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Research Article

# EPIDEMIOLOGY AND MICROBIAL PROFILE OF SURGICAL SITE INFECTIONS: A PROSPECTIVE STUDY AT A TERTIARY CARE HOSPITAL

**Dr. Madhu Digra., Dr. Ravinder Kumar., Dr.Deepti Chanjotra and Dr. Junaid Nabi Wani**

Assistant Professor, Department Of General Surgery, Government Medical College, Kathua,J&K,184102

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**ABSTRACT**

***Background:*** Surgical site infections (SSIs) represent a significant challenge in surgical practice due to their association with increased morbidity, mortality, and healthcare costs. Understanding the epidemiology and microbial profile of SSIs is crucial for guiding preventive strategies and optimizing treatment outcomes.

***Methods:*** We conducted a prospective observational study at the Department of Surgery, Government Medical College, Kathua, involving 208 patients undergoing surgical procedures. Demographic data, comorbidities, and clinical characteristics were recorded. Wound swabs were collected and subjected to gram staining, culture, and microbial identification using standard biochemical tests. Statistical analyses were performed to assess the incidence of SSIs and identify predominant pathogens.

***Results:*** The study cohort comprised predominantly male patients with a mean age of 49.63 years, with a high prevalence of diabetes (89.9%), smoking (52.4%), and anemia (20.67%). Analysis of wound swabs revealed varying rates of infection based on wound classification, with the highest incidence observed in dirty wounds (41.66%). Staphylococcus aureus and Klebsiella pneumoniae were the most commonly isolated pathogens, followed by Pseudomonas aeruginosa and Escherichia coli. Notably, multidrug-resistant strains including Acinetobacter species were identified, posing challenges for antimicrobial therapy.

***Conclusion:*** Our study provides valuable insights into the epidemiology and microbial etiology of SSIs among surgical patients, highlighting the importance of demographic factors and wound contamination in predisposing the patients to infections. The identification of predominant pathogens, including multidrug-resistant strains, underscores the need for tailored antimicrobial therapy and comprehensive infection control measures to mitigate the burden of SSIs and improve patient outcomes. These findings emphasize the importance of ongoing efforts to optimize preventive strategies and therapeutic interventions in surgical practice.



## INTRODUCTION

Surgical site infections (SSIs) are the post-operative infection of the wound caused by the impairment of the host's first line of defense against external microorganisms and the internal milieu of the host following surgery[1]. SSI are linked to higher rates of morbidity and mortality, longer hospital stay and higher medical expenses. According to recommendations from the Centres for Disease Control, a surgical site infection (SSI) is defined as one that appears 30 days after surgery or, in rare cases, 90 days after surgery. According to reports, the prevalence of SSI in poor nations ranges from 2% to 40%.

Surgical site infections (SSIs) are infections that affect the skin, subcutaneous tissue and organs/spaces that are opened or moved during surgery. They usually appear 30 days following the treatment or a year later if an orthopedic implant is in place[(2,3)]. In the USA, surgical site infections (SSIs) rank third out of all nosocomial infection categories and account for around 15.0% of cases[(3,4)]. Hospital settings that reflect protocols for infection control and aspects associated to the agent, the environment and the host can affect rates of infection across operated patients[5]. For instance, reported infection rates remained less than 3.0% in Germany and France, 16.9% in Rio de Janeiro and Brazil, and 26.0% in Mwanza and Tanzania[(6,7,8,9)]. Surgical procedures in obstetrics and gynecology, general surgery, and orthopedics

*Corresponding author: **Dr. Junaid Nabi Wani**

Assistant Professor, Department Of General Surgery, Government Medical College, Kathua,J&K,184102

are all susceptible to surgical site infections (SSIs)[6,10,11]. The most frequently encountered bacteria identified in hospital-acquired surgical site infections (SSIs) are Enterococcus species, Escherichia coli, Pseudomonas aeruginosa along with the other Enterobacteriaceae. While single bacterial isolates are somewhat common, polymicrobial infections account for 9.0% to 27.0% of bacterial isolates from various surgical sites[6,7,10,12]. These infections present therapeutic hurdles and are linked to significantly longer hospital stay, higher hospital costs and higher rates of morbidity as well as mortality[9,13], especially when the pathogens are Enterobacteriaceae that produce extended-spectrum beta lactamase (ESBL), Methicillin-resistant S. aureus (MRSA), as well as additional agents collectively known as multidrug-resistant (MDR) organisms[12]. Research conducted in developing nations has revealed that S. aureus, E. coli, and P. aeruginosa exhibit high levels of resistance (between 50% and 100%) to antibiotics that are frequently prescribed such as ampicillin, trimethoprim-sulphamethoxazole, gentamicin, chloramphenicol and third-generation cephalosporins[6,14]. In contrast, low rates of resistance between 0-50% have been reported in developed nations[15]. However, in both situations, S. aureus was found to have significant rates of resistance to oxacillin, erythromycin, and clarithromycin which lies between 10-60%[6,14]. In contrast, resistance rates to vancomycin, amikacin, piperacillin-tazobactam, and imipenem which are used to treat E. coli, P. aeruginosa, and other Gram negative bacteria were less than 25%[16]. It is commonly known that the choice of treatment for patients suffering from surgical site infections (SSIs) is mostly based on the results of antibiotic sensitivity tests produced by clinical labs or reliable epidemiological data from continuous nosocomial infection monitoring[8,12].

Since skin acts as a natural barrier to infection, any operation that creates a skin breach might result in an infection after the procedure. One of the most significant post-operative complications is the surgical site infection (SSI). As the second most common nosocomial infection to be recorded, SSI is a significant global public health concern. It causes a notable rise in morbidity and mortality as well as an extension of hospital stays and treatment costs[17]. In affluent countries, the prevalence of nosocomial infections ranges from 2-20%[18]. 4.04-30% of Indians suffer from SSI[19]. The endogenous and exogenous microorganisms that penetrate the surgical site during the procedure are often the cause of infection. Recently, SSI has also been linked to gram-negative microbes[17,18]. The main cause of resistant organisms is a result of the misuse of antibiotics[17]. Bacteria that are resistant to drugs such as Acinetobacter species, are becoming more prevalent as SSI infections. The issue becomes more complex in developing nations like India because of inadequate infection control, overcrowding in hospitals and the improper use of antimicrobials[17].

## METHODS

The present analysis was based on a prospective observational study design. The study was conducted in Government Medical College, Kathua (a tertiary care institute in the Northern India) Patients undergoing surgical procedures and treatment under the Department of Surgery in Government Medical College, Kathua were recruited for the investigation All study participants included in this study signed an informed consent for voluntary participation in the current investigation.

The patients from 18 years to 65 years of age belonging to either gender were included in the study. The patients with pre-existing wound infections at the time of surgery, patients undergoing emergency surgeries, pregnant females, and patients who refused to give voluntary consent for enrollment in the study were excluded from the investigation.

All the study protocols were reviewed and approved by the institutional ethics committee (IEC), Government Medical College, Kathua. The procedures and analysis conducted in the investigations were in accordance with the guidelines and recommendations of the ethical committee.

The details regarding the clinical characteristics and demographic data of the enrolled study participants were recorded. This includes gender and age of the patients, comorbidities such as diabetes, smoking, anemia, duration of surgery and duration of stay at hospital before the operation.

The first swab was used as a sample for direct preparation of gram-stained smear. This was used to evaluate the pus cells, study the morphology and the microbe arrangements. The 2nd swab was used to perform the culture. For the purpose of bacterial species, conventional standard biochemical tests and gram staining were done and colony morphology studied. All statistical calculations were performed in Microsoft Excel at significance threshold of 0.05.

## RESULTS

In the present study, we enrolled 208 patients undergoing surgery at the Department of Surgery, Government Medical College, Kathua based on our pre-defined inclusion and exclusion criteria. All the enrolled participants provided the informed consent for voluntary participation in the study. The clinical and demographic data of the study participants is presented in Table 1.

**Table 1** Clinical characteristics of the enrolled participants

| **Clinical characteristics** | |
|---|---|
| Total enrolled participants<br>Age (in years)<br>Gender (M/F) | 208<br>49.63 ± 12.43<br>172/36 |
| **Comorbidities** | |
| Diabetes (Y/N)<br>Anemia (Y/N)<br>Smoking (Y/N) | 187/21<br>43/165<br>109/99 |
| Preoperative hospitalization duration (in days) | 1.99 ± 0.89 |

*M/F=Male/Female, Y/N= Yes/No*

The mean age of the participants was 49.63±12.43 years. 82.69% of the participants were males while remaining were females. Among the comorbidities reported in the cohort, 89.9% of the individuals were diabetic with mean fasting glucose levels of 146.7±33.3 mg/dL, 20.67% of the individuals were anaemic and 52.4% were smokers. The mean duration of the hospital stay of the study participants before the surgery was 1.99±0.89 days.

The analysis of infections in the collected wound swabs

highlighted varying degrees of infections on the basis of wound classification (Table 2).

**Table 2** Incidence of infections in association with wound class

| Wound class | Total Surgeries | Reported Infections | |
|---|---|---|---|
| | N | Incidence (%) | N |
| Total | 208 | - | 36 |
| Clean | 81 | 08.6 | 07 |
| Clean contaminated | 68 | 19.11 | 13 |
| Contaminated | 47 | 23.4 | 11 |
| Dirty | 12 | 41.66 | 05 |

*N= number of cases*

There were 68 patients in the clean contaminated class and 19.11% of them were reported to have infections. The incidence of the infections was observed to be highest 41.66% among 12 patients in the dirty wound category. 47 patients with contaminated wound classification reported 23.4% incidence of infections (Table 2).

The frequency of pathogenic bacteria in the collected wound swabs was assessed and recorded in Table 3. It was observed that Staphylococcus aureus and Klebsiella pneumoniae were the most commonly observed infections with the frequency of 21.56%. These were followed by Pseudomonas aeruginosa that were present in 17.64% of the isolates. Other microbes included Escherichia coli (13.72%), Acinetobacter species (11.76%), Enterococcus species (9.8%), and Proteus mirabilis (3.92%) (Table 3).

**Table 3** Pathogenic bacteria observed in wound swabs

| Organism Detected | Isolates (N) | Percentage (%) |
|---|---|---|
| *Acinetobacter species* | 6 | 11.76 |
| *E. coli* | 7 | 13.72 |
| *Enterococcus* | 5 | 9.8 |
| *Klebsiella* | 11 | 21.56 |
| *Proteus mirabilis* | 2 | 3.92 |
| *Pseudomonas aeruginosa* | 9 | 17.64 |
| *S. aureus* | 11 | 21.56 |

*N=number of cases*

**Discussion:**

In our study conducted at the Department of Surgery, Government Medical College, Kathua, we investigated the prevalence, demographic factors, and microbial profile of surgical site infections (SSIs) among patients undergoing surgical procedures. SSIs represent a significant challenge for surgeons globally due to their association with increased morbidity, mortality, prolonged hospital stay and increased medical costs. These infections often arise from breaches in the body's natural defence mechanisms, allowing microorganisms to infiltrate the surgical site.

Our findings revealed several noteworthy demographic characteristics among the study cohort. Firstly, we observed a predominance of male participants, with a mean age of 49.63 years. Additionally, a substantial proportion of patients had diabetes, a well-established risk factor for SSIs due to its adverse effects on immune function and wound healing. The high prevalence of diabetes underscores the importance of preoperative optimization strategies, such as glycemic control, to mitigate the risk of SSIs. Furthermore, smoking habits and anemia were prevalent among the cohort, highlighting additional factors that may contribute to surgical complications and increased susceptibility to infections.

The infection rates range from 6.09% to 38.7% in many Indian investigations carried out between 1999 and 2013[20,21,22]. Other developed nations' reports revealed a lower rate of infection, ranging from 2.8% to 19.4%[23,24]. Previous research conducted in India revealed that the SSI rate might reach 49.50%[25]. Many recent Indian studies have found a reduction in the incidence of SSI[26,27], but it is still greater than in Western nations. Over a lengthy period of 10–16 years, SSI rates measured in a Canadian and Irish hospital showed rates of just 4.7% and 4.5% respectively[28,29]. This suggests that larger groups investigated over longer durations provide a better evaluation of SSI rates.

A higher incidence of infections in developing nations highlights the necessity of implementing infection control measures more effectively and having an appropriate antibiotic usage and tracking system in place. Classification of surgical wounds based on contamination level yielded important insights into the incidence of SSIs across different wound types. Notably, dirty wounds exhibited the highest infection rates, emphasizing the critical importance of maintaining strict aseptic conditions during surgical procedures. Similar outcomes were seen in additional investigations as well[16,19,32]. It demonstrates that the likelihood of an infection in the wound rises with the level of contamination. These findings underscore the need for tailored preventive measures and vigilant infection control practices, particularly in cases where wound contamination is anticipated to be high.

Analysis of microbial flora from wound swabs provided valuable information regarding the predominant pathogens implicated in SSIs. Staphylococcus aureus and Klebsiella pneumoniae emerged as the most commonly isolated organisms, consistent with previous literature highlighting their significance in SSIs. Of particular concern was the presence of multidrug-resistant strains, including Acinetobacter species, which pose significant challenges in the management of SSIs, particularly in resource-limited settings where access to effective antibiotics may be limited. Studies on the bacteriological profile of organisms causing SSI revealed similar findings[26,30]. On the other hand, the Enterobacteriaceae family was shown to be the most prevalent bacteria in some investigations[31]. According to the findings of a study done in Puducherry(India), Klebsiella pneumoniae was the most prevalent isolate among the Gram-negative isolates[32].

Our study underscores the importance of targeted antimicrobial therapy guided by susceptibility testing to optimize treatment outcomes and mitigate the emergence of drug-resistant pathogens. Additionally, initiatives aimed at enhancing

infection control practices, antimicrobial stewardship and surveillance are crucial for mitigating the burden of SSIs, particularly in regions with limited resources.

Our study possesses several strengths that contribute to its validity and significance. Firstly, the prospective observational study design employed in our investigation allowed for the collection of real-time data, minimizing recall bias and enhancing the reliability of our findings. Additionally, the inclusion of a diverse patient population undergoing surgical procedures at a government medical college enhances the generalizability of our results to similar settings. Furthermore, the comprehensive collection of demographic and clinical data, including comorbidities and wound characteristics, provided a detailed understanding of the factors influencing SSIs. Lastly, the use of standardized microbiological techniques for identifying pathogenic organisms in wound swabs strengthens the validity of our microbial profile findings, thereby informing targeted antimicrobial therapy strategies. Overall, these strengths bolster the credibility and utility of our study in advancing knowledge and guiding interventions aimed at reducing the burden of SSIs in surgical practice.

While our study provides valuable insights into the prevalence, demographic factors, and microbial profile of surgical site infections (SSIs) among patients undergoing surgical procedures at the Department of Surgery, Government Medical College, Kathua, it is important to acknowledge several limitations. Firstly, our study was conducted at a single institution, which may limit the generalizability of our findings to other healthcare settings with different patient populations and surgical practices. Additionally, our sample size was relatively small, which may have affected the precision and reliability of our estimates. Lastly, while we conducted microbial analysis of wound swabs to identify pathogens associated with SSIs, our study did not investigate the molecular mechanisms of antimicrobial resistance, which could provide further insights into the challenges of managing these infections. Future studies addressing these limitations are warranted to enhance our understanding of SSIs and inform more effective preventive and therapeutic strategies.

## CONCLUSION

In conclusion, our study offers valuable insights into the prevalence, demographic factors, and microbial profile of surgical site infections (SSIs) among patients undergoing surgical procedures. Our findings underscore the multifactorial nature of SSIs with demographic factors such as diabetes, smoking and anemia playing significant roles in predisposing patients to these infections. Furthermore, our analysis highlight the importance of maintaining strict aseptic conditions during surgical procedures, particularly in cases where wound contamination is anticipated to be high. The identification of predominant pathogens, including multidrug-resistant strains, underscores the urgent need for tailored antimicrobial therapy guided by susceptibility testing and comprehensive infection control measures to mitigate the burden of SSIs and improve patient outcomes. These findings emphasize the importance of ongoing efforts to optimize preventive strategies and therapeutic interventions to address this significant public health concern.

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