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TO STUDY THE PREVALENCE AND ITS ASSOCIATED RISK FACTORS OF SURGICAL SITE INFECTIONS OF PATIENTS POST SURGERY, UTTAR PRADESH, INDIA

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ABSTRACT

Introduction: Surgical site infections (SSI) are a common type of healthcare-associated infections and frequent complication of hospitalization, responsible for prolonged hospital stay, increased intensive care unit admissions, hospital readmissions after surgery, significantly increased costs and delays to adjuvant systemic therapy; they occur in 2 to 5% of patients undergoing surgery .

Aim and Objective: To study the prevalence and its associated risk factors of surgical site infections of the patients at a tertiary care centre.

Material and Methods: This was a cross-sectional study conducted in a hospital setting over the period of 1 year i.e, April 2023 to April 2024 in the Department of Microbiology and Department of Surgery at a tertiary care centre. All surgically treated adult patients of both sexes who were older than 16 years old were included. Patients who received a second surgery at the same location for any reason, patients receiving immunosuppressant medication, people with immunodeficiency diseases, people currently taking antibiotics, and people with infections elsewhere were all disqualified from participating. If there was signs of a wound infection 48 hours.

Results: In the present study a total of 120 patients underwent different types of surgeries. The prevalence of SSIs during the study period was 13.3%. SSIs were more common in abdominal surgeries. It was observed that the ratio of males 64.2% was more as compared to the females

37.2% with maximum number of cases in the age group of 35-44 years of age with 37.5%. Patients who underwent emergency surgery have a higher risk of getting SSI than those who underwent elective surgery . Those with diabetes had a higher risk of getting SSI than those who were non-diabetics. In the present study it was observed that *Klebsiella pneumoniae* (31.25%) was the most common isolate followed by *E.coli* (25%), *Pseudomonas aeruginosa* with 18.75%, *S.aureus* with 12.5% and least for *Staphylococcus epidermitidis* and *Klebsiella oxytoca* with 6.25%. It was also noted that the site of the infection was most common in the superficial site with 68.75%.

Conclusion: Abdominal surgeries were more likely to cause SSIs. Patients who were male, aged 30 years or older, had emergency surgery, had diabetes, and/or had a lengthy hospital stay were more likely to develop SSIs following any type of surgery.

Keywords: Surgical site infection, Prevalence, risk factors, Microorganisms, Hospital stay

INTRODUCTION

Surgical site infection (SSI) is a common, generic postoperative event which causes considerable morbidity but sometimes leads to death. Surveillance of SSI is an important infection control activity [1]. SSIs are responsible for increasing the treatment cost, length of hospital stay and significant morbidity and mortality.

Despite the technical advances in infection control and surgical practices, SSI still continue to be a major problem, even in hospitals with most modern facilities [2]. These infections are usually caused by both exogenous and endogenous micro- organisms which will enter in the operative wound either during the surgery (primary infection) or after the surgery (secondary infection). Primary infections are usually more serious than secondary infections, appearing within five to seven days of surgery [3]. Most of the SSIs are uncomplicated involves only the skin and subcutaneous tissue but sometimes can progress to internal organ or body cavity causing tissue necrosis.

Approximately 160,000 to 300,000 SSI are diagnosed and treated every year and represent a considerable burden for healthcare systems in terms of re-operation, increased post-surgical pain, poor wound healing, prolonged hospital stay, cosmetic appearance, and decreased quality of life [4]. SSI has also been shown to be an independent risk factor in the development of incisional hernia [5]. The incidence of all types of SSI following abdominal surgery can reach 14% of all hospital-acquired infections and the most common form is the incisional superficial SSI, which is often the first to appear and is easy to diagnose [6].

SSI was the leading cause of hospital-acquired infection in a systematic review of studies in low- and middle-income countries .They also a result in deleterious softer endpoints such as patient psychosocial distress, loss of income, and decreased productivity [7]. Multiple interventions have been proposed and employed over the past decades in an attempt to prevent SSI. These include skin cleansing protocols, hair removal, the maintenance of intraoperative normothermia, the preoperative antimicrobial prophylaxis administration, the use of plastic adhesive skin barriers, the high flow oxygen supplementation, the wound protection, the sterility of instruments, the bowel preparation, the length of the incision, and the delayed primary incision closure [8].

The development of SSI is multifactorial, and it may be related to patient's risk factors such as age, comorbidities, smoking habit, obesity, malnutrition, immunosuppression, malignancies, and the class of contamination of the wound [8].

The usual presentation of infected surgical wound can be identified by pain, tenderness, warmth, erythema, swelling and pus formation [9]. A number of patient related factors (old age, nutritional status, pre-existing infection, comorbid illness) and procedure related factors (poor surgical technique, prolonged duration of surgery, pre operative part preparation, inadequate sterilization of surgical instruments) can influence the risk of SSIs significantly . In addition to these risk factors, the virulence and the invasiveness of the organism involved, physiological state of the wound tissue and the immunological integrity of the host are also the important factors that determine whether infection occurs or not . Bacteriological studies have shown that SSIs are universal and the etiological agents involved may vary with geographical location, between various procedures, between surgeons, from hospital to hospital or even in different wards of the same hospital . In the recent years there has been a growing prevalence of Gram- Negative Bacilli as a cause of serious infections in many hospitals. In addition to irrational use of broad-spectrum antibiotics and resulting antimicrobial resistance (AMR) has further deteriorated the condition in this regard. The problem gets more complicated in developing countries like India due to poor infection control practices, overcrowded hospitals and inappropriate use of antimicrobial agents. Surgical site infections remain a major cause of hospital-acquired infections irrespective of improvements being done in operating room practices, instrument sterilization methods, better surgical technique and the best efforts of infection prevention strategies. Even though SSI rates are increasing worldwide with most modern facilities and following standard protocols and antibiotic treatments . SSIs are less frequently encountered than superficial SSIs, but are associated with greater morbidity/mortality, readmission rates, longer hospital stay, and increased overall hospital associated costs when compared with superficial SSIs [10].

Although the majority of SSIs are uncomplicated, others may be severe and more challenging to manage, such as necrotizing deep soft tissue infections. The latter often require extensive surgical debridement, multiple reoperations, and may even be life-threatening The location and extent of the infection, as well as the patient's clinical condition, guide the management approach. Establishing worldwide incidence of SSIs in general surgical patients is imperative to understand the extent of the condition, its burden on society, and the demographic and clinical risk factors that predispose general surgical patients to develop SSIs. Therefore the present study was undertaken to study the prevalence and risk factors of surgical site infections of patients.

MATERIAL AND METHODS

Study settings and duration

This was a hospital-based, cross-sectional study carried out in the Department of Microbiology with collaboration with the Surgery Department. The study was carried out over a period of 1 yeari.e, from April 2023 to April 2024. The Ethical clearance was duly obtained from the Institutional Ethical Committee.

Study population and sampling technique

As per the convenience sampling technique, all the cases admitted to the surgical wards (including both elective and emergency surgery) during the study period and those who met the eligibility criteria were included in the study.

Sample size calculation

The prevalence of SSI observed in the study by Vishal Prajapati et al. was 8.02% [11]. Based on this study, consideration.

SAMPLE SIZE :- SS (n)= 4PQ/L^2 Where,**P=**Prevalence, **Q=** 100-p, **L=** Allowable error, If the allowable error is 5%

SS (n) = 4×8.02x91.98

Sample Size (n) = 2950/25= 118

So, in order to coverup the lost- to-follow-up, drop-out rate and non-response rate the sample size taken in our research study was 120.

Inclusion criteria

All patients of both genders above 16 years who underwent surgery and were admitted to the surgical wards during the study period were included in the present study.

Exclusion criteria

All pediatric cases were excluded from the study. Patients who underwent second surgery at the same site for any reason, patients on immunosuppressant therapy or any known immunodeficiency disease, patients on antibiotics already for any other infections, and patients with infection elsewhere in the body were also excluded from the study.

Ethical clearance

The study was carried out after getting ethical approval from the Institutional Ethical Committee and written consent was obtained from every study subject.

Data collection procedure

Data about the age of the patients, gender, demographic details, clinical details including the name of the procedure, date and duration of surgery, the experience of surgeons, preoperative hospital stay, nature of the surgery, postoperative hospital stay, and the onset of illness (SSI) were collected by reviewing the patient's case sheet.

The surgical wound bandages were removed 48 hours following the surgery. If the patient demonstrated local inflammatory changes at the wound site, such as edoema, redness, warmth, or discharge, this was considered an indication of a wound infection. Before applying the bandage, samples were obtained to assess if there was any discharge. Inflammatory changes alone were present but did not have any discharge, the wounds were watched for the emergence of until the patient was sent home, the wound.

If inflammatory symptoms emerged within 48 hours, patients were followed with the assistance of the corresponding surgeons. These patients also received education and followed up for the creation of SSIs through mobile phone for the development of SSIs over a period of 30 days.

The probable wound infections were washed with sterile normal saline, followed by 70% alcohol, before the material was collected using a sterile swab. Two swabs were taken from the wound's depth, and/or aspirates were collected in a sterile disposable syringe and delivered to the laboratory within two hours.

The colour, consistency, and odour of the samples were inspected and documented.A direct thin smear was made from each wound swab and/or aspirates on a clean grease-free glass slide and was air dried.

It was then heat-fixed, and Gram staining was done with positive and negative control (American Type Culture Collection [ATCC] *Staphylococcus aureus* 25923 and *Escherichia coli* 25922). The presence of pus cells and microorganisms was observed under the oil immersion (100X) objective.

The samples were cultured onto nutrient agar, 5% sheep blood agar, and MacConkey agar plates by adopting standard microbiological techniques.

After 24 hours of incubation aerobically at 37°C, plates were read, and the isolates were identified based on colony morphology, Gram stain, motility, and biochemical tests.

Data analysis

The data obtained were entered in Microsoft Excel (Microsoft Corp., Redmond, WA), and the results were analyzed using SPSS (Statistical Package for the Social Sciences) version 21 (IBM Corp., Armonk, NY). All the data collected in the current study was categorical, so they were expressed in a table as frequency and percentage. Also, the figures were expressed as a pie chart. The association between risk factors and the presence of SSI was assessed using the Chi-square test. With a 95% confidence interval, a p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 120 patients underwent different types of surgeries, including elective as well as emergency procedures, during the study period. About 16 SSIs were documented, and hence, the overall prevalence of SSI rate during the study period was 13.3%

The number of cases that developed SSIs in relation to the type of surgery is shown in Table 1.

Table 1: Prevalence of SSI according to the Types of Surgery (n)

Site of Surgery	Types of Surgeries	No. of Surgeries, n (%)	SSI, n (%)
Abdomen	Appendectomy	25 (20.8%)	1(6.25%)
	Hernia repair	15 (12.5%)	3 (18.75%)
	Exploratory laparotomy	5 (4.1%)	4 (25%)
	Cholecystectomy	4 (3.3%)	1 (6.5%)
	Lower segment cesarian section	16(13.3%)	1 (6.5%)
	Hysterectomy	10(8.3%)	1 (6.5%)
Pelvis	Sphincterotomy	1 (0.8%)	1 (6.5%)
	Hemorrhoidectomy	1 (0.8%)	1 (6.5%)
	Fistulectomy	3 (2.5%)	2 (12.5%)
	Hip replacement	1 (0.8%)	Nill
Urogenital	Transurethral resection of prostate	2 (1.6%)	Nill
	Urethroscopy lithotripsy	2 (1.6 %)	Nil
Breast and axilla	Modified radical mastectomy	1(0.8%)	1(6.5%)
	Fibroadenoma excision	5 (4.1%)	Nil
Skin, bone, and joints	Knee replacement	3 (2.5%)	Nil
	Varicose vein	4 (3.3%)	Nil
	Open reduction and internal fixation	1(0.8 %)	Nil
Eye	Intraocular lens implantation	15 (12.5%)	Nil
Ear, nose, throat	Tonsillectomy	4 (3.3%)	Nil
	Mastoidectomy	1 (0.8%)	Nil
Neurosurgery		1 (0.8%)	Nil
Total		120	16

From the table 3 is was observed that the ratio of males 64.2% was more as compared to the females 37.2% with maximum number of cases were observed in the age group of 35-44 years of age with 37.5%.

Table 2: The Type of Isolates causing SSIs

Type of organisms Isolated	Number of Isolates	Percentage
Klebsiella pneumoniae	5	31.25%
E.coli	4	25%
Pseudomonas aeruginosa	3	18.75%
Staphylococcus aureus	2	12.5%
Staphylococcus epidermitidis	1	6.25%
Klebsiella oxytoca	1	6.25%
Total	16	100%

In the present study it was observed that *Klebsiella pneumoniae* (31.25%) was the most common isolate followed by *E.coli* (25%), *Pseudomonas aeruginosa* with 18.75%, *S.aureus* with 12.5% and least for *Staphylococcus epidermitidis* and *Klebsiella oxytoca* with 6.25%.

Graph No. 1: Graphical Representation of the Number and the Type of Isolates

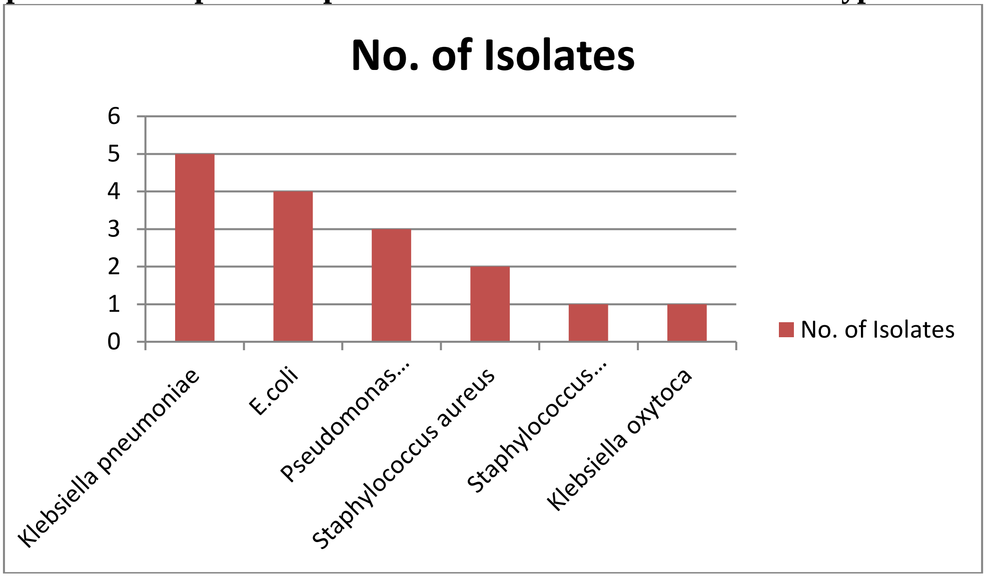
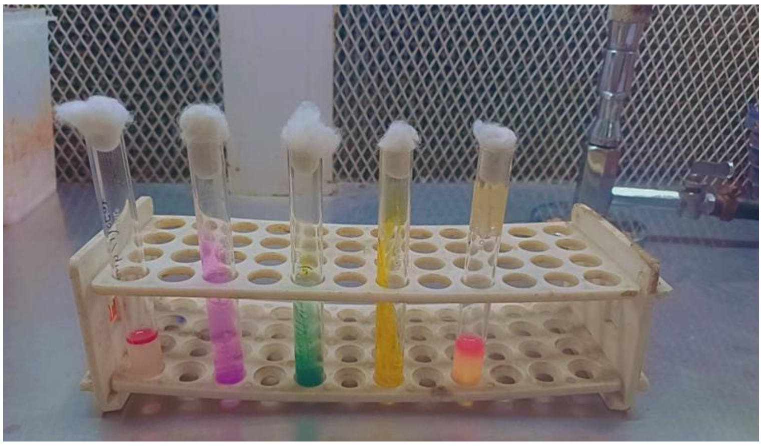


Figure 1: The Biochemicals test used for identification of the microorganisms



Graph No. 2: Graphical Representation of the Agewise Distribution of the Isolates

Graph No. 3: Graphical Representation of the Genderwise Distribution of the Isolates

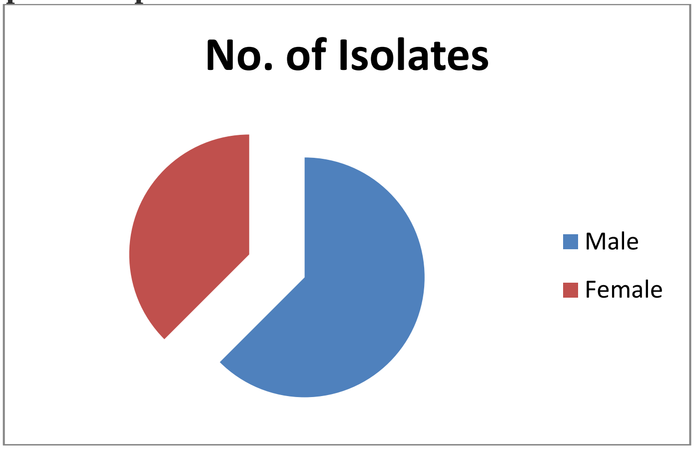


Table 3: Distribution of Risk factors of the Study Population according to SSI (n = 16)

S. No	Risk Factors		Frequency of SSI	Percentage
1	Age group (years)	16-24	1	6.25
		25-34	2	12.5
		35-44	6	37.5
		45-54	5	31.25
		≥ 55	2	12.5
2	Gender	Male	10	64.2
		Female	6	37.5
3	Type of surgery	Emergency	13	81.25
		Elective	3	18.75
4	Extend of wound	Superficial	11	68.75
		Deep	5	31.25
		Organ	0	0
5	Diabetes mellitus	Yes	10	62.5
		No	8	50
6	Smoking	Yes	8	50
		No	7	43.75
7	Alcoholism	Yes	9	56.25
		No	6	37.5
8	Anemia	Yes	10	62.5
		No	6	37.5
9	Hospital stay	1-7 days	10	62.5
		>7 days	6	37.5
10	Drain	Yes	10	62.5
		No	6	62.5

DISCUSSION

Surgical site infections (SSI), one of the most common causes of nosocomial infections, are a common surgery-related complication, with reported incidence rates ranging from 2 to 20% [12]. They are to blame for rising treatment costs, longer hospital stays, and increased morbidity and mortality. Despite technological breakthroughs in infection control and surgical techniques, SSI remains a significant concern, even in hospitals with the most contemporary facilities [13].

These infections are typically caused by exogenous and/or endogenous microorganisms that enter the surgical site during or after the procedure. Primary infections are frequently more dangerous and occur within five to seven days of surgery [14].

Bacteriological studies have shown that SSIs are universal and the etiological agents involved may vary with geographical location, between various procedures, between surgeons, from hospital to hospital or even in different wards of the same hospital [13].

Out of the total of 120 patients showed local signs and symptoms and were suspected to have postoperative wound infections. These cases were evaluated and followed up. Among them, the culture positive was observed in 16 cases and hence was considered as cases of SSI in the hospital thus, the overall prevalence rate of SSIs was 13.3% in the present study. The current status of SSIs identified in their hospital concurs with the studies of Golia et al. [15] and Iqbal et al. [16]who reported the prevalence rate as 4.3%, 5.4%, and 7.3%, respectively, which were in accordance to the current study. There were other studies performed by the other research investigators which were in contrast to the present study where, Kumar et al. [8] and Al-Mulhim et al. [17] reported in their study that the overall prevalence rate of SSIs was 2.5%, which was lesser than one third of our present study rate. There was another study which was also in contrast to the present study by Setty et al. [18] which reported the prevalence rate to be quite high with 21.66% and 22.2% respectively.

In the present study it was observed that the ratio of Males 10 (64.2%) was more as compared to that of females 6 (37.5%). This study was similar to the study performed by the other research investigator Vikrant Negi et al.,[19] where Males (74.6%) were more commonly affected than females (25.5%) and the sex ratio male: female was 2.9:1. A study by Hernandez et al., in 2005 conducted in a Peruvian Hospital reported more occurrences among males (65.6%) [20].

In contrast, a study done by Shanmugam et al. reported almost equal occurrences among females (52%) and males (48%) [21].

The increasing occurrence among males was attributable to the nature of the infected wounds with which they come to surgical departments.

In the current study it was observed that the maximum number of isolates found were in the age group of 35-44 years of age followed by 45-54 years of age and least in the age group of 16-24 years of age. This study was similar to the study performed by the other author [19] where the 31 - 50 years was affected the most. The patients with age >50 years had a higher incidence of SSI (51.8%) in comparison to an incidence of 12.4% among the patients who were ≤30 years of age. Advancing age is an important factor for the development of SSIs, as in old age patients there is low healing rate, low immunity, increased catabolic processes and presence of co-morbid illness like diabetes, hypertension, etc [22].

Table 4: Agewise distribution of the cases

STUDY	YEAR	AGE DISTRIBUTION	PERCENTAGE
Devjani De et al [23]	2013	21-25	50.8%
Mundhada et al.[24]	2015	41-50	50%
Astha Regmi et al [25]	2021	26-29	50%

The study by Devjani De et al in 2013 was in constrast to the present study where the maximum number of SSI was observed in the age group of 21-25, whereas Similar study was observed which supported the current study where , a high rate of infection was noted in the later age groups by Mundhada et al. [24].It was also observed that there were increase cases in the emergency ward (81.25%).

The increased prevalence of SSI in emergency surgeries could be attributed to a relatively short time frame without sufficient patient preparation and surgical preparedness, as well as contaminated wounds, as seen in road traffic incidents. Most previous studies on SSIs have reported the same information. Tabiri et al. also showed that emergency cases had a greater number of SSIs (23.8%) than elective cases (7.4%) [11]. In another study done by Dessie et al., SSIs were reported in 61.7% of emergency cases and 38.3% of elective cases [26].

In the present study, it was observed that superficial and deep SSIs were observed with the ratio of 68.75% and 31.25% respectively. There was no SSIs observed in the organ site.

Table 5: Site of infection of the cases

STUDY	YEAR	SITE OF INFECTION	PERCENTAGE
Astha Regmi et al [25]	2021	Superficial	94.85%
Sedina Atic Kvalvik et al [27]	2021	Superficial	77.3%
Amanu Gashaw et al [28]	2022	Superficial	64.7%
Present Study	2023-2024	Superficial	68.75%

In the present study it was observed that *Klebsiella pneumoniae* (31.25%) was the most common isolate followed by *E.coli* (25%), *Pseudomonas aeruginosa* with 18.75%, *S.aureus* with 12.5% and least for *Staphylococcus epidermitidis* and *Klebsiella oxytoca* with 6.25%. There was the another study which was in support to the present study where *E. coli* (46.4%) was the commonest gram negative bacteria isolated followed by *P. aeruginosa* (15.9%) and *Citrobacter spp* (15.9%) [19].

Similar observations have been reported by various other authors also [29-31]. Few studies have reported *P.aeruginosa* as the most frequent isolate in SSI [32,33] which remains a third most isolated strain in this study.

The prevalence of SSI in cases can vary significantly, ranging from 1.4% to 41.9%. The occurrence of this complication following surgeries poses unique challenges due to the inherent difficulty in treating infections [34].

Bacteriological studies have demonstrated that SSIs are widespread, and the etiological agents involved can vary by geography, operation, surgeon, hospital, or even ward [4]. In recent years, gram-negative germs have become a more common cause of serious infections in many hospitals.

Furthermore, irrational usage of broad-spectrum medicines and the resulting antimicrobial resistance (AMR) have exacerbated the situation. Although many programmes focus on the fundamental principles of surgical care and antibiotic prophylaxis, there are still some unresolved issues regarding antibiotic prophylaxis in surgical care patients, such as drug dose in obese patients, specific timings of antibiotic administration, the role of anti-MRSA prophylaxis, and so on.

CONCLUSION

Surveillance of SSI, combined with feedback from surgeons, will help to reduce the SSI rate, and this surveillance system should be developed in all hospitals. Additionally, guidelines for antibiotic use among surgical patients should be developed and strictly followed, which may provide an estimate of the incidence of SSI.

LIMITATION

One of the study's weaknesses was that SSI wound swabs were not cultured for fungal or anaerobic bacterial profiles. It is conceivable to conduct further study in this area.

DECLARATIONS:

Conflicts of interest: There is no any conflict of interest associated with this study

Consent to participate: There is consent to participate.

Consent for publication: There is consent for the publication of this paper.

Authors' contributions: Author equally contributed the work.

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