

## Original Research Article

# Surgical site infections in clean and clean contaminated surgeries in a tertiary care teaching hospital

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## ABSTRACT

**Background:** Despite major advances in infection control interventions, health care-associated infections (HAI) remain a major public health problem and patient safety threat worldwide. Surgical site infections (SSI) are among the most commonly reported Hospital acquired infections (HAI).

**Methods:** This was a prospective observational study conducted in a tertiary care hospital over a period of one year from May 2019 to April 2020. Total 2382 patients who underwent clean and clean contaminated surgeries were included in the study. The data on demographics, type of surgery, duration of surgery, day of SSI event, use of prosthesis, comorbidities, post-operative stay and resuturing was collected and analyzed. From suspected patients of SSI, pus aspirate/swab was sent for culture and susceptibility.

**Results:** Total 2382 clean and clean contaminated surgeries were included in the study. The incidence of SSI was 2.05%. Association between SSI and gender, age group and whether the surgeries were planned or were emergency surgeries was noted. In 37 (75.51%) patients who developed SSI the post-operative stay was prolonged (>7days). 3 (6.1%) patients had to undergo resuturing due to gaping in the surgical wound. 18(36.73%) cases of SSI were diagnosed after discharge from hospital. The predominant organism causing SSI was *Escherichia coli* followed by *Staphylococcus aureus* and *Coagulase negative Staphylococcus* (CONS).

**Conclusions:** Regular surveillance of SSI with feedback of appropriate data to the stakeholders is desirable to reduce SSI rate. Post patient discharge, surveillance of SSI is challenging but it needs to be addressed by infection control team to identify cases of SSI accurately.

**Keywords:** Surveillance, Surgical antibiotic prophylaxis, Surgery, Comorbidities

## INTRODUCTION

Health care-associated infections (HAI) are a major public health problem. Even after infection control interventions it still remains a major threat to patient safety.<sup>1,2</sup>

Surgical site infections (SSI) are one of the most common HAIs.<sup>3</sup> Incidence varies worldwide. It is estimated that SSI occurs in at least 2% of surgeries.<sup>4</sup> SSI incidence is

higher in developing countries.<sup>1</sup> In India the risk of acquiring SSI ranges from 4%-30%.<sup>5</sup> In India surveillance data is still scanty and prevention of HAI is not always prioritized.<sup>1,6</sup> SSI and its adverse effects on patients and healthcare system can be prevented by evidence based surveillance system. This will ensure patient safety and reduce the additional financial burden. Ultimately it will assist in improving quality of health care.<sup>4</sup>

Across the globe, SSIs are associated with increased morbidity; sequelae, which include revision surgeries, poor quality of life, prolonged antibiotic treatment and rehabilitation along with associated loss of work and productivity.<sup>8</sup> SSIs are associated with a substantial economic burden to the individual as well as the healthcare system due to increased length of hospital stay and increased risk of readmission.<sup>9,10</sup>

Surgical site infection are the infections following an invasive surgical procedure. It is defined as an infection that occurs within 30 days of operation without implant or 1 year of operation if implant is left in place after the procedure.<sup>11</sup> These infections can be superficial or deep incisional infections, or infections affecting organs or body spaces. As per CDC SSIs are classified as clean, clean contaminated, contaminated and dirty.<sup>12</sup>

Control of post-operative complications is an essential component of providing quality care to patients. It is very crucial to determine the prevalence of surgical site infections. This will assist in understanding the magnitude of the problem and to formulate appropriate infection control protocols in health care settings.<sup>13</sup> Knowledge about the organisms causing SSI and its antibiotic susceptibility pattern will assist to track trends in local antimicrobial resistance patterns and can provide insights into the pathogenesis of SSI. Accordingly locally relevant infection control and SSI preventive strategies can be implemented. This will also assist in early detection of any outbreak.<sup>14</sup>

This study was conducted in a tertiary care hospital to determine the prevalence of surgical site infections and associated factors in clean and clean contaminated surgeries. The Microbiological profile of these surgical site infections was also studied.

## METHODS

This was a prospective observational study conducted in a tertiary care hospital over a period of one year from May 2019 to April 2020. Universal sampling was employed for the study duration. The study was approved by the Institutional Ethics Committee.

**Inclusion criteria:** Adult patients (age  $\geq 18$  years) who underwent clean OR clean contaminated surgeries (classified as per Centre for Disease Control (CDC) guidelines) either elective or emergency surgical procedures from general surgery, gynecology /obstetric and orthopedic departments.<sup>12</sup>

**Exclusion criterion:** Contaminated and dirty surgeries as per the CDC guidelines were excluded.<sup>12</sup>

### Methodology

This study was carried out in a tertiary care hospital. List of surgeries was received from operation theatre on daily

basis. From this list only clean and clean contaminated surgeries were selected. Data regarding demographic details, type of surgery performed, whether emergency or planned surgery, the duration of surgery, surgical antibiotic prophylaxis given, duration of preoperative stay, presence of co morbid conditions and the duration of post op stay was collected.

All the patients included in the study were monitored in the ward for the development of signs and symptoms of SSI by infection control nurse and microbiologist on a daily basis during the patient's hospital stay.

Post-operative monitoring of patient was done for 30 days for surgeries without implant and for 1 year for surgeries with implant. OPD dressing register was maintained in all surgical OPDs.

Any sign of SSI was looked for when the patient came post-operative to the OPD for dressing. Also, a call was made to all patients 30 days after surgery to ensure that SSI has not developed. SSI was diagnosed based on CDC guidelines.<sup>12</sup> Surgeons were instructed to report and fill up SSI reporting form whenever there was suspicion of SSI. Samples from these patients were then collected by aspiration or with the help of sterile swab from the affected site with full aseptic precautions and sent immediately for processing to the microbiology laboratory.

In the laboratory standard procedures were followed for identification of the infecting organism.<sup>15,16</sup> Antibiotic susceptibility test was performed by Vitek II as per CLSI guidelines.<sup>17</sup>

### Statistical analysis

Data was entered in excel sheet and analyzed using SPSS version 17. Categorical variables have been expressed as frequencies and percentages.

## RESULTS

Total 2382 clean and clean contaminated surgeries were included in the study. Out of these 49 patients developed SSI. The incidence of SSI was 2.05%. There were 1298 (54.50%) male patients, out of which 9 (0.69%) developed SSI. While out of 1084 (45.50%) female patients 40 (3.70%) developed SSI. The age of the patients in the study ranged from 18 years to 75 years. Out of 49 patients who developed SSI, 21 were in the age group of 21-30, 13 were between the age group of 31-40, 8 were between the age group of 41-50, 4 were between the age group of 51 to 60 and 3 patients were above 60 years of age. The incidence of SSI in planned surgery was 1.64%, while the incidence in emergency surgery was 3.08%.

When SSI was analyzed department wise (Table 2), 30 (61.22%) were reported following Obstetrics and

gynecology surgeries, 10 cases of SSI (20.41%) followed general surgery and 9 (18.37%) followed orthopedic surgeries. The duration of surgery ranged from 20 min to 6.5 hours. 7 (24.49%) patients with SSI had undergone

surgery lasting for  $\leq 60$  minutes while 42 (85.71%) patients with SSI had surgeries, lasting for more than 60 minutes.

**Table 1: Characteristics of the participants**

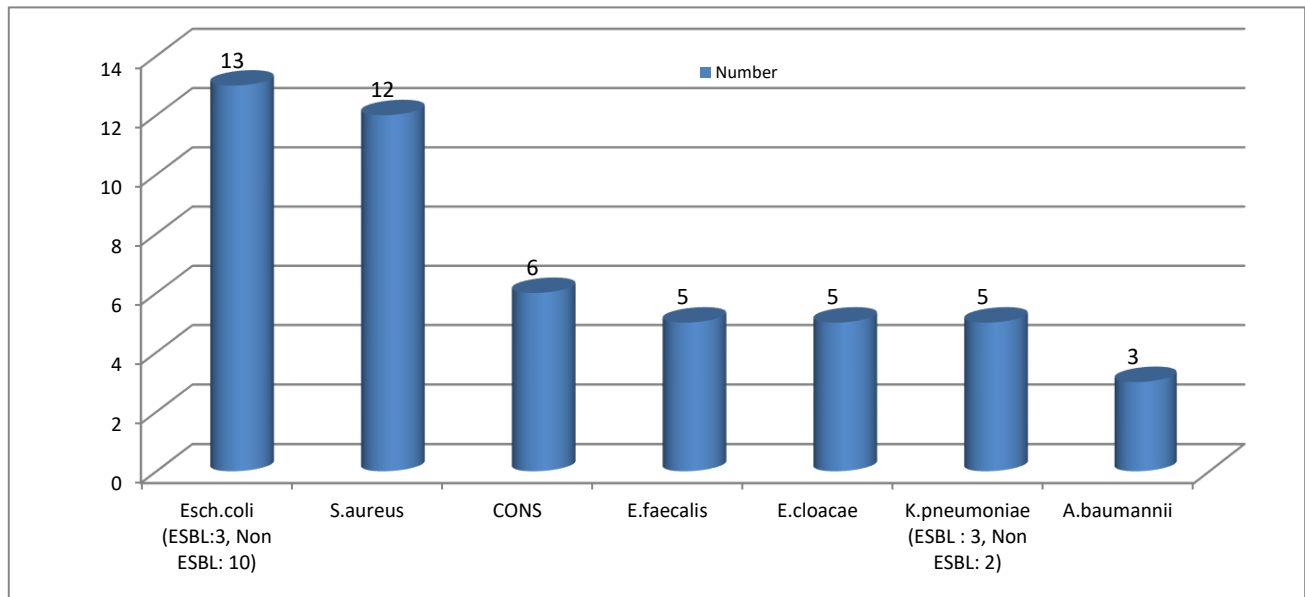
Characteristics		Total number of patients (n= 2382)	Total number of cases With SSI (n=49)	Total number of cases without SSI (n=2333)
		N (%)	N (%)	N (%)
<b>Gender</b>	Male	1298 (54.50)	9 (0.69)	1289 (99.31))
	Female	1084 (45.50)	40 (3.70)	1044 (96.30)
<b>Age (in years)</b>	18-20	430 (18.05)	3 (0.70)	427 (99.30)
	21-30	648 (27.20)	21 (3.24)	627 (96.76)
	31-40	639 ((26.83)	13 (2.03)	626 (97.97)
	41-50	384 (16.12)	8 (2.08)	376 (97.92)
	51-60	281 (11.80)	4 (1.42)	277 (98.58)
	>60	290 (12.17)	3 (1.03)	287 (98.97)
<b>Operation category</b>	Planned	1770 (74.31)	28 (1.58)	1742
	Emergency	616 (25.86)	21 (3.40)	595 (96.60)

**Table 2: Analysis of surgical site infections (n=49).**

		N (%)
<b>Department</b>	Obstetrics and Gynaecology	30 (61.22)
	General surgery	10 (20.41)
	Orthopaedics	9 (18.37)
<b>Surgical antibiotic prophylaxis</b>	Yes	39 (79.60)
<b>Stopped within 24 hrs</b>	No	10 (20.4)
<b>Duration of surgery</b>	$\leq 60$ min	7 (14.29)
	$> 60$ min	42 (85.71)
<b>Prosthesis</b>	Yes	7 (18.28)
	No	42 (85.71)
<b>Comorbid conditions</b>	Yes	7 (18.28)
	No	42 (85.71)
<b>Diagnosis of SSI</b>	During hospital stay	31 (63.27)
	After the discharge	18 (36.73)
<b>Post-operative stay in days</b>	$\leq 7$	12 (24.49)
	$> 7$	37 (75.51)
<b>Post-operative day of SSI event</b>	$\leq 5$	9 (18.37)
	6-10	24 (49.00)
	11-15	9 (18.37)
	16-20	2 (4.08)
	21.-25	2 (4.08)
	26-30	1 (2.04)
	$> 30$	2 (4.08)
<b>Comorbid conditions</b>	Yes	17 (34.7)
	No	32 (65.31)
<b>Resuturing</b>	Yes	3 (6.12)
	No	46 (93.88)

In 24 (49%) patients SSI developed between 6- 10 days after the surgery, followed by 9 (18.37%) patients who developed SSI (4.08%) between  $\leq 5$  days after surgery, 2 (4.08%) cases of SSI were seen between 16-20 days of surgery, 2 (4.08%) between 21-25 days of surgery, 1

(2.04%) patient developed SSI between 26-30 days of surgery while only 2 (4.08%) patients developed SSI after 30 days of surgery.



**Figure 1: Causative organisms of SSIs.**

7 (18.28%) patients who developed SSI had prosthesis (Table 2).

Resuturing was required in 3 (6.12%) patients who developed SSI. In 31 (63.27%) patients SSI was diagnosed when they were admitted in the hospital and in 18 (36.73%) patients it was diagnosed after the discharge. In 12 (24.49%) patients post-operative stay was  $\leq 7$  days, but in 37 (75.51%) patients the post-operative stay in the hospital was extended to more than 7 days. (Table 2)

17 (34.69%) patients who developed SSI showed co morbidities. Diabetes was present in 8 patients and anemia in 6 patients with obesity in 2 patients and hypothyroidism in 1 patient.

Of the isolates from cases of SSI *Escherichia coli* was isolated in 13 cases (26.53%), followed by *Staphylococcus aureus* in 12 (24.49%), *Coagulase negative Staphylococcus* in 6 (12.28%), *Enterococcus faecalis* in 5 (10.20%), *Enterobacter cloacae* in 5 (10.20%), *Klebsiella pneumoniae* in 5 (10.20%), and *Acinetobacter baumannii* in 3 (6.12%) patients.

Out of total *Staphylococcus aureus* isolated 8 (66.67%) were *Methicillin resistant Staphylococcus aureus* (MRSA) and 4 (33.33%) were *Methicillin sensitive Staphylococcus aureus* (MSSA). 10 (77%) *Escherichia coli* isolates were ESBL producers, while in *Klebsiella pneumoniae* 3 (60%) isolates were ESBL producers. 2 (40%) isolates of *Klebsiella pneumoniae* were carbapenem resistant and 3 (23.08%) isolates of *Escherichia coli* were carbapenem resistant. *Acinetobacter* showed 66.67% resistance to carbapenems.

## DISCUSSION

Post-operative SSI remains one of the most significant causes of morbidity among surgically treated patients. These patients incur higher costs due to longer hospitalization, more nursing care, additional wound care, potential hospital readmissions and further surgical procedures.<sup>18</sup>

With this background, the present study was conceptualized and conducted to determine the incidence of SSI in clean and clean contaminated surgeries over a period of one year. The incidence of SSI in India ranges from 4.04 % to 30 %.<sup>19</sup> In our study the incidence of SSI in clean and clean contaminated surgeries was 2.05% (49/2382). In a similar study by Madhusudan et al the incidence of SSI was 12%, which is higher than our study.<sup>20</sup> They had included 242 surgeries in their study. In another study which was conducted in Mumbai, the incidence was 3.03% in clean surgeries and 22.41% in clean contaminated surgeries.<sup>21</sup> Our SSI rate was lower than other studies. We could achieve this with regular surveillance of SSI, in depth root cause analysis and strict implementation of infection control practices.

In present study, the incidence of SSI in females was 3.70% and in males the incidence was 0.69%. Female preponderance in our study could be due to a greater number of infections occurring in obstetrics and gynecology surgeries. Similar preponderance in females was reported by Jain et al.<sup>14</sup> In their study out of 108 females who underwent surgery 8 (7.4%) developed SSI. In another Indian study in Mysore by Shetty NH et al significant proportion of males developed SSI compared to females.<sup>32</sup> According to Berard and Gandon sex is not a pre determinant of the risk of SSI.<sup>33</sup>

Maximum infections (27.20%) were seen in the age group of 21-30 years. More number of SSI were reported from lower section caesarian section, which explains the predominance in this age group. In study by Shetty NH et al higher proportion (63.15%) of SSI was found among the subjects older than 50 years. Other studies also reported a greater number of SSI in older age groups.<sup>32</sup> This is due to reduced immune response and associated comorbidities in old patients.<sup>34</sup>

There was high incidence of SSI in emergency surgeries (3.40%) as compared to planned surgeries (1.58%). Misha et al also reported more SSI in emergency surgeries. In their study out of 84 planned surgeries 8 (9.52%) developed SSI, while out of 167 emergency surgeries 45 (26.95%) developed SSI.<sup>1,18</sup> This could be due to the fact that in emergency procedures there was compromise on pre-operative skin preparation.

In our study out of all surgeries, maximum SSI was reported from obstetrics and gynaecology (61.22%, n=30) followed by general surgery (20.41%, n=10) and orthopedics (18.37%, n=9).

Wound classification and surgical duration are well documented SSI risk factors.<sup>22</sup> Surgeries longer than 2 to 3 hours increase SSI risk.<sup>23,24</sup> During surgery patient is exposed to potential contamination from time of incision to closure.<sup>25</sup> Tissue exposure and trauma also lowers tissue viability. Moreover, surgical duration is highly indicative of procedure complexity and technique used.<sup>25</sup> When we calculated duration of surgeries, in 42 (85.71%) surgeries the duration of surgery was more than 60 min and in 7 (14.29%) surgeries the duration of surgeries was ≤60 minutes. In another study by Pathak et al the duration of surgery was <60 minutes in 79.4% of surgeries and >60 minutes in 20.6% surgeries.<sup>26</sup> Ours is a teaching hospital, this could be the reason for more duration of surgeries in our study.

7 (18.28%) patients who developed SSI had prosthesis implanted during surgery. Of these, 4 (57%) cases were Umbilical hernia repair with mesh and remaining patients had Orthopedic implant related SSI.

In 24 (49%) patients SSI took place between 6-10 days after the surgery. On in-depth root cause analysis, it was noted, more SSIs were diagnosed after 1st dressing.

The impact of SSI on health system was studied. During the post-operative period resuturing was required in 3 (6.12%) patients who developed SSI. As a routine practice, patients who undergo clean and clean contaminated surgeries without any complications are discharged within 7 days in our hospital. In the present study, out of total patients who developed SSI, 37 (75.51%) patients had post-operative stay of >7 days. Several studies consistently demonstrated that hospitalization was prolonged for patients who developed SSI following surgery compared with uninfected

patients.<sup>27,28</sup> There was no mortality in patients who developed SSI in our study

The most common isolate in our study is *Escherichia coli* followed by *Staphylococcus aureus*. Similar observations were also reported by Patel et al and Misha et al.<sup>18,31</sup> Jain et al reported *Coagulase negative Staphylococcus* and *Escherichia coli* as predominant isolates while Madhusudan et al, from Puducherry, isolated *Staphylococcus aureus* most commonly from their study on surgical site infection.<sup>14,20</sup> This variation in bacterial flora could be due differences in study setting and population.

### Limitations of our study

We could not compare all the risk factors between patients who developed SSI and patients who did not develop SSI. Also, in this study we have not included contaminated and dirty surgeries. These limitations will be addressed in our future study.

### CONCLUSION

In our study association of the type of surgery, age and gender with SSI was observed. Due to SSI, post-operative stay in the hospital was increased. With good surveillance system we could diagnose SSI cases even after the discharge from the hospital. Regular surveillance of SSI with feedback of appropriate data to the stakeholders is desirable to reduce SSI rate. Post discharge surveillance of SSI is challenging and it should be addressed by infection control team for accurate mapping of SSI.

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