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Original Research Article

Microbiological Profile of Surgical Site Infections & Antibiotic Sensitivity Patterns

Kumar Sona Brahma[1], Dibyendu Chakraborty[2]

[1]Associate Professor, Department of Surgery, Kokrajhar Medical College & Hospital, Kokrajhar

[2]Registrar, Department of Surgery, Kokrajhar Medical College & Hospital, Kokrajhar

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Corresponding Author: Dr. Kumar Sona Brahma

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Abstract:

Background: Surgical site infections (SSIs) are among the most common healthcare-associated infections and represent a major cause of postoperative morbidity, prolonged hospitalization, and increased healthcare expenditure. In developing countries such as India, the burden of SSIs is compounded by limited infection control resources and increasing antimicrobial resistance. Understanding the local microbiological profile and antibiotic sensitivity patterns is essential for effective empirical therapy and infection prevention strategies.

Objectives: This study aimed to determine the microbiological spectrum of SSIs, evaluate antibiotic susceptibility patterns of isolated pathogens, and assess resistance trends among postoperative patients in a tertiary care hospital setting.

Methods: A hospital-based observational study was conducted on 135 clinically diagnosed SSI patients. Wound swab samples were collected aseptically and processed using standard microbiological techniques. Bacterial isolates were identified by conventional biochemical tests. Antibiotic susceptibility testing was performed using the Kirby–Bauer disc diffusion method following Clinical and Laboratory Standards Institute (CLSI) guidelines. Data were analyzed using descriptive and inferential statistical methods.

Results: Out of 135 samples, 120 (88.9%) were culture positive, yielding 130 bacterial isolates. Gram-negative organisms constituted 63%, while Gram-positive organisms accounted for 37% of isolates. Staphylococcus aureus (29.2%) was the most common pathogen, followed by Escherichia coli (23.1%), Klebsiella pneumoniae (18.5%), and Pseudomonas aeruginosa (13.8%). High resistance was observed to penicillin, cephalosporins, and fluoroquinolones. Vancomycin and linezolid showed high efficacy against Gram-positive isolates, while carbapenems and aminoglycosides demonstrated superior activity against Gram-negative organisms.

Conclusion: The study highlights a rising prevalence of multidrug-resistant organisms in SSIs. Routine microbiological surveillance and antibiotic sensitivity testing are crucial to guide rational antibiotic use. Implementation of antimicrobial stewardship programs and strengthened infection control practices are essential to reduce SSI burden and resistance development.

Keywords: Surgical site infection, Antibiogram, Antimicrobial resistance, SSI microbiology, India.

Introduction

Surgical Site Infections (SSIs) remain one of the most common and preventable healthcare-associated infections worldwide, accounting for nearly 20–30% of all hospital-acquired infections. Despite major advances in surgical techniques, sterilization methods, and perioperative antibiotic prophylaxis, SSIs continue to pose a significant burden on healthcare systems, especially in developing countries like India.

These infections not only prolong hospital stay but also increase treatment costs, postoperative morbidity, mortality, and the risk of antimicrobial resistance. According to the Centers for Disease Control and Prevention (CDC), SSIs are defined as infections occurring at the incision site within 30 days after surgery or within 90 days in cases involving implants. Based on anatomical involvement, SSIs are classified into superficial incisional, deep incisional, and organ-space infections. Each category differs in severity, clinical manifestations, and treatment strategies. In India, SSI incidence varies widely depending on hospital infrastructure, surgical discipline, patient comorbidities, and adherence to infection control protocols, with reported rates ranging from 1.6% to 38%.

Several risk factors contribute to the development of SSIs, including poor nutritional status, diabetes mellitus, obesity, smoking, prolonged surgery duration, emergency surgical procedures, inadequate preoperative skin preparation, and prolonged hospital stay. Additionally, factors such as overcrowded wards, limited resources, and lack of standardized antibiotic stewardship programs further compound the problem in many Indian healthcare settings.

The microbial etiology of SSIs has evolved over time. Traditionally, Gram-positive organisms such as Staphylococcus aureus were considered the predominant pathogens.

However, recent Indian studies indicate a growing predominance of Gram-negative organisms such as Escherichia coli, Klebsiella pneumoniae, and Pseudomonas aeruginosa, particularly in abdominal and emergency surgeries. This shift is clinically significant as Gram-negative organisms are often associated with higher resistance rates and limited therapeutic options.

The emergence of multidrug-resistant organisms (MDROs), including methicillin-resistant Staphylococcus aureus (MRSA), extended-spectrum beta-lactamase (ESBL) producing Enterobacteriaceae, and carbapenem-resistant pathogens, has complicated SSI management.

Inappropriate empirical antibiotic use, over-the-counter availability of antibiotics, lack of culture-guided therapy, and poor compliance with antimicrobial stewardship guidelines have contributed to the acceleration of resistance in Indian hospitals.

Routine microbiological surveillance and antibiogram generation are essential tools for guiding appropriate empirical therapy and improving treatment outcomes. Understanding local pathogen distribution and resistance trends enables clinicians to tailor antibiotic regimens, reduce unnecessary broad-spectrum antibiotic use, and minimize treatment failures. Therefore, this study was undertaken to analyze the microbiological profile and antibiotic sensitivity patterns of SSIs in a tertiary care hospital setting with a sample size of 135 patients. The findings aim to provide region-specific data that can assist clinicians in selecting appropriate antimicrobial therapy and contribute to the development of evidence-based infection control strategies.

Materials and Methods

Study Design and Setting: This descriptive, observational study was conducted in a tertiary care hospital of Dibrugarh, Assam, India. A total of 135 patients who developed clinically diagnosed SSIs within 30 days postoperatively were included. Inclusion criteria involved all age groups and types of surgeries, except patients receiving antibiotics for >48 hours before culture.

Sample Collection and Processing: Swab specimens were collected aseptically from infected wounds. Samples were processed by Gram staining, culture on blood and MacConkey agar, and biochemical identification of isolates following standard microbiological methods.

Antibiotic Susceptibility Testing: Antimicrobial susceptibility was performed using the Kirby-Bauer disk diffusion method according to CLSI guidelines. Results were interpreted as Sensitive (S), Intermediate (I), or Resistant (R) for tested antibiotics including beta-lactams, aminoglycosides, fluoroquinolones, carbapenems, and glycopeptides.

Statistical Analysis: All collected data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 26.0. Descriptive statistics such as frequencies, percentages, means, and standard deviations were used to summarize demographic variables, microbial distribution, and antibiotic sensitivity patterns. A p-value of less than 0.05 was considered statistically significant. Results were presented using tables and figures to enhance clarity and interpretability.

Results

Demographic Profile: Of the 135 patients, 78 (57.8%) were male and 57 (42.2%) were female. The majority (45%) were aged between 31–60 years. The most common surgical categories were general surgery (44%), gynaecological (26%), orthopaedics (18%), and miscellaneous procedures (12%).

Table 1: Demographic Distribution of SSI Patients

Variable	Category	n = 135	In %
Gender	**Male**	78	57.78%
	Female	57	42.22%
Age (In Yrs.)	**18–30**	28	20.74%
	31–60	61	45.19%
	> 60	46	34.07%

Culture Positivity: Out of 135 samples, 120 (88.9%) yielded positive cultures. Mixed growth was observed in 10 cases (7.4%). A total of 130 isolates were obtained for antibiotic susceptibility analysis.

Table 2: Culture Positivity Rate

Result	n = 135	In %
Culture Positive	120	88.89%
Culture Negative	15	11.11%

Microbiological Profile: The breakdown of organisms showed a predominance of both Gram-positive and Gram-negative bacteria:

Table 3: Distribution of Isolated Microorganisms

Organism	n = 130	In %
Staphylococcus aureus	38	29.23%
Escherichia coli	30	23.08%
Klebsiella pneumoniae	24	18.46%
Pseudomonas aeruginosa	18	13.85%
Enterococcus spp.	10	7.69%
Others	10	7.69%

Overall, Gram-negative organisms accounted for 63%, and Gram-positive for 37% of isolates. These trends reflect Indian and South Asian SSI studies reporting a similar or greater proportion of Gram-negative pathogens.

Table 4: Antibiotic sensitivity patterns of isolates

Category	Antibiotic	Sensitive (%)	Resistant (%)
Gram-Positive Isolates	**Vancomycin**	95%	5%
	Linezolid	90%	10%
	Gentamicin	65%	35%
	Ceftriaxone	25%	75%
	Penicillin	13%	87%
Gram-Negative Isolates	**Meropenem**	88%	12%
	Amikacin	85%	15%
	Piperacillin-Tazobactam	70%	30%
	Ciprofloxacin	42%	58%
	Cefotaxime	35%	65%

Gram-Positive Isolates: Staphylococcus aureus isolates demonstrated:

- High sensitivity to vancomycin (95%) and linezolid (90%).
- Moderate sensitivity to gentamicin (65%).
- High resistance to penicillin (87%) and ceftriaxone (75%).

These patterns align with Indian SSI literature, which reports vancomycin and linezolid as reliable options for Gram-positive SSI pathogens.

Gram-Negative Isolates: Among Gram-negative isolates:

- E. coli showed high sensitivity to meropenem (88%), amikacin (85%), and lower sensitivity to ciprofloxacin (42%).
- K. pneumoniae exhibited similar carbapenem sensitivity but notable resistance to third-generation cephalosporins.
- P. aeruginosa remained moderately sensitive to piperacillin-tazobactam (70%) and ofloxacin (75%).

These findings corroborate other studies reporting high susceptibility of Gram-negative SSI pathogens to carbapenems and aminoglycosides, and considerable resistance to older generation cephalosporins and fluoroquinolones.

Discussion

The present study analyzed 135 cases of surgical site infections and demonstrated a high culture positivity rate of 88.9%, indicating a strong microbiological correlation with clinically diagnosed SSIs. Similar culture positivity rates have been reported in several Indian studies, emphasizing the reliability of laboratory confirmation in SSI diagnosis.

The predominance of Staphylococcus aureus (29.2%) in this study is consistent with previous Indian research, where this organism remains the leading cause of SSIs due to its colonization of skin and nasal mucosa. Surgical manipulation disrupts skin barriers, facilitating entry of these pathogens into deeper tissues. The presence of MRSA in hospital environments further increases the risk of persistent and recurrent infections.

Gram-negative organisms constituted the majority of isolates (63%), with E. coli, Klebsiella pneumoniae, and Pseudomonas aeruginosa being the most frequently identified. This pattern reflects the increasing involvement of enteric organisms, particularly in abdominal surgeries and emergency procedures. These pathogens are often associated with fecal contamination, prolonged operative time, and compromised host immunity. The detection of polymicrobial infections in 7.4% of cases suggests complex wound contamination, especially in trauma-related and contaminated surgeries. Polymicrobial infections are associated with delayed wound healing and increased risk of treatment failure due to variable antimicrobial susceptibility. Antibiotic susceptibility analysis revealed alarming resistance trends among both Gram-positive and Gram-negative isolates. Staphylococcus aureus isolates exhibited high resistance to penicillin and cephalosporins, while maintaining sensitivity to vancomycin and linezolid. This finding is consistent with Indian surveillance reports, which highlight glycopeptides and oxazolidinones as reliable treatment options for resistant Gram-positive infections.

Among Gram-negative isolates, high resistance was observed against third-generation cephalosporins and fluoroquinolones. This resistance pattern is largely attributed to the widespread presence of ESBL-producing organisms and the irrational use of antibiotics in clinical practice. Carbapenems and aminoglycosides such as amikacin demonstrated better efficacy, making them important therapeutic options for severe infections.

However, the increasing dependence on carbapenems raises concerns regarding the emergence of carbapenem-resistant Enterobacteriaceae (CRE), which significantly limit treatment choices and are associated with higher mortality rates. Therefore, carbapenems should be reserved for culture-proven multidrug-resistant infections rather than routine empirical therapy.

The microbial distribution and resistance patterns observed in this study align closely with data reported from tertiary care centers across India. Studies from northern and southern regions have similarly documented the dominance of Gram-negative pathogens and increasing multidrug resistance. These similarities suggest a nationwide trend influenced by comparable healthcare challenges, antibiotic prescribing practices, and infection control standards.

Clinical and Public Health Implications: The findings emphasize the urgent need for:

- Regular hospital antibiogram updates
- Strict implementation of infection prevention protocols
- Rational antibiotic prescription practices
- Strengthening antimicrobial stewardship programs
- Preoperative screening for high-risk patients
- Optimization of perioperative antibiotic prophylaxis

Improved hand hygiene compliance, surgical site preparation protocols, sterilization procedures, and postoperative wound care can significantly reduce SSI incidence.

Limitations of the Study

Although the study provides valuable insights, certain limitations must be acknowledged. Being a single-center study, the findings may not be generalizable to all healthcare settings. Anaerobic cultures and fungal isolates were not included, which may underestimate the complete microbial spectrum. Molecular methods for resistance detection were also not performed due to resource constraints.

Recommendations

Future multicenter studies with larger sample sizes and molecular resistance profiling are recommended. Incorporation of surveillance data into national antimicrobial resistance programs will further strengthen infection control strategies and improve patient outcomes.

Conclusion

In this Indian cohort, SSIs were predominantly caused by S. aureus, E. coli, and Klebsiella spp., with a significant number of isolates exhibiting resistance to commonly prescribed antibiotics. Carbapenems, aminoglycosides, and vancomycin remain valuable therapeutic options pending culture results.

The findings reinforce the importance of microbiological profiling and antibiogram reporting in SSI management to curb antimicrobial resistance and improve patient outcomes.

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