Volume - 14 | Issue - 02 | February - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr

INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

SURGICAL SITE INFECTIONS IN ABDOMINAL SURGERIES PREVALENCE, RISK FACTORS, AND BACTERIAL PROFILE- A PROSPECTIVE CROSS-SECTIONAL STUDY

General Surgery

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ABSTRACT

Introduction: Surgical site infections (SSIs) are a primary cause of unfavorable consequences following surgery. A local pattern must be known in order to design a successful hospital infection program. The management of SSIs has become difficult due to the constantly shifting pattern of infections and the improper use of antibiotics, which has led to the emergence of drug-resistant strains. The study's goals are to determine the most frequent organisms and risk factors linked to SSIs, as well as to estimate prevalence. **Methodology:** During a six-month study period, this analytical cross-sectional study assessed the associations between different risk factors and the occurrence of SSIs in patients who underwent elective surgery and remained in the Department of General Surgery at least seven days after surgery. We used modified CDC criteria to diagnose SSIs. In cases of probable subsequent septicemia, we collected blood following the wound. We cultured blood samples on brain-heart infusion broth while we cultured pus on MacConkey and blood agar. We used Mueller-Hinton agar and the Kirby-Bauer method to test for antimicrobial sensitivity. **Results:** In 13 out of 50 postsurgical wound infections, Gram-negative organisms outnumbered Gram-positive ones. Age, BMI, wound class, American Society of Anesthesiologists (ASA) score, preprocedural WBC count > 10,000, and surgical time are the risk factors linked to this study. Escherichia coli causes the majority of infections (45.7%). This investigation identified gram-negative bacteria that produced extended-spectrum lactamase (ESBL). The majority of microbes were multidrug resistant. Overall, 26% of gastrointestinal procedures resulted in SSIs, according to the current study. Hospitals can develop a successful antibiotic prophylactic policy by using the sensitivity and resistance patterns of the isolated bacteria.

KEYWORDS

SSI, prevalence, Microbes, risk factors

INTRODUCTION:

Most preventable mortality and morbidities result from surgical site infections (SSIs), commonly referred to as postoperative wound infections. SSIs account for about 14%–16% of all nosocomial infections among hospitalized patients, making them the third most reported nosocomial infection [1, 2]. SSIs often make it more difficult for patients to recover, requiring them to pay for extended hospital stays. They may also have certain negative effects, such as premature death.

Surgical site infections (SSIs) are defined by the CDC as infections that occur at the surgical site or area of the body, persisting for up to 30 days without implants and up to 1 year if the patient has an implanted device. Nonetheless, nearly 90% of SSIs appear during the second week following surgery, and 50% appear in the first week. Both the type of surgery and the patient's demographics influence the causal infections; in gastrointestinal surgeries, Escherichia coli, Enterococcus faecalis, and Pseudomonas aeruginosa are the most frequently isolated organisms [3].

We can categorize SSIs into three types: deep incisional, which affects muscle and fascia; superficial/incisional, which only affects skin and subcutaneous tissue; and organ space, which affects a bodily cavity (such as the abdominal cavity after gastrointestinal surgery). While deep tissue and organ space SSIs are less common than surface SSIs, they are associated with higher rates of morbidity and death, readmissions, longer hospital stays, and higher total hospital-associated expenses. While most SSIs are simple, some, like necrotizing deep soft tissue infections, can be more serious and difficult to treat. The latter can even be fatal and frequently necessitate numerous reoperations and significant surgical debridement.

Infected wounds can extend a patient's hospital stay by five to twenty days, leading to a significant rise in their medical costs [4]. SSIs are the cause of death in 75% of cases, and they have a 3% mortality rate [1].

Hospital infection control measures are ineffective in many poor and low-resource nations. Because of advancements in infection control measures such as excellent ventilation in operating rooms, sterilizing methods, and hand hygiene practices, developed countries have been able to reduce the incidence of SSI [5]. However, countries with lower health budgets tend to exhibit higher rates of SSI.

The management of SSIs has become difficult due to the constantly shifting trends in hospital-acquired infections (HAIs) and the improper use of antibiotics, which has led to the emergence of drug-resistant strains. It is necessary to conduct thorough and regular surveillance of different HAIs due to the rise in nosocomial infections and multi-drug resistance. Programs tracking infections must also use consistent language to avoid calculating and reporting disparate SSI rates [6]. Knowledge of local trends is crucial for developing a successful hospital infection program. This kind of data could be useful for hospital infection management and prove to be informative on a nationwide scale.

Methodology:

There are fifty participants in this analytical cross-sectional study. After receiving approval from the Institutional Ethics Committee, the Department of Surgical General Surgery conducted a six-month study from June to December 2024 to examine the prevalence of SSIs and microbiological isolates as well as the association between different risk factors that contribute to SSIs. Those who met the study's inclusion requirements gave their informed permission.

This study included individuals who underwent elective procedures and stayed for at least seven days afterward. We excluded individuals who were immunosuppressed or taking immunosuppressive drugs like steroids, as well as specimens collected and labeled incorrectly.

Demographic details, including age, sex, socioeconomic status, nutritional status, smoking history, alcohol consumption, and the patient's medical history, were gathered from preoperative to postoperative assessments. Comorbidities such as diabetes, hypertension, chronic obstructive pulmonary disease, renal insufficiency, and a history of immunosuppressant medication use were seen. Operative-level criteria include the American Society of Anesthesiologists (ASA) score, wound classification, surgical type, duration of surgery, history of prior blood transfusions, and volume of blood loss. Prior to dressing, we obtained pus from the site utilizing a sterile swab; microbiological data were gathered every 24 hours.

The 30-day SSI incidence, as defined by US CDC criteria, constituted the primary outcome measure. The ultimate goal is to improve patient outcomes and guide best practices in surgical care. Infection Event of the CDC [1].

Ethics Committee:

The research was approved by the Institutional ethics committee of Kanyakumari Government Medical College and research was conducted in accordance with the Declaration of Helsinki. All participants in this study are explained about the procedure, their rights, withdrawal from the study option and contact person details for clarifications in their language and signed in the presence of a witness.

The consent for the publication of the study data , without the identity of individual is obtained .

Statistical Analysis:
The risk factors for the patients were analyzed statistically using IBM SPSS Statistics for Windows, Version 27. Analysis of continuous data utilizing the mean and standard deviation, and categorical variables employing frequency and percentage. A p-value below 0.05 was considered statistically significant with a 95% confidence range.

RESULTS

Distribution of age and sex
The 50 participants had an average age of 42.71 years, with a standard deviation of 19.16. Eleven years was the minimum and 76 years was the maximum. The participants' age distribution is displayed in Table 1. Three individuals with ages under or equal to 20 years developed SSIs (42.85%); two individuals with ages 21 to 35 developed Social Security Disability (22.23%); four individuals with ages 36 to 50 developed Social Security Disability (26.67%); two individuals with ages 51 to 65 developed Social Security Disability (18.18%); and one individual over 65 developed an SSI (12.5%). Of the study's participants, approximately 68% (n = 34) were male, with 11 of them experiencing SSIs (32.35), and 32% (n = 16) were female, with one experiencing an SSI (6.25%).

Table 1 Shows The Distribution Of Participants' Ages And Sexes Who Had SSIs (N = 50).

Distribution of ages	Participants' number (n)	The number of infected participants (n)
≤ 20	7	3
21-35	9	2
36-50	15	4
51-65	11	2
>65	8	1
Sex distribution of participants	Male	34
	Female	16

Table 2 shows that the overall infection rate was 24% (n = 12), with deep incisional infections accounting for 25% and superficial incisional infections for 75%. The current analysis discovered SSIs 6.25 days after they occurred on average.

The type of infection among study participants who experienced SSIs (N = 50) is displayed in Table 2.

Table 2: Type Of Infection Among Study Participants Who Developed SSIs (N=50)

Participants	Frequency (n)	Type of infection	Frequency (n)
Infected	12	Superficial SSI	9
		Deep SSI	3
Not infected	38		

Class Of Wounds
The Centers for Disease Control and Prevention revised the SWC system and divided wounds into four classes to represent the bacterial load [8]. Class 1 includes clean wounds that are free of infection and inflammation. There is no compromise to the respiratory, alimentary, or urogenital tracts. Access into the respiratory, alimentary, genital, or urinary tracts occurs only under controlled settings in Class 2, classified as clean/contaminated with a low level of contamination. Usually, a gastrointestinal system leak or a breach in sterile procedures causes Class 3 contaminated wounds. A ruptured viscus, purulent discharge, fecal contamination during surgery, or an active infection in the surgical site distinguish Class 4 wounds as unclean or infected. Two out of five individuals with wound class 1 experienced SSI development (40 percent); three out of 35 participants with wound class 2 experienced SSI development (8.57%); six out of nine participants with wound class 3 experienced SSI development (66.67%); and one patient experienced SSI with wound class 4 (Table 3).

Table 3: The Wound Class And SSI Frequency Of The Subjects (N =50) Are Displayed.

Wound class	Description	Total (n)	Participants with SSIs (n)
1	Clean	5	2
2	Clean/contaminated	35	3
3	Contaminated	9	6
4	Dirty/Infected	1	1

Identified Microbes:
In 83.34% of the 12 patients with positive cultures, a single pathogen infection was identified, whereas a mixed culture containing MRSA, E. coli, Klebsiella, and Pseudomonas was observed in 16.66% of the patients. Escherichia coli constituted 35.7% of all isolated species from culture (5 out of 12 cultures), whereas Klebsiella represented 28.5% of all isolated cultures (4 out of 12 cultures) (Table 4). Nine out of twelve cultures (75%) contained gram-negative bacteria, while one culture comprised a mixed strain of both E. coli and MRSA. According to Table 5, two out of the twelve patients had subsequent septicemia.

Table 4: The Infections Linked To SSIs In Study Participants (N = 50) Are Displayed

Organism	Number (n)	Percentage (%)
Escherichia coli	5	35.7
Klebsiella	4	28.5
Pseudomonas	2	14.2
Acinetobacter	2	14.2
MRSA	1	7.1

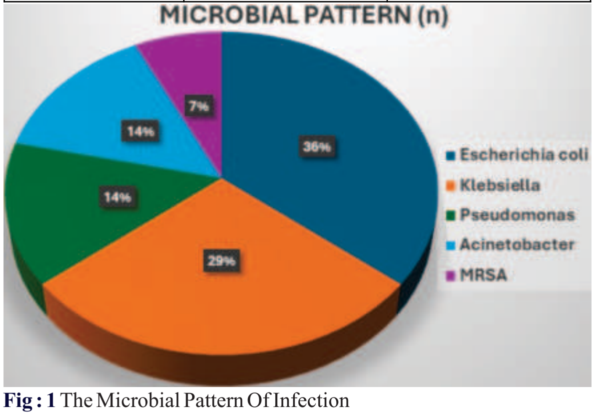

Fig : 1 The Microbial Pattern Of Infection

Table 5: Pathogens Identified In Persons With Secondary Septicemia (N = 50)

Secondary septicemia participants	Correlation between samples	
	Wound	Blood
Participant 1	Klebsiella	Klebsiella
Participant 2	E. coli and MRSA	Staphylococcus aureus

Antibiotic Susceptibility Patterns Of The Isolates:
The investigated medications included carbapenems (Meropenem and Imipenem), quinolones (Ciprofloxacin, Norfloxacin, and Levofloxacin), cephalosporins (Cefepime, Cefotaxime, and Ceftazidime), and tigecycline for Gram-negative bacteria. Penicillin, ampicillin, bacitracin, vancomycin (minimum inhibitory concentration for Staphylococcus aureus), doxycycline, teicoplanin, and linezolid were assessed for a Gram-positive bacterium. The Gram-negative organisms found in the investigation exhibited complete resistance to both amoxicillin-clavulanate (100%) and ciprofloxacin (100%), as illustrated in Table 6. Except for tigecycline (100% sensitivity), amikacin (60% sensitivity), and gentamicin (20% sensitivity), E. coli, the predominant isolate (5 out of 12), shown significant resistance to all other tested antibiotics. Klebsiella exhibited 50% sensitivity (1 out of 2) to gentamicin, amikacin, meropenem, and cotrimoxazole, while demonstrating 100% sensitivity (2 out of 2) to tigecycline and imipenem. Table 7 indicates that the gram-positive isolate, MRSA, exhibited susceptibility to vancomycin, doxycycline, teicoplanin, and linezolid.

The Link Between Risk Factors And SSIs :
The patient's whole medical history, from preoperative to postoperative procedures, was gathered, and they were then routinely checked on. The following details were examined: Co-morbidities include a history of diabetes mellitus, hypertension, chronic obstructive pulmonary disease, renal insufficiency, and recent use of immunosuppressants; patient level factors include age, sex, socioeconomic information, BMI, alcohol consumption, and smoking; operative level factors include ASA score, wound class, type of surgery, duration, blood loss during the procedure, and history of

transfusions; and other environmental factors (Table 7). Among the variables examined, the preprocedural WBC count, wound class, ASA score, and length of surgery were found to be statistically significant risk factors for the occurrence of SSIs.

Table 6 Shows The Antimicrobial Susceptibility Patterns Of Gram-negative Bacterial Isolates From The Wound Cultures Of Participants Suspected Of Having SSIs (N = 12).

Organism isolated	Sample	IMP	TGC	GEN	AK	FEP	CAZ	MRP	CIP	LEV	TAX	TMP-SMX	PTZ	AMC
Pseudomonas	pus	R	R	S	S	S	R	S	R	R	R	R	S	R
Acinetobacter	pus	R	S	R	R	R	S	R	R	R	R	R	R	R
Klebsiella	Pus	R	S	R	R	R	R	R	R	R	R	S	R	R
Pseudomonas		R	R	S	S	S	R	S	R	S	S	R	S	R
Klebsiella	serous discharge	R	S	R	R	R	R	R	R	R	R	R	R	R
E. coli	pus	R	S	R	R	R	R	R	R	R	R	R	R	R
Acinetobacter	serous discharge	R	S	S	R	R	R	R	R	R	R	R	R	R
E. coli	serous discharge	R	S	R	S	R	R	R	R	R	R	R	R	R
E. coli	pus	R	S	R	R	R	R	R	R	R	R	R	R	R
E. coli	pus	R	S	R	S	R	R	R	R	R	R	R	R	R
Klebsiella	pus	S	S	S	S	R	R	S	R	R	R	S	R	R
E. coli	pus	R	S	S	S	R	R	R	R	R	R	R	R	R
Klebsiella	pus	S	S	R	R	R	R	R	R	R	R	R	R	R

(AMC stands for amikacin, FEP for cefipime, CAZ for ceftazidime, MRP for meropenem, CIP for ciprofloxacin, LEV for levofloxacin, TAX for cefotaxime, TMP-SMX for cotrimoxazole, PTZ for piperacillin tazobactam, NSIs for surgical site infections, and IMP for imipenem.)

Table : 7 Relationship Between The Study Participants' (N=50) SSIs And The Risk Factors That Were Shown To Be Significant SSIs:

Risk factor	Parameter	Infected (n)	Not infected (n)	p-value
Surgery duration	<2 hours	9	16	0.047
	>2 hours	3	22	
ASA score	1	0	1	0.042
	2	0	8	
	3	11	28	
	4	1	1	
Wound class	1	2	3	0.01
	2	3	32	
	3	6	3	
	4	1	0	
Preprocedural WBC count	< 10,000	5	29	0.026
	>10,000	7	9	

DISCUSSION:

According to the current study, 24% of SSIs will occur. It is consistent with the rates observed across India, albeit being far higher than those reported in surgical literature. The patients' pre-existing illnesses and co-morbidities may be the cause of the increased rates in this study [9]. Several criteria were statistically examined to determine the risk variables that contribute to the development of SSIs. According to the findings of the logistic regression analysis, SSIs were associated with the

- patient's age,
- nutritional state,
- ASA score,
- wound type,
- preprocedural WBC count, a
- surgical length.

One risk factor that surfaced was the patient's age (p=0.046). According to Table 1, the age group of 21 to 50 had the greatest rates. Because of a declining immune system, pre-existing co-morbidities, and a poor reaction to stressors—delayed or impaired wound healing is a significant contributing factor—the likelihood of infection increases in direct proportion to age, particularly after the age of 50. Males were more likely to get SSIs in the current study. Due to the unequal number of male and female participants, the nature of the association between sex and SSI is unknown and has not yet been revealed.

Both underweight (BMI<18.5 and overweight (BMI>25) were linked to postsurgical wound infection in the current study (p=0.032). Patients who are malnourished have weakened immune systems, which can be restored by giving them nutritional support prior to surgery. This is believed to be beneficial in lowering the risk of infections, particularly in cases of colorectal cancer [9]. Obese people have less skeletal muscle mass because their mobility is impaired. Inadequate tissue perfusion, which provides insufficient nourishment necessary for tissue healing, exacerbates this [10].

When it comes to the consistent delivery of prophylactic antibiotics prior to surgery, the best time frame is 30 to 60 minutes prior to the incision [11,12]. Antibiotics with the lowest antibacterial spectrum are recommended for surgical prophylaxis in order to stop the emergence of multidrug resistance. Throughout the procedure, the antibiotic concentration should be kept constant. When there is a significant blood loss (>1500 ml blood) or when the procedure takes longer than expected, a second dose is recommended. In certain circumstances, SSIs with related comorbidities may be caused by blood transfusions because of their immunomodulatory action. It has been demonstrated that a surgical procedure lasting more than two hours is an independent risk factor for the emergence of infection (p=0.047) [13]. The development of SSIs is directly correlated with the ASA score (p=0.042) and wound class (p=0.01). It has been established that ASA scores of II and III are independent risk factors for the onset of SSIs [14]. Patients with an ASA score of 4 or 5 had a lower risk of SSIs, which is explained by the fact that a small percentage of the population is categorized in this manner, which is like the inconsistencies occasionally seen in this study because of varied wound class.

Age, operation difficulty, and personal taste all influence the type of anesthetic used. The current analysis finds no significant correlation between the development of wound infection and general versus regional anesthesia, despite several studies showing a higher prevalence of SSIs with the use of general anesthetic. Fluid and electrolyte imbalances, as well as compromised host defenses including reduced polymorphonuclear cell mobilization, are frequently linked to uncontrolled hyperglycemia. Parameters for long-term glucose control, such as a history of diabetes mellitus or HbA1c, may not be reliable indicators because short-term control of blood glucose levels and perioperative blood glucose levels have been proven to be reliable factors for assessing the development of infections [15].

A condition known as secondary bacteremia occurs when bacteria enter the bloodstream as a result of an infection. Two cases of postoperative bacteremia occurred, and some investigations have demonstrated that the risk is doubled for Staphylococcus aureus isolates or growth in mixed cultures [16,17]. These types of bloodstream infections are linked to a bad prognosis. As shown in Table 4, Escherichia coli is the most often isolated organism (35.7%), and it is noteworthy that most of the organisms isolated are Gram-negative. This result supports the findings of earlier investigations [18], which suggests that the patient's endogenous microbiome invading the gut may be the source of the infection. Anaerobes may proliferate promisingly in any situation that upsets the tissues' oxidation and reduction balance. Endogenous flora from the patient's epidermis or the leakage of intestinal contents after surgery are two possible sources of infection [19,20]. In this investigation, gram-negative bacteria that produced extended-spectrum β-lactamase (ESBL) were identified. In the current investigation, Klebsiella has demonstrated increasing resistance, with 50% of the isolates displaying carbapenem resistance. Because of their capacity to gather resistant plasmids, CRE has been developing recently [21]. Every Gram-negative isolate exhibited tigecycline sensitivity. The two Acinetobacter species that were identified for this study were only sensitive to tigecycline and colistin and exhibited multi-drug resistance. [22] Quinolones are glaringly ineffective.

Study Limitations:
Despite the correlation between the evaluated risk factors and the occurrence of SSIs, the cross-sectional nature of this study precludes the establishment of causality. The study did not consider other well-established characteristics that have a proven link with SSIs, such as shaving before surgery and using antibiotics. This study excluded emergency procedures. This single-centered analysis revealed a preponderance of Gram-negative pathogens and a modest number of infected cases. We may employ a multicentric strategy with a larger study sample to boost the study's power and provide insight into the patterns and risk factors linked to the development of SSIs in the study population. Furthermore, the data presented for a two-month period, which ignores environmental conditions and other confounding variables, may prevent proper extrapolation of incidence rate calculations to a full year.

CONCLUSIONS:
The current study found that 24% of abdominal procedures resulted in SSI, and it also details the risk factors that contribute to this incidence. The study found that higher risks were associated with the older age group, those with pre-existing comorbidities, wound class, and those who underwent complex surgeries that took a long time to complete. Therefore, we should prioritize maintaining an aseptic environment in operating rooms and strongly advise periodic evaluation of antibiotic resistance trends. The bacteria most likely to cause SSIs and the type of operation should determine the antibiotic prophylactic. Escherichia coli was the most frequently isolated bacterium in the current investigation (35.7%). The organisms that were isolated in this study and their sensitivity and resistance patterns, along with the sensitivity patterns of the main pathogen, will help make a good antibiotic policy for hospitals right now.

Funding Declaration : This study has not received any funding

Conflict Of Interest : NIL

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