemiarthroplasty and one Trust was an outlier in both hip and knee prosthesis. These Trusts are aware that their rates may be comparatively high and should be taking action to investigate and address any problems identified.

A number of Trusts had rates that fell below the lower 95% control limit. In some this is likely to reflect high standards of clinical practice; however these rates may also have been influenced by a combination of other factors, such as short post-operative hospital stays and poor case ascertainment. These Trusts have already been alerted and have been asked to confirm that they are following the SSI surveillance protocol.

Figure 5: Cumulative incidence of SSI in hip prosthesis plotted against the number of operations by Trust, April 2006 to March 2007

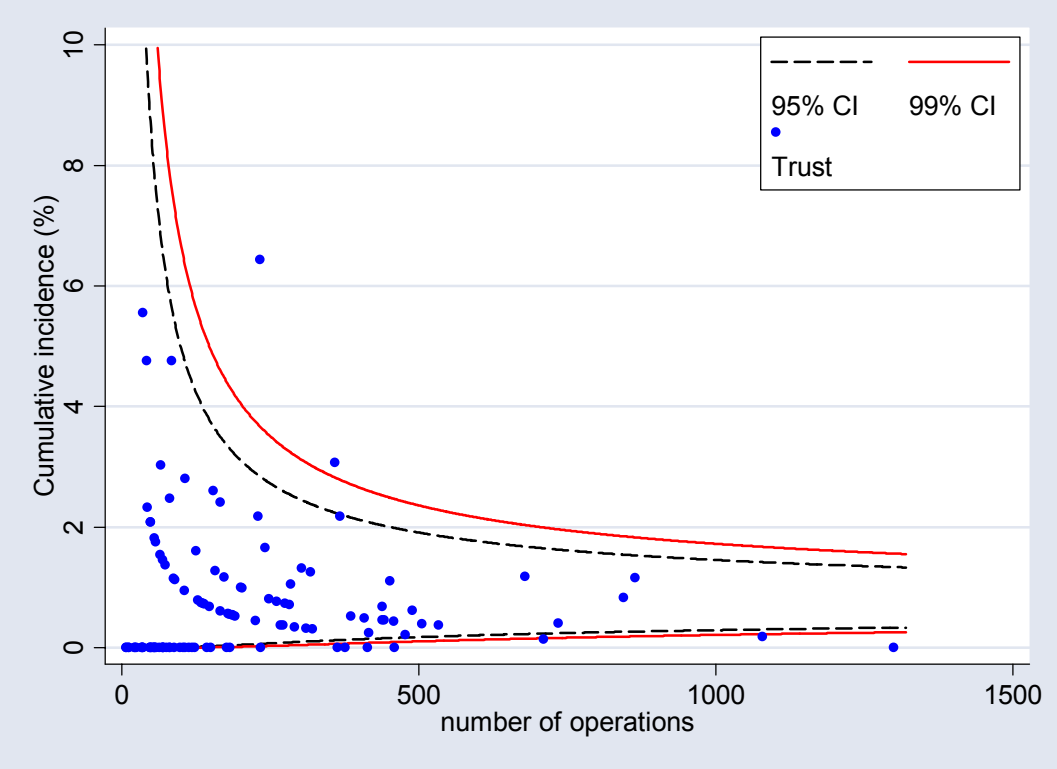


Figure 6: Cumulative incidence of SSI in hip hemiarthroplasty plotted against the number of operations by Trust, April 2006 to March 2007

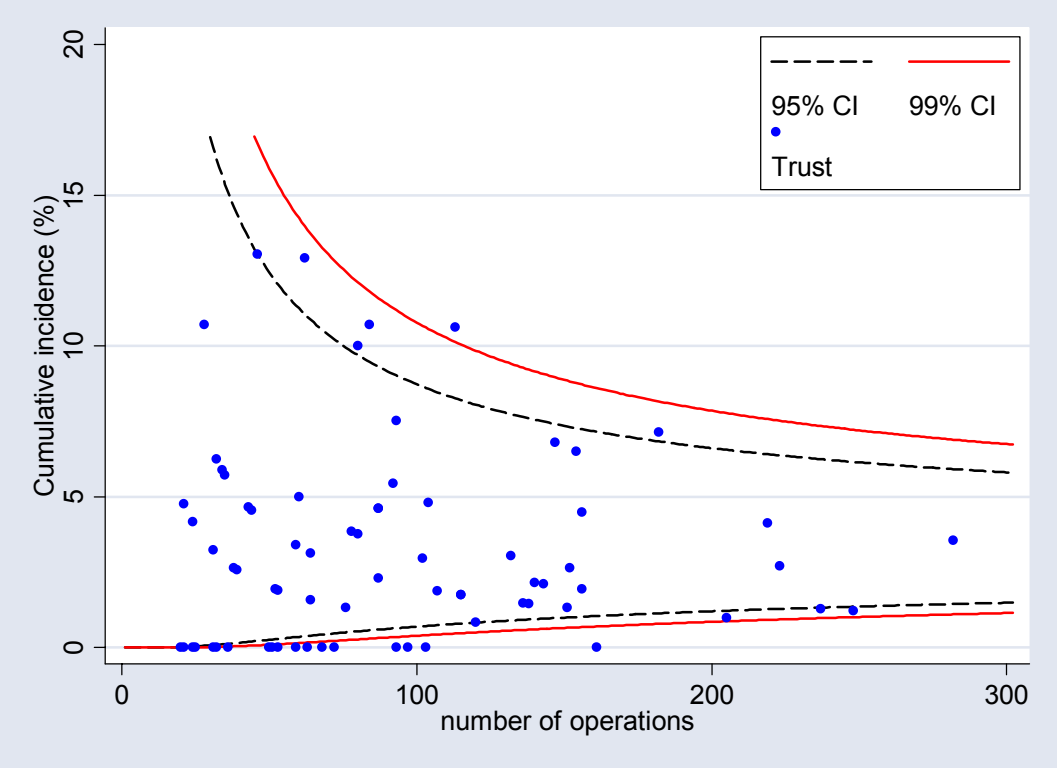


Figure 7: Cumulative incidence of SSI in knee prosthesis plotted against the number of operations by Trust, April 2006 to March 2007

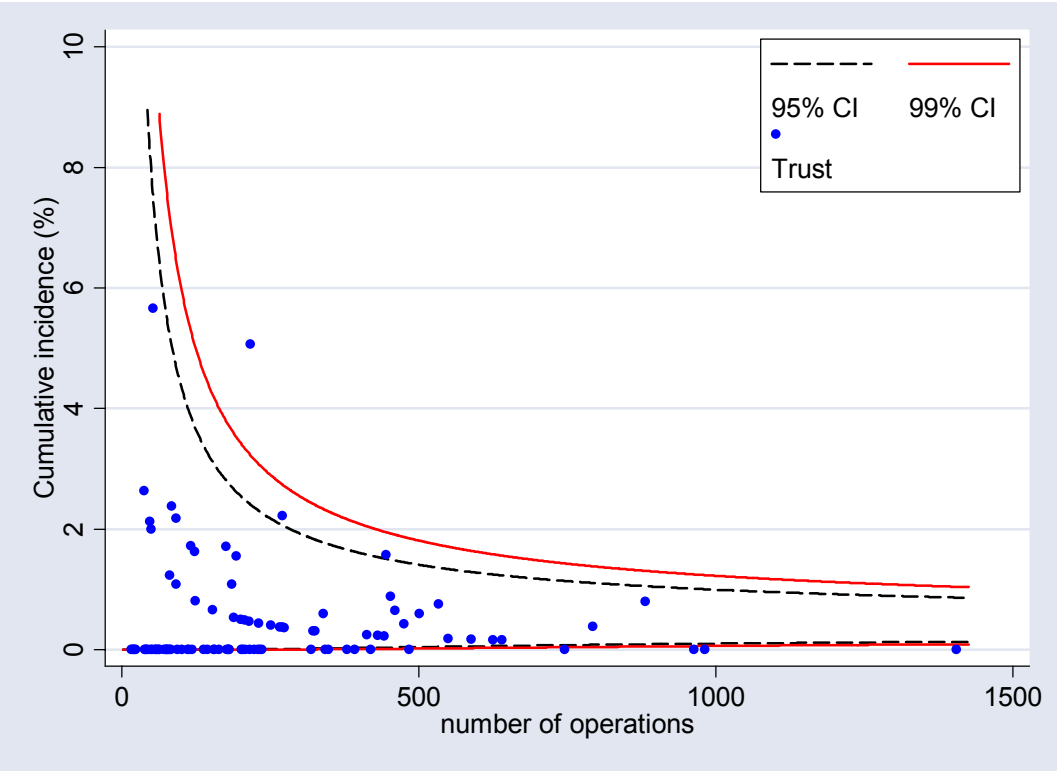
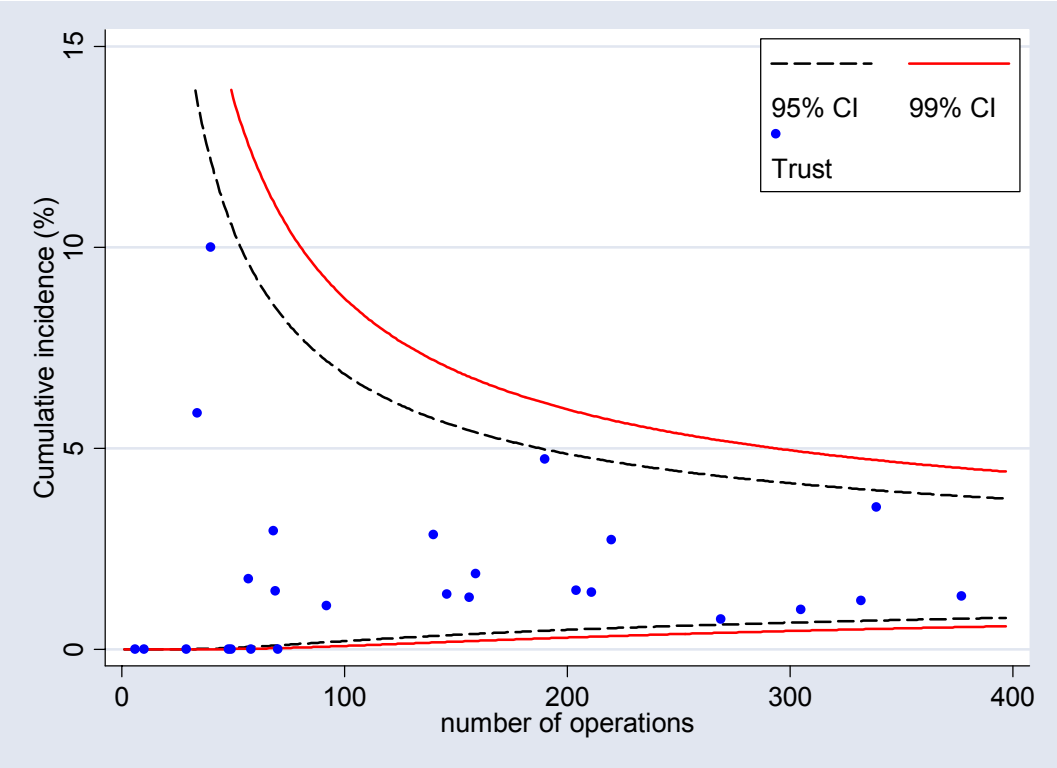


Figure 8: Cumulative incidence of SSI in open reduction of long bone fracture plotted against the number of operations by Trust, April 2006 to March 2007



5. Conclusions

In this third year of mandatory surveillance of SSI in orthopaedic surgery data have been collected on more than 60,000 operations by 150 NHS Trusts. The results suggest the rate of SSI in these procedures has decreased over the last three years, although some of this decrease may be related to reductions in post-operative stay in hospital.

Many Trusts now undertake surveillance on orthopaedic surgery continuously throughout the year. The average number of procedures per Trust per quarter varies, but in many cases is fewer than one hundred for a particular category. Where the number of procedures is low, the rate of SSI cannot be estimated precisely and this must be taken into account when comparing rates between Trusts. A more precise estimate can be obtained where the surveillance is continued for longer.

The ability of Trusts to compare their rates of SSI with others depends on the robust application of a standard method of identifying and reporting SSI. Consequently the SSISS places a high priority on Trusts adhering to the standard SSI surveillance protocol. However, there is evidence that some Trusts may be under-reporting rates of SSI and this emphasises the importance of ensuring data collection methods are robust if reliable inter-hospital comparisons are to be made.

Most of the SSIs reported affected the superficial layers of the wound. These are likely to resolve with minimal long-term adverse effects on the patient. However, approximately a quarter involved the deeper tissues. These infections are of concern because they are more difficult to treat and may require subsequent re-operation. *S.aureus* are commonly found on the skin and hence surgical wounds are vulnerable to infection caused by these micro-organisms. *S.aureus* was reported as the cause of half of SSI and a high proportion of these were methicillin-resistant strains. This demonstrates the continued importance of national strategies to reduce the risk of infections caused by MRSA.

Rates of SSI were higher in hip hemiarthroplasties, which are generally undertaken following a traumatic injury to the hip. This is partly explained by patients undergoing these procedures being at greater risk of SSI due to their increased age and other underlying conditions. In addition, their post-operative stay in hospital is longer than those patients undergoing elective hip or knee replacement and therefore the chance that SSI will be detected by this surveillance is increased.

In most Trusts the rates of SSI in orthopaedic surgery were found to be low and comparable with rates reported by other countries in Europe[8]. However, since the surveillance detects only those SSI that develop during the post-operative hospital stay they are likely to be an underestimate. In recent years the length of post-operative stay has reduced considerably for many elective surgical procedures. The median length of stay for patients included in this surveillance has decreased by one day between the first and third year of the mandatory surveillance (from 7 to 6 days) for both hip and knee prosthesis surgery. Changes in length of stay affect the interpretation of rates of SSI over time and may, at least partially, explain the reductions in rates of SSI seen in orthopaedic surgery between the first and third year of this surveillance.

Overall, eight Trusts were identified as having unusually high rates of SSI. Whilst these rates may still reflect chance or risk factors for SSI in their patients, rather than poor performance, the possible reasons underlying the rate should be investigated and action taken to ensure optimal infection control practice. It is reassuring that in most Trusts identified as high outliers in previous years the rates of SSI have subsequently reduced.

6. References

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7. Glossary of terms

Cumulative incidence
The total number of surgical site infections (identified during the hospital admission) as a proportion of the total number of patients undergoing a procedure in the same category of surgery. This is usually expressed as '% infected'.

Incidence density
The total number of surgical site infections (identified during the hospital admission) as the proportion of the sum of post operative days contributed by each patient that was followed-up whilst in hospital. This is expressed as the number of infections per 1000 in-patient days.

Confidence and Control Limits (CL)
The 95% confidence limits provide a guide to the precision of the rate estimate based on the number of procedures. Given the level of confidence, they indicate that the 'true' rate could lie anywhere between the lower and higher confidence limit. Control limits (CL) are equivalent to exact binomial confidence limits at 95% (warning) and 99% (action). The probability of a rate lying above the 95% CL by chance is less than 5% and above the 99% CL, less than 1%.

Risk Ratio
This is one type of a relative risk measure. This is the risk of an event, such as an infection, in a group of subjects ('exposed' group) compared to a different group of subjects ('non-exposed' group). A risk ratio if 1 indicates that there is no difference in risk between the two groups. A risk ratio greater than 1 indicates that the risk of an event, such as an infection, is greater in the 'exposed' group compared to the 'non-exposed' group. A risk ratio lower than 1 indicates that risk is higher in the 'non-exposed' group compared to the 'exposed' group.

P-value
This measures the probability of obtaining a particular result (i.e. a risk ratio value) as extreme or more extreme than that determined by chance alone, *if* such a result does not occur in the true population (i.e. if the Null Hypothesis is true). The significance level for the p-value is conventionally set at a low level (i.e. less than or equal to 0.05). This means that we are prepared to accept no more than a 5% chance of being wrong in claiming that our observed result is true. If the p-value for a given risk ratio is less that 0.05, this indicates that our data provides us with sufficient evidence to reject the Null Hypothesis.

Hip hemiarthroplasty
This is a surgical procedure in which the damaged or diseased head and neck of the femur are removed and replaced with a prosthesis. The procedure is commonly carried out on elderly patients who have fractured the neck of femur as a result of a fall.

Open reduction of fracture
This is a surgical procedure to repair a fractured bone using plates, screws or rods to stabilise the bone.

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