ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

A prospective study of post-operative surgical site infections after open gastrointestinal surgeries

Vijay Kumar Tekam[1], Priyanka Singh[2], Utkarsh Bhandhari[3], Ashok Kumar Rathore[4], Akshara Rathore[5]

[1]Associate Professor, [2]Assistant Professor, [3,4,5]Postgraduate Resident, Department of General Surgery, Gandhi Medical College and Associated Hamidia Hospital, Bhopal, Madhya Pradesh, India

Submission: 06-05-2023 Revision: 27-07-2023 Publication: 01-09-2023

ABSTRACT

Background: Surgical site infections (SSIs) are infections of the tissues, organs, or spaces exposed by surgeons while performing an invasive procedure. SSI is one of the most common healthcare-associated infections, but its importance as a health-care priority is not fully understood, and limited work has been published defining the role of surgeons in SSIs. **Aims and Objectives:** In the present study, we assess the burden of SSI after gastrointestinal (GI) surgery in a tertiary care hospital in the Central India. **Materials and Methods:** The present study was conducted on patients admitted to Gandhi Medical College-affiliated Hamidia Hospital, Bhopal, in the General Surgery Department. The study included 207 patients who underwent emergency/routine GI surgeries between September 2020 and April 2022. Patient characteristics and laboratory data were recorded on a pre-designed form, and all patients were evaluated postoperatively for soakage along with culture and antibiotic testing. **Results:** The overall incidence of SSI was 42.51% and its distributions between emergency and routine surgeries were 22.7% and 19.8%, respectively. SSI was predominant in male patients. White blood cell level was significantly associated between emergency and routine surgeries, while Hb level, serum protein level, and the time required for surgery were insignificant. SSI under contaminated dirty wounds was prevalent in both emergency and routine surgeries. *Klebsiella* was the most commonly isolated organism, followed by *Escherichia coli.* The commonly susceptible antibiotics have been found to be meropenem, pipzo, amikacin, and imipenem. Commonly resistant antibiotics were amoxiclav, ceftriaxone, linezolid, and doxycycline. **Conclusion:** This paper presents the incidence of SSI in the hospital setting of Central India and the factors that may contribute to the high incidence of SSI. Further research needs to be done to better understand how specific risk factors are responsible for post-operative wound infections in open GI surgery.

Key words: Surgical site infection; Routine surgery; Emergency surgery; Surgical site infection organism; Gastrointestinal surgery

Access this article online

Website:

http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v14i9.54675

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

According to the World Health Organization, nosocomial infections are the most common adverse events worldwide and are an important factor that can significantly affect patient safety.[1] One of the most common type of health care-associated infection is surgical site infection (SSI), especially in low-and middle-income countries.2 The occurrence of SSI prolongs the length of hospital stay and increases associated medical costs.[3] Although the risk of SSI can be minimized to some extent, its prevention is challenging as multiple risk factors are present throughout the perioperative period. The chance of SSI can be as high as 20% depending on the different types of intervention performed during the surgery. According to a study by Burke SSIs are considered the second most common cause of nosocomial infections.[4]

Address for Correspondence:
Dr. Ashok Kumar Rathore, Resident of Surgery, Department of General Surgery, Gandhi Medical College and Associated Hamidia Hospital, Bhopal - 462 001, Madhya Pradesh, India. **Mobile:** +91-8770063337. **E-mail:** dr.avi.rathore1777@gmail.com

SSI definitions can vary, ranging from relatively trivial wound emissions with no complications to serious conditions with a fatal outcome. With the different types of clinical manifestations of SSIs, they enter and invade different tissue depths and can have different effects, from a simple superficial skin infection to a severe and life-threatening sepsis.[5] However, the Center for Disease Control and Prevention in the US have attempted to standardize their definition, and they have classified SSIs into three categories: (1) Superficial incisional, (2) deep incisional, and (3) organ/space based on the depth of the tissue involved.[6] Typically, the presence of signs of inflammation or pus discharge arising (within 30 days) from a surgical incision that was primarily closed constitutes SSI.[7-9]

The development of SSIs in general depends on the interplay of four factors: (1) The inoculum of bacteria, (2) the virulence of bacteria, (3) the microenvironment of the surgical site, and (4) host defenses. From these four factors, many of the risk factors known to cause SSIs can be linked to their pathogenesis.[7] Furthermore, the presence of devitalized tissue, dead space (for example, poor technique), and necrotic tissue, as well as poor tissue perfusion and oxygenation (for example, COPD), results in a conducive microenvironment for the seedling of infection. Host factors that may decrease immunity — such as poor nutrition, as reflected by hypoalbuminemia, diabetes mellitus, smoking, cancer, extreme ages, and other comorbidities, which are reflected by a higher American society of anesthesiologists score — are at a much higher risk of developing SSIs.[7,10,11]

SSI occurs in all types of procedures, including clean surgery. SSI studies have most commonly focused on gastrointestinal (GI) surgery, which can result in a higher rate of SSI than other procedures. SSI is linked to 38% of deaths in patients with SSI.[12] The patients undergoing GI surgeries develop 12.2% SSIs, which result in prolonged hospitalization, increased morbidity and mortality, and increased surgery-related costs.[13] Among the types of GI surgery, colorectal surgery is the most concerning regarding the development of SSI due to the presence of multiple microbes in the colon and rectum. The previous studies have evaluated the incidence of SSI after various GI surgeries in diverse regions worldwide.[14-17]

The incidence of SSI after GI surgery in India has rarely been reported in the past few years. Considering the rapid development of perioperative management techniques, it is inappropriate to use the results of studies performed many years ago to guide present protocols for SSI prevention. Thus, there is an urgent need for the attainment of present data regarding SSI after GI surgery to provide guidance for SSI prevention and management.

Therefore, to reduce SSI, it is important to investigate risk factors for various types of GI surgeries. In this study, we tried to identify the incidence, various patient, and procedure-related factors that could have led to SSIs, the various organisms associated with the SSIs, and their patterns of sensitivity and resistance to various antibiotics. Since these factors keep changing with time, along with the causative organisms and their sensitivity patterns, through this study, we aim to provide essential data and tools to genuinely attempt to decrease the rate of infections and wound and tissue complications in our institute by suggesting remedial measures and possible modifications in our setup. Hence, we conducted the present work to study post-operative SSIs after open GI surgeries and assess various responsible factors for SSIs.

Aims

We aimed to study the post-operative surgical site infections after open gastrointestinal surgeries.

Objectives

To assess the incidence of surgical site infections and various responsible factors, after gastrointestinal surgeries.

MATERIALS AND METHODS

The present prospective and observational study was conducted in the Department of General Surgery at Gandhi Medical College and associated Hamidia Hospital, Bhopal, M.P., in accordance with the recommended ethical guidelines of the Institutional Ethics Committee. The study included 207 patients who undergone emergency/routine GI surgeries between September 1, 2020, and April 30, 2022. Patients who underwent gastrointestinal resection, open cholecystectomy, open appendicectomy, primary indication of trauma, and hernia repair with bowel resection were included in the study. We excluded patients with previous GI surgery, wound sites previously infected, laparoscopic GI surgeries, patients with HIV, steroid medications, operations with a primary indication classified as vascular surgery, gynecology, urology, or transplantation, cesarean sections, simple hernia repair, and patients younger than 12 years of age. Patients baseline data (gender, age, dates of admission, surgery, and discharge, comorbidities, cigarette, and alcohol use), operation details (wound class, surgical diagnosis and procedure, position in the surgical list, emergency or routine surgery, and duration of surgery), details regarding post-operative tissue and wound infection, and antibiotic prophylaxis were noted on the predesigned pro forma. Following their surgery, patients were monitored for signs of SSIs daily as per standard hospital protocol by the patients' primary physician. Any signs of inflammation (pain or tenderness, erythema, swelling, and warmth), pus discharge, or positive culture of a swab or fluid were considered positive SSI. All patients were examined after 24–72 h for soakage after primary dressing, or even earlier if there was a lot of soakage. A culture swab was taken and subjected to bacteriological examination, culture, and antibiotic sensitivity testing in the college's microbiology laboratory. All laboratory data were collected and noted.

Statistical analysis

The data were compiled and entered into a Microsoft Excel spreadsheet. SPSS Version 20.0 (SPSS Inc. Chicago, Illinois, and USA) was used for statistical analysis. Continuous and categorical variables were expressed as mean (standard deviation) and as frequencies and percentages, respectively. A Student's t-test was used for comparing continuous variables. Categorical variables are compared using either the Chi-square test or Fisher's exact test. P<0.05 was considered statistically significant.

RESULTS

In the present study, a total of 207 patients were included in the study. Out of them, SSI was present in 88 patients. The total incidence of SSI was 42.51% (Table 1). This higher percentage of incidence was observed since our study was designed on the basis of type of surgery and, furthermore, a higher number of emergency cases than routine cases.

Table 2 shows patient characteristics and factors associated with SSI. The incidence of emergency and routine procedures was 22.7% and 19.8%, respectively. In the age distribution of the patients, the total number of patients included in the emergency setting was 47. Of these patients, 2 patients (4.3%) were below 20 years old, and 23 patients (48.9%) were between 21 and 40 years old. 15 patients (31.9%) were in the age group of 41–60 years, and 7 patients (14.9%) were older than 60 years. In the routine setup, the total number of patients included was 41. Of these patients, 6 (14.6%) were below 20 years old, 25 (61%) were between 21 and 40 years old, 9 (22%) were between 41 and 60 years old, and 1 (2.4%) were older than 60 years. There was no statistically significant association observed between both settings (P=0.0524), and the data were comparable. The majority comprised males (61, or 69.3%). In an emergency setting, out of a total of 47 patients, 15 (31.9%) were male and 32 (68.1%) were female, whereas in a routine setting, of the total 41 patients, 6 (14.6%) were male and 35 (85.4%)

Table 1: Prevalence of surgical site infection

Surgical site infection	No.	%
Present	88	42.5
Absent	119	57.5
Total	207	100.0

were female (P=0.0593). In the emergency setting, the total number of people who had a history of smoking was 21 (38.2%), whereas 34 (61.8%) patients did not have any history of smoking. In routine settings, the total number of people who had a history of smoking was 14 (42.4%), whereas 19 (57.6%) did not have any history of smoking (P=0.6955). In an emergency setting, the total number of people who had a history of smoking was 23 (41.8%), compared to 32 (58.2%) patients who did not have any history of tobacco. In routine settings, people who had a history of tobacco were 13 (39.4%), whereas 20 (60.6%) patients did not have any history of tobacco (P=0.6955). Table 2 describes the incidence of alcohol history among patients with SSI. In the emergency setting, the total number of people who had a history of alcohol was 24 (43.6%), whereas 31 (56.4%) patients did not have any history of tobacco. In routine settings, the total number of people who had a history of alcohol use was 10 (30.3%), whereas 23 (69.7%) patients did not have any history of alcohol use (P=0.2163). In an emergency setting, the total number of people who had comorbidity was 17 (30.9%), whereas 38 (69.1%) patients did not have any comorbidity. In routine settings, the total number of people who had comorbidity was 6 (18.2%), whereas there were 27 (81.8%) patients who did not have any comorbidity (P=0.1909). It was observed that all patients, irrespective of surgery type, were given antibiotics pre-operative and post-operative, and all patients also required blood transfusions.

Figure 1 describes the mean values of Hb, white blood cell (WBC), serum protein, and time taken in surgery among patients with SSI. In emergency settings, these were 10.08±1.23, 9800.00±2601.78, and 5.59±0.57 whereas in routine settings, these were 10.19±1.55, 8596.96±1744.00, and 5.65±0.72 respectively, and no statistically significant differences were observed in both surgery types regarding Hb (P=0.7091) and serum protein (P=0.6767) levels, whereas WBC levels had a statistically significant difference and the data were not comparable (P=0.0208). In an emergency setting, the mean time taken for surgery was 2.35±0.16 h, whereas in routine setting, it was 2.31±0.17 h. No statistically significant difference was observed between them, and the mean time taken for surgery was comparable between groups (P=0.3140). In emergency cases, the total number of patients operated on with clean, contaminated, and contaminated dirty wounds was 3 (5.5%), 21 (38.1%), 7 (12.7%), and 24 (43.6%), respectively, whereas in routine settings, these were 12 (36.4%), 211 (33.3%), 1 (3.0%), and 24 (27.3%), respectively. A statistically significant difference occurs between them and the type of wound distribution is different between groups (P=0.0016).

Figure 2 shows various organisms isolated from surgical sites. In the emergency setting, *Klebsiella* was the most common organism isolated, from 13 cases (23.6%), followed

Table 2: Patient characteristics and surgical site infection related factors

Variables	Surgery type			
	Emergency (n=55)	Routine (n=33)	Total (%)	P-value
<20 years	1 (1.8)	6 (18.2)	7 (8.0)	
Age (year)				
21–40 years	25 (45.5)	18 (54.5)	43 (48.9)	0.0069
41–60 years	18 (32.7)	8 (24.2)	26 (29.5)	
>60 years	11 (20.0)	1 (3.0)	12 (13.6)	
Sex				
Female	19 (34.5)	8 (24.2)	27 (30.7)	0.3131
Male	36 (65.5)	25 (75.8)	61 (69.3)	
Smoking history				
Present	21(38.2)	14(42.4)	35 (39.8)	0.6955
Absent	34(61.8)	19(57.6)	53 (60.2)	
Tobacco history				
Present	23(41.8)	13(39.4)	36 (40.9)	0.8238
Absent	32(58.2)	20(60.6)	52 (59.1)	
Alcohol history				
Present	24(43.6)	10(30.3)	34 (38.6)	0.2163
Absent	31(56.4)	23(69.7)	54 (61.4)	
Comorbidity				
Present	17 (30.9)	6 (18.2)	23 (26.1)	0.1909
Absent	38 (69.1)	27 (81.8)	65 (73.9)	
Clean	3(5.5)	12(36.4)	15 (17.0)	
Type of wound				
Clean contaminated	21(38.2)	11(33.3)	32 (36.4)	0.1909
Contaminated	7(12.7)	1(3.0)	8 (9.1)	
Dirty	24(43.6)	9(27.3)	33 (37.5)	

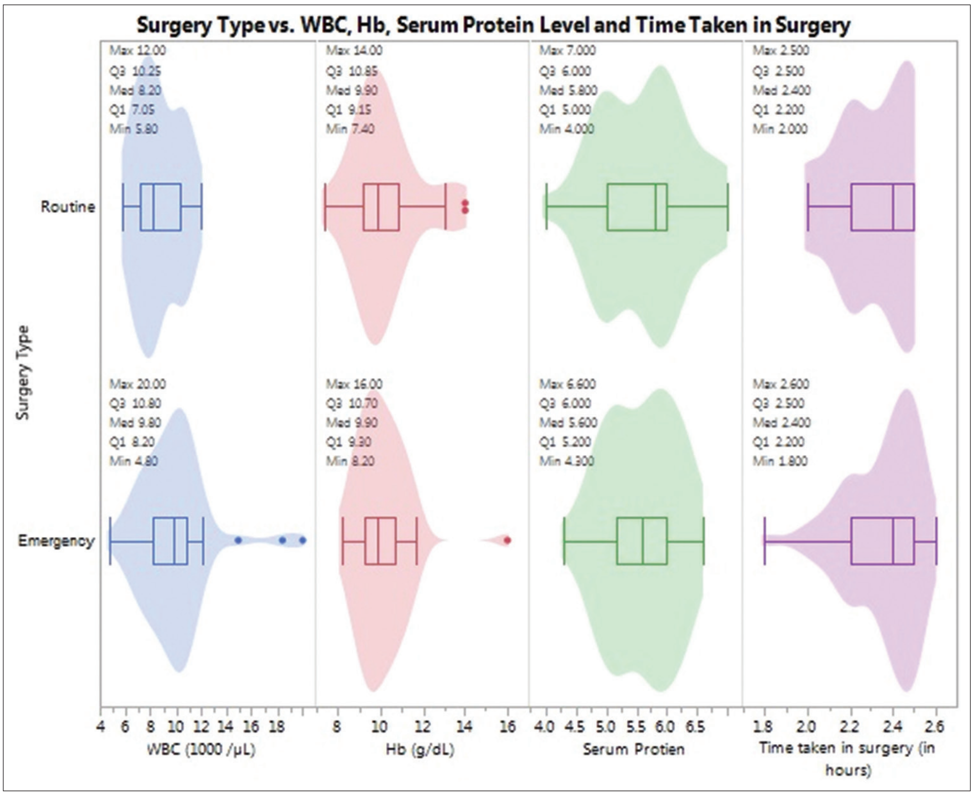

Figure 1: Distribution of white blood cell (10^3/µL), Hb (g/dL), Serum protein, and time taken in surgery (in hours) among type of surgery

by *Escherichia coli* from 12 patients (25.9%), Staphylococcus from 6 cases (10.9%), and others were 5 cases (9.1%), pseudomonas, 3 cases (5.5%) of Acinetobacter, 1 case (1.8%) of Acinetobacter and Citrobacter, 1 case (1.8%) of Bacillus, and 4 cases (7.3%) of Citrobacter. In the routine setting, *Klebsiella* was also the most common organism isolated, from 10 cases (30.3%), followed by *E. coli* from 7 patients (21.2%), 5 cases (15.2%) of pseudomonas, and others: 2 cases (6.1%) of Acinetobacter, 1 case (3.0%) of Bacillus, 2 cases (6.1%) of Citrobacter, and 1 case (3.0%) of Staphylococcus. No statistically significant difference occurs between them and the organism isolated post-operative surgery was comparable between groups (P=0.3041).

Figure 3 shows the culture sensitivity of various antibiotics. In the emergency setting, Meropenem was the most sensitive antibiotic, sensitive in all 11 (20.0%) cultures, followed by Pipzo in 10 (18.2%) cultures, Amikacin in 3 (5.5%), Clindamycin in 3 (5.5%), Imipenem in 3 (5.5%), and Linezolid in 3 (5.5%), while Ceftriaxone, Amoxiclav, Ciprofloxacin, Ciprofloxacin and Meropenamin, Doxycycline, Meropenem and Amikacin, and Vancomycin were observed in 1 (1.8%) cultures each. In the routine setting, again Meropenem was the most sensitive antibiotic, sensitive in all 13 (39.4%) cultures, followed by Pipzo in 3 (9.1%), Amikacin in 2 (6.1%), Gentamycin in 2 (6.1%), Ceftriaxone in 1 (3%), Colistin in 1 (3%), Pipzo+metro in 1 (3%), and Vancomycin in 1 (3%) cultures. No statistically significant difference occurred

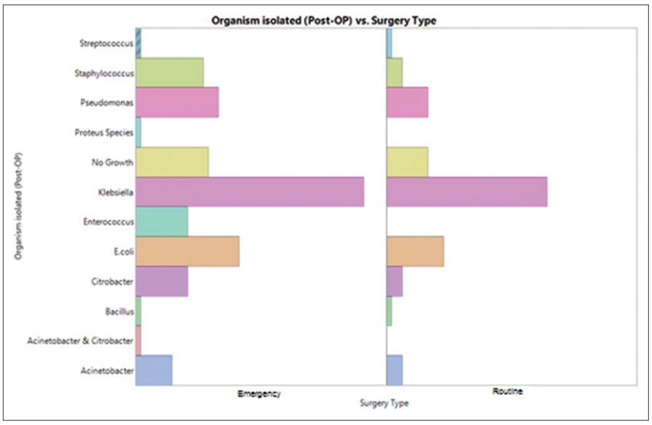

Figure 2: Distribution of organism isolated (Post-OP) between types of surgery

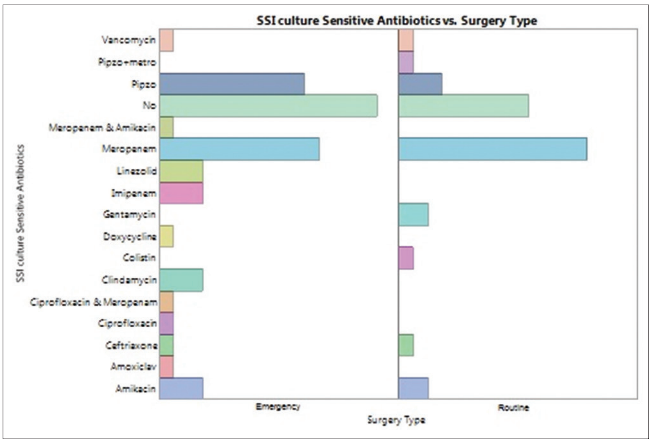

Figure 3: Distribution of culture sensitive antibiotics (Post-operative) between types of surgery

between them, and antibiotics sensitiveness was comparable between groups (P=0.2512).

DISCUSSION

Overall incidence of SSI

In the present study, a total of 207 patients were included in the study, out of which 88 developed SSI s, for an overall infection rate of 42.51%. The present study gave an incidence of SSI that is higher compared to international studies but partially higher than the range of incidence found in Indian studies on the same subject like Mekhla and Borle (39%).[18] Janugade et al., reported an overall incidence of 14%.[19] Yadalwar and Singh reported an incidence of 26.4%, but they only included emergency surgeries; in our study, both emergency and emergency surgeries were included in the study.[20] International studies done on similar subjects found a low rate of SSI compared to Indian studies, Raka et al., found an overall incidence of 12% in their study,[21] and Cheng et al., in 2007, in a teaching hospital in China found an overall incidence of 3.34% in post-operative SSIs.[22]

Age incidence

In the present study, SSI developed in the age group of 21–40 years in the majority in both settings (emergency 48.9% and routine 61.0%). Janugade et al.,[19] showed that the incidence of SSI was highest among patients over 60 years of age (28.6%). Mekhla and Borle[18] also reported a higher incidence of SSI among patients >50 years of age (23%) compared to patients <50 years (17%). It has been reported and assumed that extremes of age have long been thought to influence the chances of wound infections, perhaps because of decreased immune competence. The deviation from the previous findings of this study may be due to inadequate representation of different age groups and the study being designed on the basis of surgery type.

Sex incidence

The incidence of SSI in male patients was higher than female patients in both emergencies and emergency surgeries, but this finding was not statistically significant in the present study (P=0.0593). A higher incidence of infection among male patients was also shown by Janugade et al.,[19] who found the incidence of SSI in males to be 18.2% and in females to be 5.9%, Yadalwar and Singh[20] also showed a higher SSI rate among males (28.1%) compared to females (20.6%), and Mekhla and Borle[18] also showed a higher incidence of SSI among males compared to females in their study. The higher incidence of SSI among males compared to females in the present study could be explained by multiple factors, such as the higher prevalence of smoking, alcohol consumption, and tobacco chewing among males compared to female patients.

Role of tobacco and smoking

Smoking delays healing by causing local and systemic vasoconstriction, which results in tissue hypoxia and hypovolemia, resulting in a higher rate of infection. This association between smoking and SSI has been established by several previous studies, like Mekhla and Borle[18] and Cheng et al.,[22] Mekhla and Borle[18] reported a significant association between smoking and the incidence of SSI, with smokers having an SSI rate of 60%, which was significantly higher compared to non-smokers. The present study also showed a higher incidence of post-operative SSIs among smokers compared to non-smokers, but a significant association could not be established (P=0.6955).

Role of alcohol

It has been postulated that several immunological changes may potentiate the relationship between alcohol and infection. Alcohol reduces the level of tumor necrosis factor, decreases the number of neutrophils, modifies the production of regulatory immunological cytokines such as interleukin 1 and 6, reduces T cell proliferation, and produces changes in the inflammatory macrophage response to interferon.[23] Further alcohol abuse has significantly increased post-operative morbidity, prolonged hospital stays, and the requirement for secondary surgery.[24] In the present study, the incidence of alcohol history among patients having SSI was 24 (43.6%) in the emergency setting, whereas in the routine setting, 10 (30.3%) had a history of alcohol, but no statistically significant association between them was observed (P=0.2163). This might be due to the fact that the majority of patients undergo routine surgery.

Role of comorbidity

Table 2 shows the incidence of comorbidity (i.e., diabetes and hypertension) among patients with SSI. Mekhla and Borle[18] reported the incidence of SSI in diabetics to be significantly higher than that in non-diabetics (66% in diabetics, 35% in non-diabetics). Similar findings were also reported by Janugade et al.,[19] who reported the incidence of SSI to be 31.25% in diabetics as compared to non-diabetics. We observed that the total number of patients who had comorbidity was 17 (30.9%) in the emergency setting, whereas in the routine setting, these were 6 (18.2%). The patients with comorbidities showed a lower percentage of SSI, and an insignificant association was established between the presence of comorbidity and percentage of SSI with P>0.05 (P=0.1909). These findings may be due to the higher percentage of young individuals in our study.

Transfusion of blood and SSI

In both the emergency and routine settings, all 88 patients who had SSI received transfusions during surgery and irrespective of surgery type. Mekhla and Borle[18] reported the incidence of SSI in patients receiving perioperative blood transfusions at around 65%, which was significantly higher than in patients not receiving transfusions (24%). Cheng et al.,[22] also found a significant association between blood transfusion and an increased incidence of post-operative SSIs. The relationship between blood transfusions and SSI has been a matter of debate for a long time. It has been established that the incidence of SSI increases with increasing volumes of blood transfusions in the previous described studies and several others.

Role of Hb level

Janugade et al.,[19] showed a higher SSI rate for anemic (31.25%) compared to patients with normal Hb levels. Yadalwar and Singh[20] established pre-operative anemia as a significant risk factor for the development of SSI. Mekhla and Borle[18] in their study, found the incidence of SSI in anemic at 22%, which was higher compared to patients with normal Hb levels, who had an SSI rate of 17%. This finding was statistically significant in their study. Similarly, in the present study, both settings (emergency-10.08±1.23, routine-10.19±1.55, P=0.7091) had patients with lower HB levels (g/dL) and a higher risk of developing post-operative SSI compared to patients with normal Hb levels and irrespective of surgery type.

Role of serum albumin

In the present study, the incidence of SSI in patients with low serum protein levels was very high compared to patients with normal serum albumin levels, since in both surgery type settings, serum protein levels were lower (emergency-5.59±0.57, routine-5.65±0.72) and comparable (P=0.6767). Similarly, Janugade et al.,[19] reported an incidence of 25% for post-operative SSI, in patients with low albumin levels, which was significantly higher compared to the overall incidence of 14%. Mekhla and Borle[18] also reported a significantly higher incidence of SSI in patients with low serum albumin levels as compared to patients with normal serum albumin levels (80% in the low albumin group vs. 21% in the normal serum albumin level group). The significance of hypoalbuminemia causing decreased wound healing and leading to higher rates of infection has been established in the studies described above, and this association was also noted in our study as the incidence of SSI was significantly higher in patients with hypoalbuminemia.

Role of WBC level

In the present study, in the emergency setting, the mean WBC level ($10^3/\mu L$) was 9.80±2.6, whereas in the routine setting, it was 8.59±1.74 and a statistically significant difference occurred between them (P=0.0208). Zhao et al.,[25] reported that higher infection indexes, such as WBC count, ESR, and CRP level, were independent risk factors for SSI. Our findings are also comparable with their study since we consider all SSI cases with a higher WBC level, which shows a higher infection index.

Incidence based on type of wound

In the present study, the incidence of post-operative SSIs in both surgical settings was highest among dirty wounds, followed by clean-contaminated wounds, then clean-wounds and least in contaminated wounds. A statistically significant difference occurred between them, and the type of wound distribution was different between groups (P=0.0016). Janugade et al.,[19] reported the incidence of SSI as 6% in clean-contaminated cases, 23.8% in contaminated cases, and 40% in dirty cases. Raka et al.,[21] reported the incidence of SSI as 3.1% for clean, 9.8% for clean-contaminated, 46.1% for contaminated, and 100% for dirty cases. Mekhla and Borle[18] reported the incidence of SSI as 23.7% for clean and clean contaminated cases and 60.9% for contaminated and dirty cases. Ortega et al.,[26] also reported similar results in accordance with the present study. Findings from present and previous studies show that endogenous contamination remains a high-risk factor for the development of SSI due to the enormous dose of the organism available from the bowel and other hollow organs.

Microorganism and antibiotics sensitivity

Various organisms were isolated from surgical sites. *Klebsiella* was the most common organism isolated in both settings, from 13 cases (23.6%), followed by *E. coli* from 12 patients (25.9%) in the emergency setting, whereas in the routine setting, these were isolated, from 10 cases (30.3%), followed by *E. coli* from seven patients (21.2%). No statistically significant difference occurs between them in terms of organisms isolated (P=0.3041). Yadalwar and Singh[20] also found *E. coli* to be the most common organism causing SSI (40.9%), followed by *Staphylococcus aureus* (28.7%), pseudomonas (24.2%), and *Klebsiella* (6%). Raka et al.,[21] also described *E. coli* as the most common organism causing post-operative SSI. The reason for *E. coli* found as the most common organism is that the majority of patients with SSI, have undergone surgery for intestinal pathology (perforation, abscess, and appendicitis) and further *E. coli*, being the most common organism found in the intestinal flora, might have contaminated the wound. The handling of tissues is another major factor in development of SSI. Mishra et al.,[27] and Jain et al.,[28] reported *S. aureus* as the most common organism isolated (46.2%), followed by *E. coli* (38.5%) in their study, and our findings partially match the previously reported findings. Meropenem was the most sensitive antibiotic in both settings in the present study, while vancomycin was the least sensitive. No statistically significant difference occurred between distribution of sensitivities of antibiotics was observed and data was comparable between both settings (P=0.2512). Other commonly sensitive antibiotics in this study were found to be Pipzo, Amikacin, and imipenem, whereas common resistant antibiotics were amoxiclav, ceftriaxone, linezolid, and doxycycline. The reason for resistance to these antibiotics in our study is probably due to their more common use in hospitalized patients for prolonged periods as well as their extensive use in outpatient departments, and the need for more judicious use of antibiotics is needed to reduce this scenario.

Limitations of the study

The important limitations of this study include its single institute based study and the relatively small number of sample size.

CONCLUSION

This paper presented the incidence of SSI in the hospital setting of central India, as well as the factors that may contribute to the high incidence of SSI. We observed an increased risk of SSI in patients operated on in emergency, patients younger than 60 years old, surgeries with dirty and contaminated wounds, and patients with a higher WBC level. Further research must be conducted to better recognize how specific risk factors are responsible for SSI.

ACKNOWLEDGMENT

We would like to extend our thanks to Dr. ML Soni for extending his support in data assessment, the preparation of figures, and statistical analysis.

REFERENCES

1. Allegranzi B, Bischoff P, de Jonge S, Kubilay NZ, Zayed B, Gomes SM, et al. New WHO recommendations on preoperative measures for surgical site infection prevention: An evidence-based global perspective. Lancet Infect Dis. 2016;16(12):e276-e287. https://doi.org/10.1016/S1473-3099(16)30398-X
2. Bhangu A, Ademuyiwa AO, Aguilera ML, Alexander P, Al-Saqqa SW, Borda-Luque G, et al. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: A prospective, international, multicentre cohort study. Lancet Infect Dis. 2018;18(5):516-525. https://doi.org/10.1016/S1473-3099(18)30101-4
3. Ohno M, Shimada Y, Satoh M, Kojima Y, Sakamoto K and Hori S. Evaluation of economic burden of colonic surgical site infection at a Japanese hospital. J Hosp Infect. 2018;99(1):31-35. https://doi.org/10.1016/j.jhin.2017.12.013
4. Burke JP. Infection control-a problem for patient safety. N Engl J Med. 2003;348(7):651-656. https://doi.org/10.1056/NEJMhpr020557
5. Korol E, Johnston K, Waser N, Sifakis F, Jafri HS, Lo M, et al. A systematic review of risk factors associated with surgical site infections among surgical patients. PLoS One. 2013;8(12):e83743. https://doi.org/10.1371/journal.pone.0083743
6. Hedrick TL, Sawyer RG, Hennessy SA, Turrentine FE and Friel CM. Can we define surgical site infection accurately in colorectal surgery? Surg Infect (Larchmt). 2014;15(4):372-376. https://doi.org/10.1089/sur.2013.013

7. Singh R, Singla P and Chaudhary U. Surgical site infections : Classification, risk factors, pathogenesis and preventive management. Int J Pharma Res Health Sci. 2014;2(3):203-214.
8. Oh AL, Goh LM, Azim NA, Tee CS and Phung CW. Antibiotic usage in surgical prophylaxis: A prospective surveillance of surgical wards at a tertiary hospital in Malaysia. J Infect Dev Ctries. 2014;8(2):193-201.
   https://doi.org/10.3855/jidc.3076
9. Ng RS and Chong CP. Surgeons' adherence to guidelines for surgical antimicrobial prophylaxis-a review. Australas Med J. 2012;5(10):534-540.
   https://doi.org/10.4066/AMJ.2012.1312
10. Nwankwo E and Edino S. Seasonal variation and risk factors associated with surgical site infection rate in Kano, Nigeria. Turk J Med Sci. 2014;44(4):674-680.
    https://doi.org/10.3906/sag-1305-47
11. Haridas M and Malangoni MA. Predictive factors for surgical site infection in general surgery. Surgery. 2008;144(4):496-501; discussion 501-503.
    https://doi.org/10.1016/j.surg.2008.06.001
12. Astagneau P, Rioux C, Golliot F, Brücker G and INCISO Network Study Group. Morbidity and mortality associated with surgical site infections: Results from the 1997-1999 INCISO surveillance. J Hosp Infect. 2001;48(4):267-274.
    https://doi.org/10.1053/jhin.2001.1003
13. Utsumi M, Shimizu J, Miyamoto A, Umeshita K, Kobayashi T, Monden M, et al. Age as an independent risk factor for surgical site infections in a large gastrointestinal surgery cohort in Japan. J Hosp Infect. 2010;75(3):183-187.
    https://doi.org/10.1016/j.jhin.2010.01.021
14. Sutton E, Miyagaki H, Bellini G, Kumara HM, Yan X, Howe B, et al. Risk factors for superficial surgical site infection after elective rectal cancer resection: A multivariate analysis of 8880 patients from the American College of Surgeons National Surgical Quality Improvement Program database. J Surg Res. 2017;207:205-214.
    https://doi.org/10.1016/j.jss.2016.08.082
15. Shirata C, Hasegawa K, Kokudo T, Arita J, Akamatsu N, Kaneko J, et al. Surgical site infection after hepatectomy for hepatocellular carcinoma. Dig Surg. 2018;35(3):204-211.
    https://doi.org/10.1159/000477777
16. Pedroso-Fernandez Y, Aguirre-Jaime A, Ramos MJ, Hernández M, Cuervo M, Bravo A, et al. Prediction of surgical site infection after colorectal surgery. Am J Infect Control. 2016;44(4):450-454.
    https://doi.org/10.1016/j.ajic.2015.10.024
17. Allegranzi B, Aiken AM, Kubilay NZ, Nthumba P, Barasa J, Okumu G, et al. A multimodal infection control and patient safety intervention to reduce surgical site infections in Africa: A multicentre, before-after, cohort study. Lancet Infect Dis. 2018;18(5):507-515.
    https://doi.org/10.1016/S1473-3099(18)30107-5
18. Mekhla and Borle FR. Determinants of superficial surgical site infections in abdominal surgeries at a Rural Teaching Hospital in Central India: A prospective study. J Family Med Prim Care. 2019;8(7):2258-2263.
    https://doi.org/10.4103/jfmpc.jfmpc_419_19
19. Janugade HB, Nagur BK, Sajjan KR, Biradar SB, Savsaviya JK and Reddy M. Abdominal surgical site infection occurrence and risk factors in Krishna institute of medical science, Karad. Int J Sci Study. 2016;3(11):53-56.
    https://doi.org/10.17354/ijss/2016/56
20. Yadalwar V and Singh LM. Study of post-operative surgical site infection in patients of emergency laparotomy in teaching hospital of Central India. IJSS J Surg. 2018;4(1):59-64.
21. Raka L, Krasniqi A, Hoxha F, Musa R, Mulliqi G, Krasniqi S, et al. Surgical site infections in an abdominal surgical ward at Kosovo Teaching Hospital. World Hosp Health Serv. 2008;44(2):32-36.
    https://doi.org/10.3855/jidc.375
22. Cheng K, Li J, Kong Q, Wang C, Ye N and Xia G. Risk factors for surgical site infection in a teaching hospital: A prospective study of 1,138 patients. Patient Prefer Adherence. 2007;9:1171-1177.
    https://doi.org/10.2147/PPA.S86153
23. Felding C, Jensen LM and Tonnesen H. Influence of alcohol intake on postoperative morbidity after hysterectomy. Am J Obstet Gynecol. 1992;166(2):667-670.
    https://doi.org/10.1016/0002-9378(92)91695-7
24. Gordon AJ. Identification and Management of Unhealthy Alcohol Use in the Perioperative Period. United States: UpToDate; 2022.
25. Zhao S, Ye Z, Zeng C, Zhang L, Huang J, Zhang W, et al. Retrospective analysis of infection factors in secondary internal fixation after external fixation for open fracture of a long bone: A cohort of 117 patients in a two-center clinical study. Biomed Res Int. 2022;2022:7284068.
    https://doi.org/10.1155/2022/7284068
26. Ortega G, Rhee DS, Papandria DJ, Yang J, Ibrahim AM, Shore AD, et al. An evaluation of surgical site infections by wound classification system using the ACS-NSQIP. J Surg Res. 2012;174(1):33-38.
    https://doi.org/10.1016/j.jss.2011.05.056
27. Mishra A, Pandey CP, Mohan M and Prakash V. Study of surgical infection in a tertiary care hospital. Int J Contemp Med Res. 2020;7(3):C1-C5.
    https://doi.org/10.21276/ijcmr.2020.7.3.20
28. Jain S, Shivhare R, Pardhan S and Chaurasiya D. A prospective study of post-operative surgical site infections after abdominal surgeries. Int Surg J. 2021;8(10):3088.
    https://doi.org/10.18203/2349-2902.isj20214000

Authors Contribution:
VKT**-** Concept and design of the study; **PS-** Microbial testing, reviewed the literature; **UB-**Interpreted the results; concept; **AKR-** Prepared first draft of manuscript; statistical analysis and interpretation and manuscript preparation, Collection and compilation of data; **AR-** Collection and compilation of data, coordination, preparation of manuscript, and revision of the manuscript.

Work attributed to:
Department of General Surgery, Gandhi Medical College and Associated Hamidia Hospital, Bhopal - 462 001, Madhya Pradesh, India.

Orcid ID:
Dr. Vijay Kumar Tekam- https://orcid.org/0000-0003-3938-6986
Dr. Priyanka Singh- https://orcid.org/0000-0003-2376-5148
Dr. Utkarsh Bhandhari- https://orcid.org/0009-0001-9057-3632
Dr. Ashok Kumar Rathore- https://orcid.org/0000-0002-5054-9865
Dr. Akshara Rathore- https://orcid.org/0009-0001-1661-4483

Source of Support: Nil, **Conflicts of Interest:** None declared.