Original Article

Determinants of superficial surgical site infections in abdominal surgeries at a Rural Teaching Hospital in Central India: A prospective study

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Abstract

Introduction: Abdominal surgeries have high rate of surgical site infection (SSI), which leads to significant morbidity and financial burden. There is paucity of studies on SSI in rural Indian setup, where there is scarcity of adequate resources. The aim of this study was to determine the incidence and determinants of SSI after abdominal surgeries in a rural setup. **Aim:** To determine the incidence of and associated risk factors for superficial SSIs in abdominal surgery cases at a central Indian rural teaching hospital. **Methods:** This cohort study included 100 patients undergoing abdominal surgery between April 2016 and May 2017 at a central Indian rural teaching hospital. The outcome of interest was superficial SSI and the factors associated with it. Association between risk factors and SSI was calculated using either Chi-square test or odds ratio with 95% CI. **Results:** The cumulative incidence rate of superficial SSI was 39% with 95% CI (29.4%–49.2%). The analysis defined 12 variables significantly associated with superficial SSI: middle or elderly age, male gender, diabetes mellitus, preoperative anemia, preoperative hypoalbuminemia, tobacco smoking, higher ASA score, perioperative blood transfusion, drain placement, surgery duration >2 h, contaminated/dirty wound class and emergency surgery. However, economic status and BMI grade of the study subjects were not associated with development of superficial SSI.

Keywords: Abdominal surgery, ASA score, rural hospital, surgical site infection

Introduction

Surgical site infection (SSI) is described as the infection that develops in a surgically created wound. SSI is the most frequently reported Hospital acquired infection in lower and middle income countries and the level of risk is significantly higher than developed countries.[1] The pooled SSI incidence is 11.8% in lower- and middle-income countries.[2]

Abdominal surgeries in particular have high chance of developing SSI.[3] Mortality resulting from SSIs is only tip of the iceberg; the more submerged problems are increased hospital stay, re-operation, re-admission, limitation of quality of life, and loss of daily wages, which, in turn, leads to financial and social catastrophe for the families.[4] This would eventually inflate the cost of healthcare, especially in rural setting. Hence, SSIs also serve as the measure of quality of care provided by the hospitals.[5]

In India, SSIs are one of the leading causes of morbidity and mortality.[6,7] The SSI rate in India widely varies and depending on setting, ranges from 1.6% to 38%.[7-10] This variability can be due

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to differences in the characteristics of the hospital population, differences in clinical procedures, infection control measures, and hospital environment.

Approximately 70% of India's population lives in rural areas, where accessibility to quality health care is lacking.[11] Data on SSI rates is mainly based on information obtained from tertiary centers located in urban areas in the country. The SSI data coming from rural hospitals of India are meager. Hence, results may not reflect the true magnitude of the SSI burden. With this background, this study was planned to estimate the incidence rate and associated determinants of SSI, in a rural teaching hospital from Central India (April 2016–May 2017). The findings of study will not only help to determine the burden of SSI in rural setting but also help device strategies for infection control and provision of quality healthcare services to people, who access resource constrained rural hospitals of India.

Methods

Study setting

General setting

This study was carried out in a rural teaching hospital in Central India. The population of district is 1,300,774 with 67.46% population living in rural area. The literacy rate among male and female is 91.92% and 81.81%, respectively.[12] Almost one-third of the district population is below poverty line (BPL).

Specific setting

There are 28 Primary Health Centers, 2 teaching hospitals, and 1 district hospital, which provide healthcare services to the population of the district. This study was carried out in one of these teaching hospitals of the district, which has 700 beds and provides healthcare services approximately to 10 lac rural population.

Study period and population

The study was carried out over a period of 1 year from April 2016 to May 2017. All the patients, who underwent abdominal surgery, in the department of surgery, during the study period were invited to participate in the study. Patients were recruited in study only after obtaining an informed written consent for the same. Those patients who were not able to understand the purpose of study, consent was obtained from their relatives/legal guardians.

Those who underwent laparoscopic surgery, received antibiotics for duration of >1 week before surgery, reoperative surgery, who had ongoing infection at surgical site, failed to comply for follow-up, patients receiving corticosteroids, had American society of Anesthesiologists (ASA) class 5 or above and those who did not give consent were excluded from the study [Figure 1].

All the patients included in study received prophylactic antibiotics at the time of induction for surgery. In clean and clean contaminated cases, only preoperative prophylactic antibiotics

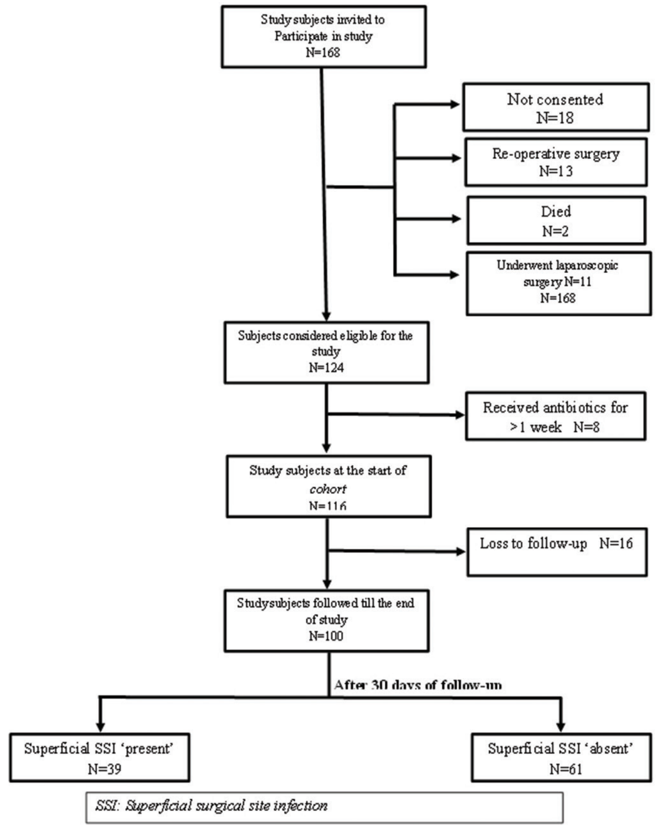

Figure 1: Flowchart depicting flow of patients from start to final outcome in this cohort study carried out in a teaching hospital of Central India

were given. In contaminated and dirty cases, antibiotics were continued postoperatively till 5 days.

Study design

This was a cohort study.

Sampling technique and sample size

This study had a convenient sampling design. In total, 168 patients underwent abdominal surgery during the study period. After exclusion as per protocol, 124 eligible subjects formed the study cohort.

Subjects who continued to receive antibiotics for >1 week and those lost to follow-up were further excluded from the study. In total, 100 patients were studied [Figure 1].

Data collection method and tool

Data were collected by using pretested and predesigned questionnaire. The data were collected in three phases. In first phase, data were collected during preoperative period, in second phase during the operation, and in third phase during the postoperative period, from the day after surgery to 30th day after the surgery. The first phase contained the information pertaining to predictor variables which included sociodemographic profile, biomedical characteristics of the subject, i.e. the body mass index, past medical history of diabetes, history of smoking tobacco, anemia, and hypoalbuminemia.

The information related to type of surgery, i.e. elective or emergency, indication for surgery, ASA class, and blood transfusion was recorded before surgery. Intraoperatively information regarding drain placement, wound class, and duration of surgery was recorded in second phase. Each patient was followed up from time surgery until 30-day postoperatively. The outcome of interest in postoperative follow-up was superficial surgical site infection. During this follow-up, surgical wound was inspected at the time of first dressing and weekly thereafter till 30-day postoperatively.

Superficial surgical site infection was diagnosed if it was confined to skin and subcutaneous tissue with any one of the following criteria, as per CDC definition was fulfilled: 1) purulent drainage, with or without laboratory confirmation, from the superficial incision; 2) organisms isolated from an aseptically obtained culture of fluid or tissue from the superficial incision; 3) at least one of the following signs or symptoms of infection: pain or tenderness, localized swelling, redness, or heat and superficial incisions deliberately opened by surgeon, unless incision is culture-negative; and 4) diagnosis of superficial incisional SSI by the surgeon or attending physician.[13]

Statistical analysis

The data were entered and analyzed by using Epi_info (language en-US VERSION 7.2.1.0) software package. Frequency of all variables was derived to check completeness of data. Magnitude was expressed in percentages. The cumulative incidence rate of SSI was estimated. Relative risk (RR) was calculated for different risk factors to test the association of SSI with predictor variables. RR > 1 with the 95% confidence interval was taken as significant. Chi-square test was used to calculate the P value. P value < 0.05 was considered significant. The STROBE guidelines were used for reporting the study.[14]

Ethical consideration

An approval from Institutional Ethical committee was obtained before conducting the present study. Patients and/or relatives who needed any medical assistance were further appropriately managed in the department of surgery.

Results

In total, 168 patients underwent abdominal surgery during the study duration at a central Indian rural teaching hospital. Out of them 18 did not give consent, 13 had reoperative surgery, 2 patients died within 24 h of surgery, 11 underwent laparoscopic procedure, and 8 received antibiotics for >7 days. Hence, 52 patients were excluded from study and 16 patients were lost during follow-up [Figure 1].

The indications for surgery are given in Figure 2. Superficial surgical site infection was detected in 39 out of 100 patients (39%). The age of study subjects ranged from 3 years to 85 years. The mean age of study population was 46.4 ± 18.3 years. SSI was significantly higher in patients >50 years of age [Table 1]. SSI rate between male and female was 26% and 50%, respectively.

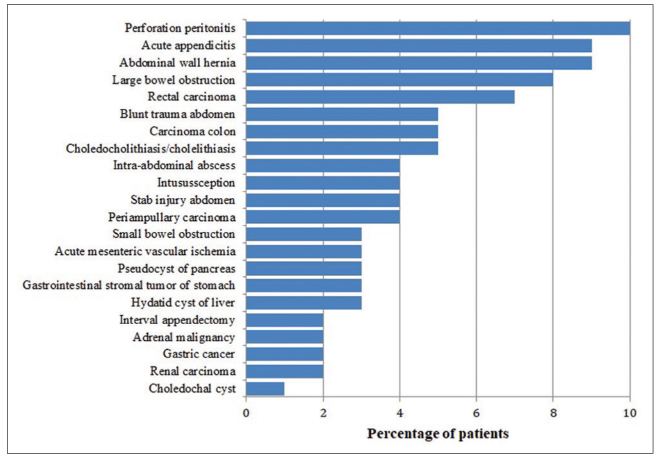

Figure 2: Proportion of patients with different indications for surgery (n = 100)

Table 1: Relation between SSI and sociodemographic factors

Risk factors	SSI (n=100)		Relative risk (95% CI)
	Yes (39)	No (61)	
Age (years)			
<50	17	44	Reference
>50	23	17	2.063 (1.27-3.34)
Gender			
Female	12	34	0.52 (0.29-0.9)
Male	27	27	Reference
Economic status			
Below poverty line	11	18	0.96 (0.55-1.66)
Above poverty line	28	43	Reference

SSI=surgical site infection; CI=confidence interval

Twenty-nine (29%) study subjects belonged to BPL and 71 (71%) were above poverty line (APL). SSI rate between BPL and APL subjects was 37.9% and 39.4%, respectively. There was no significant association between development of SSI and economic class of the study subjects (RR 0.96, CI 0.55–1.66).

Risk factors for SSI

Pre morbid illness [Table 2]

About 12 study subjects had diabetes, and 30 had anemia and hypoalbuminea. The SSI rate for these subjects was 66.6%, 73.3%, and 80%, respectively. These conditions were found to be significantly associated with development of superficial SSI.

The SSI rate for subjects having ASA score of 1 or 2 was 28.8% compared with 91.6% in subjects having ASA score of 3 or 4. There was significant association between higher ASA score and development of superficial SSI (RR 4.05, CI 2.65–6.33).

Body mass index

The study subjects were stratified according to BMI. Among the 100 subjects, 6 were underweight, 47 had normal BMI, 45 were preobese, and 11 were obese. The rate of superficial SSI among these BMI groups was 33.3%, 31.9%, 35.5%, and 54.5%, respectively. There was found to be no association between being underweight, preobese, or obese and developing superficial surgical site infection [Table 2].

History of cigarette smoking

In this study, 27 subjects had history of cigarette smoking. Of these, 16 (59.2%) developed superficial SSI. There was a statistically significant association between cigarette smoking and SSI (RR 1.88, CI 1.18–2.98).

Blood transfusion, use of drain

Thirty-five study subjects received blood transfusion. About 23 (65.7%) developed superficial SSI. This association was found to be significant ($P < 0.05$). Drains were placed in 33 study subjects following the surgery. Of these, 24 (72.7%) developed SSI.

Operative duration

The operative duration was >2 h in 17 study subjects. Rest of the 83 study subjects has operative duration of <2 h. The SSI rate of 32.5% in study subjects with longer duration of surgery was clinically significant (RR 3.24, CI 1.98–5.31).

Wound class

Among the 100 study subjects, 59 had clean and clean-contaminated wound class. About 41 had contaminated and dirty wounds. The superficial SSI rates in these groups were 23.7% and 60.9%, respectively. The SSI rate in contaminated and dirty cases was significantly higher (RR 2.57, CI 1.52–4.31).

Emergency versus elective surgery

The superficial SSI rate in elective surgery cases was 28% and in emergency surgery cases was 50% [Table 3]. The development of superficial SSI in emergency surgery cases was significantly higher (RR 1.8, CI 1.1–3.0)

Table 2: Relation between SSI and studied risk factors

Risk factors	SSI (*n*=100)		Relative risk (95% CI)
	Yes (39)	No (61)	
Body mass index			
Underweight	2	4	1.1 (0.2-6.4)
Normal	15	32	Reference
Preobese	16	29	1.2 (0.5-2.8)
Obese	6	5	2.5 (0.7-9.7)
Diabetes			
Yes	8	4	1.89 (1.15-3.09)
No	31	57	Reference
Smoking			
Yes	16	11	1.88 (1.18-2.98)
No	23	50	Reference
Anaemia			
Yes	22	8	3.02 (1.89-4.81)
No	17	53	Reference
Preoperative hypoalbuminemia			
Yes	24	6	3.73 (2.3-6.05)
No	15	55	Reference
Blood transfusion			
Yes	23	12	2.67 (1.63-4.34)
No	16	49	Reference
ASA score			
1 and 2	17	59	Reference
3 and 4	22	2	4.09 (2.6-6.33)
Drains			
Yes	24	9	3.24 (1.98-5.31)
No	15	52	Reference
Operative duration (h)			
>2	24	9	3.24 (1.98-5.31)
<2	15	52	Reference
Operation time			
Routine hours	15	39	Reference
Nonroutine hours	24	22	1.87 (1.12-3.13)
Wound class			
Clean and clean contaminated	14	45	Reference
Contaminated and dirty	25	16	2.57 (1.52-4.31)

SSI=surgical site infection; CI=confidence interval

Table 3: Relation between SSI and nature of surgery

Risk factors	SSI infection		Relative risk (95% CI)
	Yes	No	
Elective surgery	14	36	Reference
Emergency surgery	25	25	1.8 (1.1-3.0)

SSI=surgical site infection; CI=confidence interval

Discussion

In this study, most of the study subjects were in middle age group (30–60 years) and there was male preponderance. Most study subjects were from the rural background and 29% belonged to a lower socioeconomic class. The SSI rate found in this study was 39%. This was higher than the other similar studies performed in India.[7-9] This higher rate of SSI could be due to the rural setup of this study, where the patients usually present late in the course of disease, have significant comorbidities and lack of sanitation. The rate of SSI was significantly higher in male patients than in females. This could be explained by multiple risk factors in male subjects in this study, such as cigarette smoking, blood transfusion, etc., This can also be due to improved immune function in females and differences in skin colonization between males and females.[15,16]

A recent study have shown association between lower economic class and development of SSI.[17] No such association was found in this study. The reason for this is not known but could be due to difference in the study settings. This study did not find any association between SSI and BMI grading of underweight, preobese, and obese. Prior studies have shown association between obesity and SSI.[18,19]

Premorbid illnesses, such as diabetes, anemia, and hypoalbuminemia, have been shown to have high risk of developing SSI in the previous studies; this was confirmed in this study.[3,20-22] This could be attributed to impaired wound healing in the affected subjects. Cigarette smoking was found significantly associated with development of SSI. Smoking tobacco is known to cause reduced tissue oxygenation and immune impairment, which might be a reason for increased SSI.[23] Significant association was observed between higher ASA class and SSI. The overall poor general health of the study subjects with higher ASA class could be the reason for this association. Studies have shown that blood transfusion leads to immunomodulation, increased serum iron, and microcirculatory dysfunction, which can cause bacterial overgrowth.[24,25] In this study, perioperative blood transfusion was significantly associated with SSI.

In agreement with other studies, this study found that length of surgery >2 h doubles the risk of developing SSI. The increasing length of surgery can lead higher risk of SSI due to desiccation of tissues, increased bacterial exposure and decreased level of prophylactic antibiotic in the tissues.[26] In addition, use of drains has been reported to be associated with increased risk of SSI, which was confirmed by this study.[9,27]

Surgical wound classification has been the predictor of developing SSI.[28] Previous studies have shown higher risk of SSI in contaminated and dirty wounds.[3,9] Similar findings are echoed in this study. This is explained by the higher bacterial load in contaminated and dirty wounds as compared with clean and clean-contaminated wounds.[29] Studies have shown emergency surgery to be associated with significantly higher SSIs.[9,30] Our study found similar results. Nonroutine surgeries are performed in less than ideal conditions and without usual preoperative workup; this might contribute to higher SSI in these cases. Also, emergency surgeries are more likely to be associated with gross contamination and poor general health of patients, which are known risk factors for SSI.

The SSI rate was higher in this study. Better preoperative optimization, stringent quality control measures and training of hospital staff is needed to reduce the incidence of SSI in this hospital. This is one of the very few studies undertaken in resource constrained rural hospital. This study shows higher than normal SSI rate. It also identifies preoperative risk factors contributing to SSI. Early involvement of primary care physicians for optimization of known risk factors in patients planned for surgery can reduce the morbidity and cost of treatment. The strength of the study was that it was studied with robust methodology and medical comorbidities were included in the study.

SSI incurs heavy financial burden on patients and healthcare establishments.[4] SSI surveillance system is present in most urban tertiary care setups, but data from other resource constrained health establishments is lacking. Primary care physicians can contribute to the surveillance system and help in early detection and to know real burden of SSI. This would further strengthen the existing surveillance system, antibiotic policy, training, and quality control in low-resource setting hospitals.

The limitation of the study was that it was a single center study for duration of 1 year. It calculates cumulative incidence rather than actual incidence rate of SSI. Other known factors associated with SSI, such as preoperative shaving, antibiotic use, and hospital stay, were not studied. The patients lost to follow up could not be included in study, so inherent selection bias could not be completely ruled out.

Conclusion

Superficial SSIs are a major nosocomial infections based on this local institutional study. SSI incidence is higher than the other reported studies in India. Preoperative morbidity, smoking, blood transfusions, higher ASA class, use of drains, prolonged operative time, contaminated or dirty wound class, and emergency surgery were significantly associated with superficial SSI. Better preoperative optimization of comorbidities, quality healthcare, and robust surveillance is needed for SSI prevention and management in rural setting.

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Conflicts of interest

There are no conflicts of interest.

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