

Research Article

Surgical Site Infections: Risk factors, aerobic bacteriological profile and it's antibiogram in a tertiary care hospital, Visakhapatnam – A Retrospective study

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ABSTRACT

Introduction: Surgical site Infections (SSIs) are one of the most common Hospital acquired or Nosocomial infections which leads to significant post-operative morbidity and mortality, prolonged hospital stay and increase in the economic burden to the patients. Despite advances in surgical techniques and surgical antimicrobial prophylaxis, SSIs continue to pose a challenge, particularly with the emergence of multidrug-resistant organisms even in the hospitals with most advanced settings. Surveillance of SSIs, analysis of risk factors and knowledge on local antibiogram patterns of the bacterial isolates is essential for effective prevention and management.

Methodology: This retrospective observational study was conducted in the Department of Microbiology of a tertiary care hospital in Visakhapatnam over a period of two years (October 2023–October 2025). All patients who underwent major elective or emergency surgeries and subsequently developed SSIs as identified under hospital-acquired infection surveillance were included. Demographic details, type of surgery, wound classification, and associated risk factors were analyzed. Bacterial isolates from SSI samples and their antibiotic susceptibility patterns were retrieved from hospital records. Data was analyzed using Microsoft Excel.

Results: Out of 4,395 surgeries performed during the study period, 46 cases of SSI were identified, giving an infection rate of 1.04%. SSIs were more common in females (80.4%) and in clean-contaminated surgeries (78.3%). Anaemia (26%) and diabetes mellitus were the most frequent risk factors. Gram-negative organisms predominated, with *Escherichia coli* being the most common isolate (41%), followed by *Pseudomonas aeruginosa* (21%) and *Klebsiella* species (17%). Gram-negative isolates showed higher sensitivity to Gentamicin and Meropenem, while Gram-positive isolates were uniformly sensitive to Linezolid and Teicoplanin.

Discussion: The low SSI rate reflects effective infection control practices. Identification of predominant pathogens, risk factors, and antibiogram patterns highlights the importance of targeted preventive strategies and periodic surveillance to further reduce SSIs.

Keywords: Antibiotic susceptibility, Hospital-acquired infection, Infection control practices, Postoperative wound infection, Risk factors, Surgical site infections (SSIs).

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INTRODUCTION

Surgical site Infections (SSIs) are one of the most common Hospital acquired or Nosocomial infections which leads to significant post-operative morbidity and mortality, prolonged hospital stay and increase in the economic burden to the patients [1,2].

According to the Centre for Disease Control and Prevention (CDC), SSIs account for nearly 20–30% of all healthcare-associated infections worldwide [3].

Centre for Disease Control and prevention (CDC), Atlanta, defines Surgical Site Infection (SSI) as an infection occurring within 30 or 90 days after a surgical operation or within 1 year if an implant is left in place after procedure and affecting either incision or deep tissues at the operation site. These infections may be superficial infections or deep incisional infections involving organ or body space. As per CDC, wounds are classified as Class I/Clean, Class II/Clean contaminated, Class III/Contaminated, Class IV/Dirty-infected [3,4].

The pathogenesis of SSI has been associated with both the endogenous contamination such as skin flora and exogenous contamination by healthcare personnel or contaminated surgical instruments. Other factors such as burden of organism and virulence of pathogen also plays a role in the occurrence of SSI [5,6]. Many risk factors like pre operative, intraoperative, postoperative and patient related factors play a significant role in the occurrence of SSI.

Although surgical antimicrobial prophylaxis can reduce postoperative Surgical Site Infections (SSI) due to bacterial contamination with normal skin flora, SSIs still continue to be a major problem even in hospitals with most modern facilities [7]. Widespread use of prophylactic broad-spectrum antibiotics can lead to emergence of multi-drug-resistant bacteria. Since initial antibiotic therapy is empirical, it is important to know the prevailing antibiotic susceptibility patterns of individual institutions by routine surveillance [8]. SSI is one of the quality indicators of the health care system of any hospital. With the increase in incidence of nosocomial infections and multi-drug resistance, a meticulous and periodic surveillance of various hospital acquired infections became mandatory [9]. With an active Infection Control team operating in the hospital, SSI surveillance is one of the top most priority. Hence the following study was undertaken to identify the local burden of SSIs, determine the aerobic bacteriological spectrum and antibiogram, and analyze relevant risk factors causing SSIs.

Objectives of the study:

- To estimate the proportion of SSIs during the study period
- To describe the risk factors associated with SSIs in our hospital
- To identify the common bacterial isolates from pus samples of SSI cases
- To study the antibiogram of the isolated organisms

METHODOLOGY

This observational study was done in the Department of Microbiology in a tertiary care hospital in Visakhapatnam. The study period was from October 2023 to October 2025(2 years).

The patient details such as type of surgery, type of wound class including clean, clean contaminated and contaminated were recorded. (**Table No.2**) (**Figure No.2**)

Inclusion criteria

Patients who underwent emergency or elective major surgeries in any surgical department of the hospital and subsequently developed Surgical Site Infection (SSI) as identified under the Hospital-Acquired Infection (HAI) surveillance during the study period.

Exclusion criteria

Patients who underwent minor surgical procedures which are not included in the Hospital-Acquired Infection (HAI) surveillance, Patients with a pre-existing infection at the surgical site at the time of surgery (PATOS) and Patients who had undergone surgery at another hospital and presented with symptoms of SSI prior to admission to our hospital are excluded from the study.

Study procedure

Demographic details and information on pre-operative, intra-operative, and post-operative risk factors for SSIs are obtained from the Medical Records Department (MRD) and analyzed. Permission to access the medical records prior to data collection was taken.

The details of the bacterial isolates from the clinical samples of SSI cases and their antibiotic susceptibility reports are retrieved from the case sheets or hospital data base and are analyzed.

Statistical analysis was done using Microsoft excel.

RESULTS

A total of 4395 patients were operated during the study period. Out of which 46 patients developed surgical site infections. Infection rate was 1.04%. Out of the 46 patients, 9(19.6%) were males and 37 (80.4%) were females (Figure No.1).

In the cases included, 8 (17.4%) were clean surgeries, 36 (78.3%) were clean contaminated and 2(4.3%) were contaminated surgeries (Figure No.2).

Among the 46 SSI patients, more patients were in the age group between 41-60 years accounting for 37% (Table No.1) and Elective surgeries were 22(47.8%) and Emergency surgeries were 24(52.2%) (Figure No.3)

Figure 1: Gender Distribution of SSI Cases (n=46)

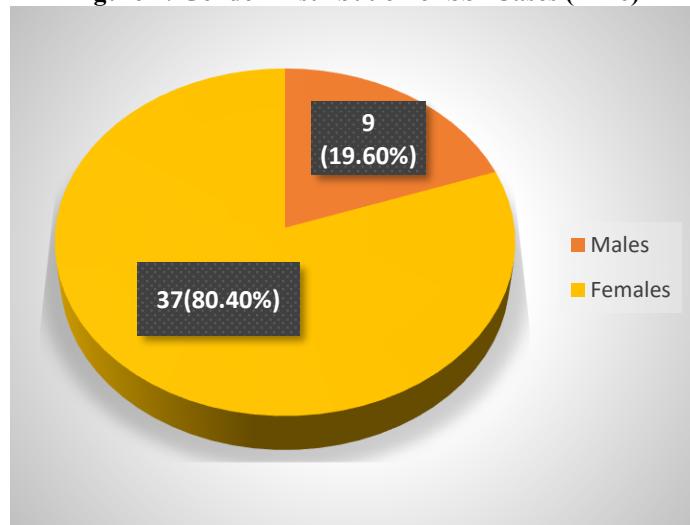


Figure 2: Type of Wound class in SSI Cases (n=46)

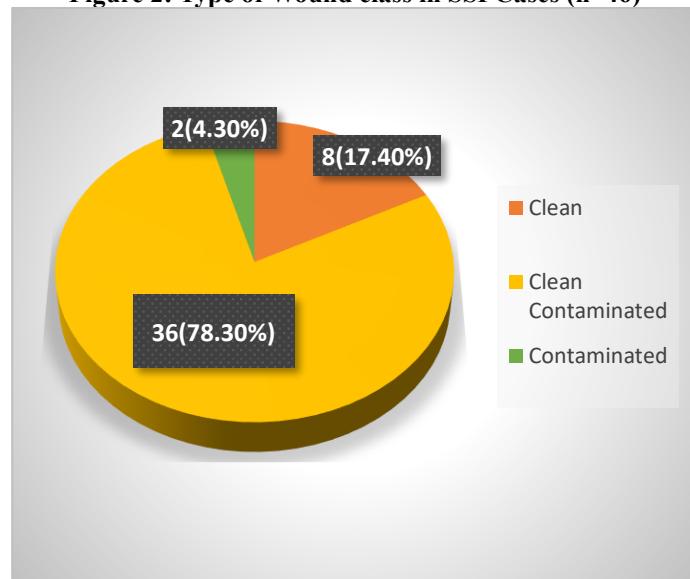


Table No.1 Age wise distribution of SSI patients(n=46)

Age Group (years)	Number of SSI Cases	Percentage
<20	3	6.5%
21-40	23	50%
41-60	17	37%
61-80	3	6.5%
>80	0	0

Figure 3: Category of surgery in SSI cases

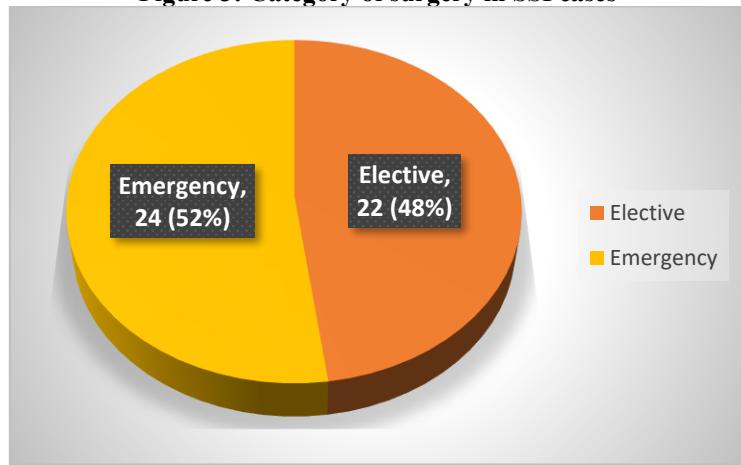


Table No.2: Details of type of Surgery

Name of surgery	Number of SSI patients(n=46)
Lower Segment Caesarean Section (LSCS)	20
Exploratory laparotomy	4
Extended right hemicolectomy and side to side ileocolic anastomosis	1
Total Abdominal Hysterectomy (TAH)+Bilateral Salpingo-oophorectomy	6
TAH + Left Salpingectomy	1
Umbilical Hernioplasty	2
Laparoscopic cholecystectomy	2
Open cholecystectomy	2
Laparoscopic Appendicectomy	1
Hernioplasty with mesh repair	2
Total Knee Replacement (TKR)	1
Arthroscopic Anterior crucial ligament (ACL) reconstruction of Right knee	1
Right Hip Bipolar Hemiarthroplasty	1
Left Patellar tendon repair	1
Open Reduction with Internal Fixation with Plating Left Tibia	1

Table no.3 Distribution of risk factors(n=46)

Factor observed	N	%
Anaemia	12	26%
Gestational Diabetes Mellitus	9	19%

Poor infection control practices post discharge or unsterile dressings	9	19%
Premature rupture of membranes with meconium-stained liquor	8	17%
Overt Diabetes mellitus	7	15%
Hypertension	5	10%
Obesity (more than 10% of ideal body weight)	5	10%
Hypothyroidism	4	8%

In this study pre operative, intra operative, post operative and patient related risk factors associated with SSIs were studied in detail. Anaemia is the commonest associated risk factor accounting for 26% of SSIs followed by Gestational Diabetes Mellitus and Overt Diabetes Mellitus which accounts for 19% and 15% respectively. Along with patient related risk factors, other post-operative factors like poor personal hygiene and unsterile dressings post discharge from the hospital also accounts for nearly 19% of all SSI patients (Table No.3).

Out of 20 patients who underwent Lower Segment Caesarean Section (LSCS), 8 (40%) patients had premature rupture of membranes with meconium-stained liquor. Other patient related risk factors like obesity (10%), hypertension (10%), hypothyroidism (8%) are also associated with SSIs (Table No.3).

Out of 46 samples collected from SSI patients, in 40 samples Gram negative organisms, in 4 samples Gram positive organisms and in 2 samples more than 1 organism were isolated. Among the Gram-negative isolates, *Escherichia coli* (41%) was the predominant organism followed by *Pseudomonas aeruginosa* (21%) and *Klebsiella* species (17%) (Table No.4).

Table No.4: Organisms isolated in Surgical site Infections

Name of the isolate	Number	Percentage
Gram negative isolates	Escherichia coli	19
	<i>Pseudomonas aeruginosa</i>	10
	<i>Klebsiella</i> species	8
	<i>Acinetobacter</i> species	2
	<i>Citrobacter freundii</i>	1
Gram positive isolates	Methicillin Sensitive <i>Staphylococcus aureus</i>	3
	<i>Enterococcus</i> species	1
Mixed isolates		2
		4%

Among the Gram-negative isolates varied antibiotic susceptibility pattern has been noted.

Among the Gram-negative isolates, *Escherichia coli* was the commonest isolate and was sensitive to Gentamicin (78%) and Meropenem (78%) followed by Ceftazidime+ avibactam (68%) and Cotrimoxazole (52%) and Amikacin (52%) (Table No.5).

Gram positive isolates were mostly sensitive to Gentamicin (100%), Tetracycline (100%), Cotrimoxazole (100%), Teicoplanin (100%) and Linezolid (100%) (Table No.6)

Table No.5 Antibiotic sensitivity pattern of pure Gram-negative isolates(n=40)

Isolate	GEN	AK	AMC	CPM	CTR	COT	MRP	CXM	IPM	PIT	CZA	AT	TOB	CIP
Escherichia Coli(n=19)	15 (78%)	10 (52%)	1 (5%)	6 (31%)	1 (5%)	10 (52%)	15 (78%)	0	4 (21%)	8 (42%)	12 (68%)	5 (26%)	--	
Klebsiella species (n=8)	4 (50%)	3 (37%)	1 (12%)	4 (50%)	1 (12%)	4 (50%)	4 (50%)	1 (12%)	0	3 (37%)	4 (50%)	3 (37%)	--	

'seudomonas aeruginosa (n=10)	--	--	--	8 (80%)	--	--	10 (100%)	--	6 (60%)	10 (100%)	5 (50%)	3 (30%)	4 (40%)	7 (70%)
S Acinetobacter species(n =2)	--	2 (100%)	--	1 (50%)	--	1 (50%)	1 (50%)	--	--	1 (50%)	--	--	--	--
Citrobacter freundii(n=1)	--	--	--	1 (100%)	--	--	1 (100%)	--	--	1 (100%)	--	--	--	--

NOTE: GEN: Gentamicin; AK: Amikacin; AMC - Amoxicillin + Clavulanate; CPM: Cefepime; CTR: Ceftriaxone; COT: Cotrimoxazole; MRP: Meropenem; CXM: Cefuroxime; IPM: Imipenem; PIT: Piperacillin + Tazobactam; CZA: Ceftazidime+ Avibactam; AT: Aztreonam; TOB: Tobramycin; CIP: Ciprofloxacin

Table No.6Antibiotic sensitivity pattern of pure Gram-positive isolates(n=4)

Isolate	LZ	TE	GEN	COT	CD	E	TEI	PEN	AMP	CIP
Methicillin Sensitive Staphylococcus aureus(n=3)	2 (66.67%)	3 (100%)	3 (100%)	3 (100%)	2 (66.67%)	2 (66.67%)	--	--	--	--
Enterococcus species (n=1)	1 (100%)	1 (100%)	1 (100%)	--	--	1 (100%)	1 (100%)	1 (100%)	1 (100%)	1 (100%)

NOTE: LZ: Linezolid; TE: Tetracycline; GEN: Gentamicin; COT: Cotrimoxazole; CD: Clindamycin; E: Erythromycin; TEI – Teicoplanin; PEN: Penicillin; AMP: Ampicillin; CIP: Ciprofloxacin;

DISCUSSION

The rate of surgical site infections greatly varies worldwide and from hospital to hospital from 2.5% to 41.9% [10]. In our study the infection rate was 1.04%, which correlates to Muqtadir et al⁵ who reported 1% and is very much lower than other studies by Anvikar et al [11]. and Patel et al [12]. who reported 6.09% and 16% of surgical site infections respectively. In the present study we report the occurrence of SSI at very low percentage which emphasize the continuity of strict adherence of standard operating procedure and effective work of hospital infection control committee.

In our study, there is female preponderance in SSIs as there are more obstetric and gynecological surgeries. Varsha Shahene et al reported marginal male preponderance [2]. However, it has been known that gender is not a pre determinant of risk of SSI [13].

In our study, the rate of surgical site infections was marginally higher in emergency surgeries (52.2%) than in elective surgeries (47.8%). This study was concordant with Patel et al [12] who also reported a similar preponderance of infections in emergency surgeries (24.1%) over elective surgeries (12.6%). Operative settings (elective or emergency) also play a significant role in determining infection rates. Cases operated in emergency are more likely to get infected due to inadequate preparation, breach in sterilization protocol, pre-existing infection and reduced immunological status of patient. However, no significant difference is noted in present study.

In our study, the surgical site infections incidence in clean surgeries was 8 (17.4%), in clean contaminated surgeries was 36 (78.3%) and in contaminated surgeries was 2(4.3%). This is compared to Sivasankari et al [8] who reported 46.6% in clean surgeries and 53.3% in clean contaminated surgeries. This is much higher than Madhusudhan et al. [14] who reported 12% in clean contaminated and 11% in clean surgeries. Type of surgery is directly related to the risk of developing wound infection. It is based on potential bacterial contamination of the tissues at the time of surgery and the level of bacterial burden.

The rate of surgical site infections varies from surgeon to surgeon. The skill and experience also affect the degree of contamination of surgical site through breaks in technique [12].

Several factors are responsible for causing infections which vary from patient to patient, hospital environment, food, hospital staff, infected surgical instruments, dressings, and even medicines and injections. SSIs are also associated with higher incidence of coexisting diseases, impaired immunological status, personal hygiene, etc. in the patients.

In our study, peri operative anaemia is a significant risk factor associated with SSI in most of the cases followed by Diabetes mellitus. Studies by Sivasankari et al⁸, S.M.Patel et al [12] and Ramesh et al [15] reported significant association with Diabetes mellitus in their studies.

Escherichia coli is the predominant isolate among Gram negative and in Gram positive *S. aureus* is the predominant isolate in our study. This is concordant with Sivasankari et al [8], Ramesh et al [15] who have also isolated a similar pattern of organisms.

It has been found that in clean surgeries, *Staphylococcus aureus* from the exogenous environment or the patient's skin flora is the usual pathogen. Whereas in other categories of surgical procedure like clean contaminated wounds, the polymicrobial flora closely resembling the normal endogenous microflora of the affected site is the frequently isolated pathogen [8,16].

The organisms most frequently involved in surgical site infections change from time to time and from place to place and so does their sensitivity to various antibiotics [17].

In the present study, Gram negative bacilli were sensitive to Gentamicin, Piperacillin + Tazobactam, Ceftazidime + Avibactam and Meropenem which correlated with M. Saleem et Al [18] who reported that Gram negative bacilli were sensitive to Amikacin, Imipenem, Piperacillin + Tazobactam and Meropenem.

In the present study, Gram positive cocci were mostly sensitive to Gentamicin, Tetracycline, Cotrimoxazole, Teicoplanin, Linezolid which correlated with Sunitha B et al [4] who reported that Gram positive cocci were sensitive to Vancomycin, Teicoplanin and Linezolid.

CONCLUSION

The surgical site infection (SSI) rate in our study was 1.04%, with *Escherichia coli* being the predominant Gram-negative isolate. SSIs were more frequent among anaemic and diabetic patients, highlighting the need for careful evaluation and optimization of underlying risk factors. Thorough preoperative assessment, appropriate perioperative care, and enhanced postoperative support to improve immunity can reduce SSI occurrence. Effective infection control measures including active SSI surveillance, staff training, adherence to antibiotic prophylaxis, maintenance of normothermia, and glycaemic control are essential. Regular SSI surveillance with feedback to surgeons will aid the Infection Control Committee in implementing targeted strategies to further reduce SSI rates, a key indicator of healthcare quality.

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Conflict of Interest: The authors declare no conflicts of interest related to this study.

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Authors' Contribution

Dr Yasoda Devi Kakaraparthi conceptualized and designed the study, collected and analyzed the data, interpreted the results, and drafted and finalized the manuscript.

Dr Swathi Kuna critically revised and edited the manuscript for important intellectual content.

Dr Sowmya Kambagowni critically revised and edited the manuscript for important intellectual content.

Dr P Lakshmi Vasantha provided critical scientific input and contributed to data analysis and interpretation.

Ethical Approval Statement

The study was reviewed and approved by the Institutional Ethics Committee of the tertiary care hospital, Visakhapatnam. No. GIMSR/ Admn./Ethics/approval/ IEC- 502/2025

Informed Consent Statement

As this was a retrospective study using existing medical records, the requirement for informed consent was waived by the Institutional Ethics Committee.

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