ISSN: 0975-3583,0976-2833 VOL15, ISSUE 11, 2024

TO STUDY THE CLINICAL CORRELATION OF POST OPERATIVE ASSOCIATED RISK FACTORS OF SURGICAL SITE INFECTIONS OF PATIENTS

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ABSTRACT

Introduction: Surgical site infections remain a major issue among hospital-acquired infections. This long-standing issue is exacerbated by the growing challenge of antibiotic resistance, an increase in surgical interventions, the presence of comorbidities among patients, significantly increased costs, and delays to adjuvant systemic therapy; they affect 4 to 5% of patients undergoing surgery.

Aim and Objective: To study the clinical correlation of post operative associated risk factors of surgical site infections of patients

Material and Methods: This was a Cross-sectional study carried out in a hospital setting over a period of 12 months i.e, August 2023 to August 2024 in the Department of Microbiology and Department of Surgery at a tertiary care centre. A total of 162 patients underwent different types of surgeries were included. The study covered all surgically treated adult patients, both sexes, over the age of 16. Patients who had a second operation at the same place for any reason, patients taking immunosuppressant medicine, persons with immunodeficiency illnesses, people currently

ISSN: 0975-3583,0976-2833 VOL15, ISSUE 11, 2024

taking antibiotics, and those with other infections were all excluded. If there were evidence of a wound infection within 48 hours.

Results: The prevalence of SSIs was observed to be 14.8%. SSIs were more common in abdominal surgeries. It was observed that the ratio of males 66.6% was more as compared to the females 33.3% with maximum number of cases in the age group of 35-44 years of age been affected the most. 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* (29.1%) was the most common isolate followed by *E.coli* (20.8%), Pseudomonas *aeruginosa* with 16.6%, *S.aureus* with 16.6% and least for *Staphylococcus epidermitidis* and *Klebsiella oxytoca* with 8.3%. It was also noted that the site of the infection was most common in the superficial site with 62.5%. Imipenem, tigecycline, meropenem, chloramphenicol, amikacin, and gentamycin were effective against *E. coli* while these isolates were resistant to ampicillin, cefixime, amoxicillin, cefepime, ceftriaxone, amoxicillin-clavulanic acid, and ciprofloxacin. In case of GPC, Gram-positive isolates were 100% susceptible to teicoplanin, vancomycin and linezolid but 25% resistance was observed for cefoxitin.

Conclusion: As the medical landscape evolves, there is a critical need to provide a comprehensive knowledge of the many factors that contribute to surgical site infections, with the overriding goal of supporting more effective management and prevention efforts. By thoroughly investigating these factors, we hope to improve patient safety and the quality of surgical care in this period of changing healthcare problems.

Keywords:SSI, Prevalence, Risk factors, Surgery, Post operative

INTRODUCTION

Surgical site infections (SSI) are the third most commonly reported nosocomial infection, accounting for roughly 25% of all nosocomial infections. It has a negative influence on both the hospital and the patients. It is responsible for increasing the length of stay of patients, resulting in social and economic losses for patients and their families. SSIs are serious operative complications that occur in approximately 2% of surgical procedures and account for 20% of healthcare-associated infections. Host factors, wound variables, and surgery-related factors are

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all implicated in the development of SSI [1].It is a common, general postoperative occurrence that causes significant morbidity but can also result in mortality. Surveillance of SSIs is an important infection control measure [1]. Despite technological breakthroughs in infection control and surgical techniques, SSI remains a significant concern, even in hospitals with the most contemporary facilities [2].

Sources of SSIs include the patient's own normal flora, organisms present in the hospital environment that are introduced into the patient by medical procedures, specific underlying diseases, trauma, or burns that may cause a mucosal or skin surface interruption. These infections are typically caused by both foreign and endogenous microorganisms that enter the operation wound either during (primary infection) or after (secondary infection). Primary infections are typically more severe than secondary infections and develop within five to seven days of surgery [3]. The majority of SSIs are straightforward and affect only the skin and subcutaneous tissue, but they can occasionally spread to an internal organ or bodily cavity, resulting in tissue necrosis.Each year, a significant amount of morbidity and mortality is caused by infection at or around the surgical site, which occurs within 30–90 days of an operative procedure. A Centers for Disease Control and Prevention (CDC) survey from 2015 estimated approximately 110,800 SSIs among inpatient surgeries. There was 5% reduction in SSIs in 2020 when compared with 2015 data as baseline among all NHSN operative procedure categories combined [4].

Every year, around 160,000 to 300,000 SSI are identified and treated, posing a significant burden on healthcare systems in terms of re-operations, increased post-surgical pain, poor wound healing, longer hospital stays, cosmetic appearance, and lower quality of life [4,5]. The frequency of all varieties of SSI following abdominal surgery can approach 14% of all hospital-acquired infections, with the most common form being incisional superficial SSI, which is frequently the first to show and is simple to detect [6]. A systematic evaluation of research in low- and middle-income countries found that SSI was the most common cause of hospital-acquired infection.

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 [7, 8].

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Infected surgical wounds are typically characterised by pain, discomfort, warmth, erythema, swelling, and pus development [9]. Several 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 sterilisation of surgical instruments) can have a significant impact on the risk of SSIs.

In addition to these risk variables, the virulence and invasiveness of the organism involved, the physiological state of the wound tissue, and the host's immunological integrity all play crucial roles in determining whether or not infection develops. Bacteriological research have demonstrated that SSIs are universal, with the etiological agents varying by geographical location, surgery, surgeon, hospital, or even ward within the same hospital. In recent years, Gramme- Negative Bacilli have become a more common source of dangerous infections in several hospitals. In addition, irrational usage of broad-spectrum antibiotics and the resulting antimicrobial resistance (AMR) has further aggravated the situation in this regard.The problem is exacerbated in underdeveloped nations such as India due to poor infection control measures, congested hospitals, and inappropriate antimicrobial use. Surgical site infections continue to be a leading source of hospital-acquired infections, despite advancements in operating room practices, equipment sterilisation methods, superior surgical technique, and the best efforts of infection prevention strategies [3]. Even though SSI rates are rising globally, most contemporary facilities are following conventional protocols including antibiotic treatments. The risk factors associated with the development of an SSI vary according to specific patient factors and clinical characteristics, in addition to the nature of the surgical procedure.Despite improvements in surgical techniques, sterilisation of instruments, operation theatre practices, and the best efforts of infection prevention strategies, SSIs remain a major cause of hospital-acquired infections. These are further complicated by an increasing prevalence of multidrug-resistant organisms.Most of the time, it is the patient’s endogenous flora that is responsible for many SSIs, and the commonly isolated pathogens include *Staphylococcus aureus, coagulase-negative staphylococci*, *Enterococcus* spp., and *Escherichia coli* [10,11]. However, the identification of factors that cause or predict these SSIs remains an important area of research. Therefore the present study was undertaken to study the the clinical correlation of post operative associated risk factors of surgical site infections of patients.

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MATERIAL AND METHODS

The present study was a Cross-sectional study carried out in the Department of Microbiology with collaboration with the Surgery Department for a period of 12 months 1.e, from August 2023 to August 2024.The Study population and sampling technique used was the convenience sampling technique, where 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.

Inclusion criteria

The current study included all patients over 16 years of age, male and female, who had surgery and were admitted to the surgical wards during the study period.

Exclusion criteria

The study did not include any paediatric instances. Patients on immunosuppressive medication or any known immunodeficiency illness, patients using antibiotics for other infections, patients with infections elsewhere in the body, and patients who had a second operation performed at the same location for any reason were also not included in the study.

Data collection procedure

Through the review of the patient's case sheet, information was gathered regarding the patient's age, gender, demographics, clinical details, including the procedure name, date and duration of surgery, surgeon experience, preoperative hospital stay, type of surgery, postoperative hospital stay, and the onset of illness (SSI).48 hours after the procedure, the bandages covering the surgical wound were taken off. A wound infection was thought to be present if the patient showed signs of local inflammation at the wound site, such as edoema, redness, warmth, or discharge. Samples were taken to determine whether there was any discharge prior to the bandage being applied. Until the patient was discharged home, the wounds were monitored for the appearance of inflammatory changes only, without any discharge. Patients were monitored with the help of the appropriate surgeons if inflammatory signs appeared within 48 hours. Over the course of 30 days, these patients also received education and follow-up regarding the creation of SSIs via mobile phone.Before the material was collected using a sterile swab, the likely wound infections were cleaned with sterile normal saline and 70% alcohol. Within two hours, two swabs were extracted from the depth of the wound, and aspirates were gathered in a sterile,

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disposable syringe and sent to the lab. The samples' colour, consistency, and smell were examined and recorded.

Every wound swab and/or aspirate was directly applied as a thin smear to a sanitised, grease-free glass slide, which was then allowed to air dry. Following heat fixation, Gramme staining was performed using both positive and negative controls (*Escherichia coli* 25922 and *Staphylococcus aureus* 25923 from the American Type Culture Collection [ATCC]). Under the oil immersion (100X) objective, pus cells and bacteria were seen. Using conventional microbiological methods, the samples were cultivated onto MacConkey agar plates, 5% sheep blood agar, and nutrient agar. Plates were read during a 24-hour aerobic incubation period at 37°C, and the isolates were identified using biochemical assays, motility, colony morphology, and Gramme stain.

Data analysis

SPSS (Statistical Package for the Social Sciences) version 21 (IBM Corp., Armonk, NY) was used to analyse the data after it had been imported into Microsoft Excel (Microsoft Corp., Redmond, WA). Since all of the information gathered for this study was categorical, it was displayed in a table as frequency and percentage. Additionally, a pie chart was used to display the information. The Chi-square test was used to evaluate the relationship between risk factors and the existence of SSI.

RESULTS

A total of 162 patients underwent different types of surgeries, including elective as well as emergency procedures, during the study period. About 24SSIs were documented, and the overall prevalence of SSI rate during the study period wasobserved to be 14.8%

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

SiteofSurgery	TypesofSurgeries	No.ofSurgeries,n(%)	SSI,n(%)
	Appendectomy	33 (20.3%)	2 (8.3%)
	Herniarepair	17 (10.4%)	4 (16.6%)
	Exploratorylaparotomy	7(4.3%)	6 (25%)
	Cholecystectomy	5 (3.0 %)	2 (8.3%)

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Abdomen	Lowersegmentcesariansection	18 (11.1%)	1(4.1%)
	Hysterectomy	14 (8.6%)	2(8.3%)
Pelvis	Sphincterotomy	1(0.6%)	1(4.1%)
	Hemorrhoidectomy	1(0.6%)	1(4.1%)
	Fistulectomy	6 (3.7%)	3(12.5%)
	Hipreplacement	1 (0.6%)	Nil
Urogenital	Transurethralresectionofprostate	3 (1.8%)	Nil
	Urethroscopylithotripsy	4 (2.4 %)	Nil
Breastandaxilla	Modifiedradicalmastectomy	2 (1.2%)	1(4.1%)
	Fibroadenomaexcision	7 (4.3%)	Nil
Skin,bone,andjoints	Kneereplacement	5 (3%)	Nil
	Varicosevein	6 (3.7%)	Nil
	Openreductionandinternal fixation	3(1.8%)	Nil
Eye	Intraocularlensimplantation	17 (10.4%)	Nil
Ear,nose,throat	Tonsillectomy	8(4.9%)	Nil
	Mastoidectomy	2(1.2%)	Nil
Neurosurgery	Neurosurgery	2(1.2%)	1(4.1%)
Total		162	24

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

From the table 2 is was observed that the ratio of males 66.6% was more as compared to the

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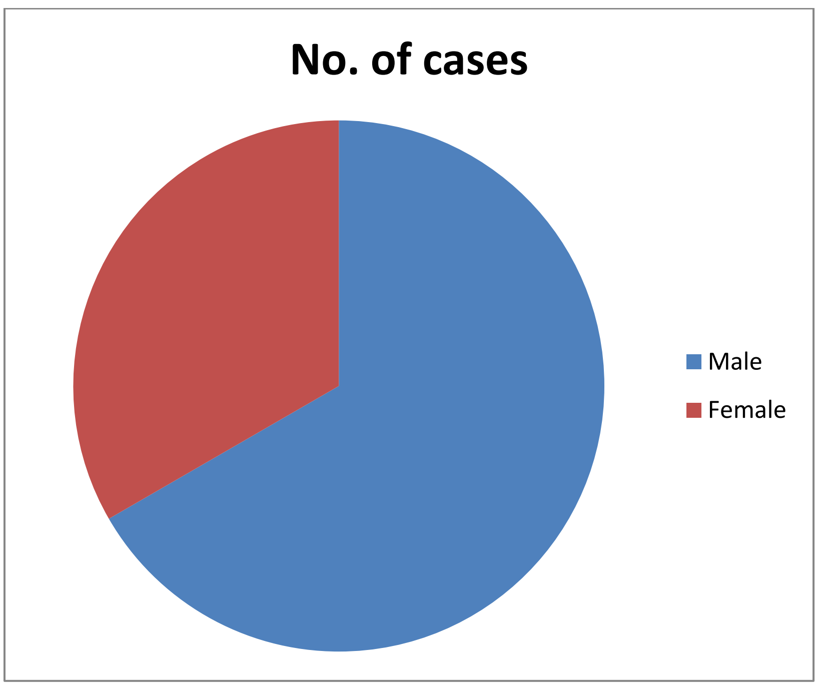
females 33.3% with maximum number of cases observed in the age group of 35-44 years of age with 41.6% [Table 3].

Gender	No. of Isolates	Percentage
Male	16	66.6
Female	8	33.3

Table 2: Genderwise distribution of the cases



Graph No. 1: Graphical Representation of the Genderwise distribution of the cases

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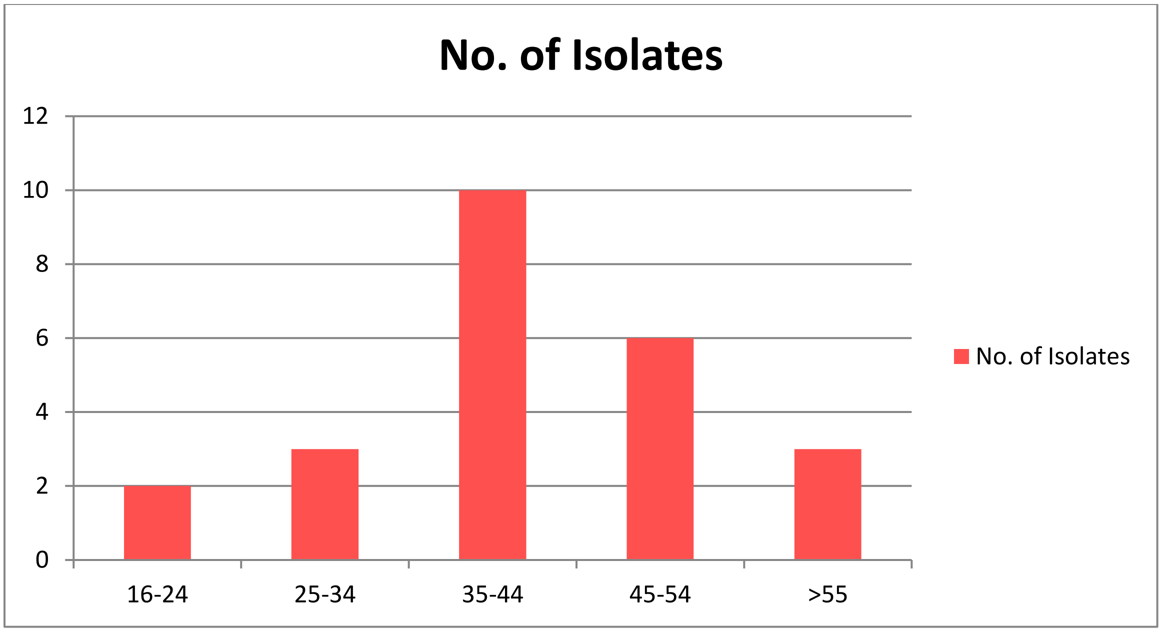

Graph No. 2: Graphical Representation of the Agewise Distribution of the Isolates

Table 3: Agewise Distribution of the cases

Agegroup(years)	No. of cases	Percentage
16-24	2	8.3
25-34	3	12.5
35-44	10	41.6
45-54	6	25
≥ 55	3	12.5

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Type of organisms Isolated	Number of Isolates	Percentage
Klebsiella pneumoniae	7	29.1%
E.coli	5	20.8%
Pseudomonas aeruginosa	4	16.6%
Staphylococcus aureus	4	16.6%
Staphylococcus epidermitidis	2	8.3%
Klebsiella oxytoca	2	8.3%
Total	24	100%

Table 4: The Type of Isolates causing SSIs

In the present study it was observed that *Klebsiella pneumoniae* (29.1%) was the most common isolate followed by *E.coli* (20.8%), *Pseudomonas aeruginosa* with 16.6%, *S.aureus* with 16.6% and least for *Staphylococcus epidermitidis* and *Klebsiella oxytoca* with 8.3%.

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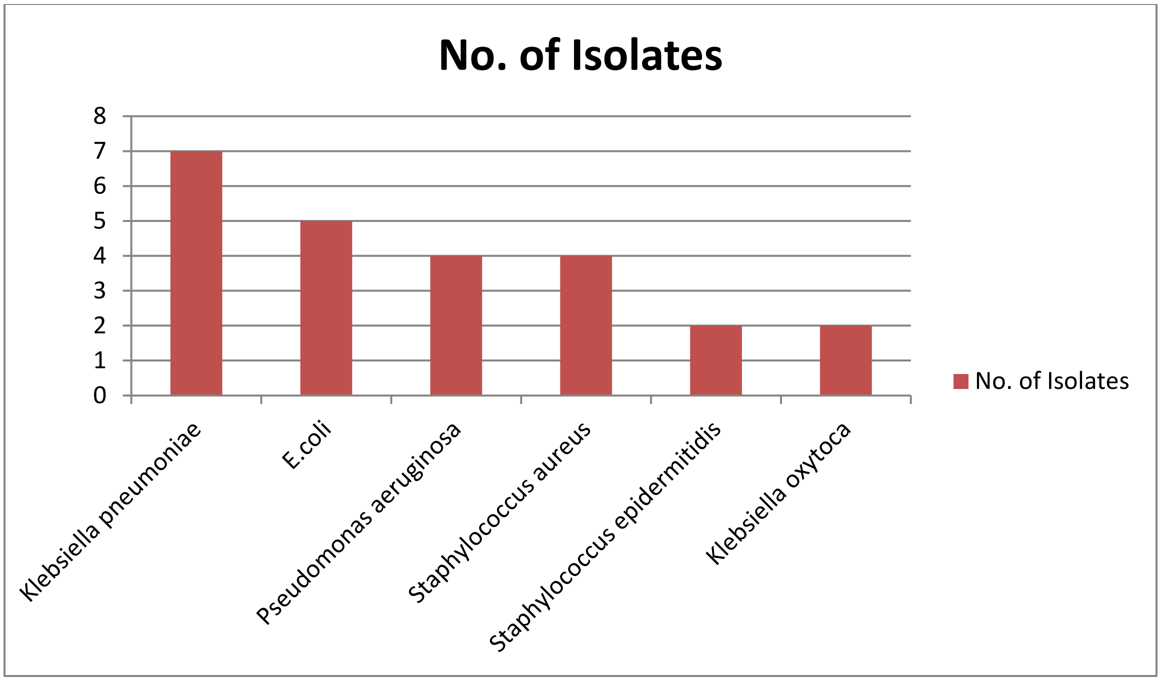

Graph No. 3: Graphical Representation of the Number and the Type of Isolates

S.No	RiskFactors		FrequencyofSSI	Percentage (%)
1.	Typeofsurgery	Emergency	19	90.4
		Elective	5	20.8
2.	Extendofwound	Superficial	15	62.5
		Deep	8	33.3
		Organ	1	4.1

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3.	Diabetesmellitus	Yes	14	58.3
		No	10	41.6
4.	Smoking	Yes	15	62.5
		No	9	37.5
5.	Alcoholism	Yes	14	58.3
		No	10	41.6
6.	Anemia	Yes	14	58.3
		No	10	41.6
7.	Hospitalstay	1-7days	14	58.3
		>7days	10	41.6
8.	Drain	Yes	12	50
		No	12	50

Table 5: Distribution of Risk factors of the Study Population according to SSI (n = 24)

DISCUSSION

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SSIs are serious operative complications that occur in approximately 2% of surgical procedures and account for 20% of healthcare-associated infections. Many studies have reported that SSIs rank third among common nosocomial infections, next to the urinary tract and respiratory tract infections [12,13]. Recent studies reported that the SSI rate ranges from 19.4% to 36.5% all over the world, whereas it ranges from 3% to 12% in India [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 [3].

In the present study out of the total of 162 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 24 cases and hence was considered as cases of SSI in the hospital thus, the overall prevalence rate of SSIs was 14.8% in the present study.

The present study was in support to the studies performed by the other investigator 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. 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 [18].

In the present study it was observed that the ratio of Males 16 (66.6) was more as compared to that of females 8 (33.3%).

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%). A study by Hernandez et al., reportedmore 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].

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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 [22,23]. The study by Devjani De et al in 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].In the present study, it was observed that superficial and deep SSIs were observed with the ratio of 62.5% and 33.3% respectively. There was only 4.1% SSIs observed in the organ site. This study was in alignment to the study by Astha Regmi et al [25,26] in 2021 where the maximum number of cases were observed in superficial site with 94.85%. Another study by Sedina Atic Kvalvik et [27] was also in support to the present study where 77.3% were the superficial site affected. Study by Amanu Gashaw et al [28] in 2022 was also found similar to the current study with superficial 64.7% being affected the most. It was also observed that there were increase cases in the emergency ward (90.4%). 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].It was observed that *Klebsiella pneumoniae*7 (29.1%) was the most common isolate followed by *E.coli*5 (20.8%), *Pseudomonas aeruginosa* with 16.6%, *S.aureus* with 16.6% and least for *Staphylococcus epidermitidis* and *Klebsiella oxytoca* with 8.3%. 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.*

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aeruginosa (15.9%) and *Citrobacter spp* (15.9%) [19]. Similar finding was observed by Mohammad Eid M Mahfouz et al in 2024 where out of 40.8% (n = 53) of patients, the most detected pathogenic bacteria was *Escherichia coli*, followed by *Staphylococcus aureus* (n = 11, 44%, and n = 7, 25%, respectively) [29].According to a similar study, *Staphylococcus aureus* was the most frequently detected organism among patients with SSI, followed by *Pseudomonas aeruginosa* and *Escherichia coli* [30].There was another study which was in accordance to the present study where out of 108 isolates, 43 (39.8%) were gram-positive and 65 (60.2%) were gram-negative bacteria. *Escherichia coli* (39.8%) was the most commonly isolated organism [31].

Imipenem, tigecycline, meropenem, chloramphenicol, amikacin, and gentamycin were effective against *E. coli* while these isolates were resistant to ampicillin, cefixime, amoxicillin, cefepime, ceftriaxone, amoxicillin-clavulanic acid, and ciprofloxacin. In case of GPC, Gram-positive isolates were 100% susceptible to teicoplanin, vancomycin and linezolid. There was 25% ressitance observed for cefoxitin. This study was parallel to the study by Dahal et al in 2024 [31]. Bacteriological studies have demonstrated that SSIs are widespread, and the etiological agents involved can vary by geography, operation, surgeon, hospital, or even ward [32, 33]. 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.Over the past few decades, a number of interventions have been put forth and used in an effort to stop SSI. Skin cleansing procedures, hair removal, maintaining intraoperative normothermia, administering preoperative antimicrobial prophylaxis, using plastic adhesive skin barriers, high flow oxygen supplementation, wound protection, instrument sterility, bowel preparation, incision length, and delayed primary incision closure are a few of these [34]. Surgical-site infection (SSI) is one of the most common health-care-associated infections, substantially contributing to antibiotic use. Targeted antibiotic prophylaxis to prevent SSIs and effective treatment are crucial to controlling antimicrobial resistance (AMR) [35].

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The management technique is guided by the location and severity of the infection, as well as the patient's clinical status. Establishing the global incidence of SSIs in general surgical patients is critical for understanding the condition's scope, societal impact, and the demographic and clinical risk factors that predispose general surgical patients to developing SSIs. As a result, the current study aimed to investigate the prevalence and risk factors of surgical site infections in patients.Awareness should be created about the adverse effects of antimicrobial resistance among patients as well as clinicians. Every acute healthcare facility should create and put into practice its own version of evidence-based guidelines for the prevention of such infections.

CONCLUSION

Gram-negative bacteria were found to be more predominant in the postoperative wound samples. From the present study it was observed that microorganisms, both gram-positive and gram-negatives are resistant to more commonly used drugs. The very high levels of antimicrobial resistance among bacteria causing SSIs along with high rate of MDR organisms complicates the management of patients with prolongation of hospital stay and increased financial loss.

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.

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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