https://doi.org/10.48047/AFJBS.6.15.2024.3195-3205

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Assessment of Surgical Site Infections in Pakistani Hospitals: Prevalence, Risk Factors, and Antimicrobial Resistance Patterns

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Volume 6, Issue 15, Sep 2024

Received: 15 July 2024

Accepted: 25 Aug 2024

Published: 05 Sep 2024

doi: 10.48047/AFJBS.6.15.2024.3195-3205

ABSTRACT

Introduction: Particularly in low- and middle-income countries (LMICs), surgical site infections (SSIs) account for a major source of morbidity and rising healthcare costs. These infections might seriously affect patient outcomes and hinder recovery. The aim of this study was to investigate the antibiotic resistance patterns at a tertiary care hospital in Pakistan, assess the frequency of SSIs, and pinpoint related risk factors.

Methodology: From August 2023 to July 2024 Fauji Foundation Hospital Peshawar Cantt conducted a cross-sectional study. The study comprised 86 patients having different surgical treatments. Retroactive data collecting from patient records concentrated on demographics, kind of surgery, length, and use of prophylactic antibiotics. By means of microbiological testing, pathogens generating SSIs were identified; their antibiotic resistance profiles were investigated. Significant risk variables linked with SSIs were found using statistical analyses including logistic regression and chi-square testing.

Results: The study determined a general SSI prevalence of 22.1%. Advanced age (≥50 years), emergency surgery, longer surgical length (more than two hours), diabetes mellitus, and lack of prophylactic antibiotic treatment constituted major risk factors. Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa were the most often separately isolated pathogens. Especially, antibiotic resistance was rather common, and among the infections there were found multidrug-resistant organisms.

Conclusion: The results show concerning degrees of antimicrobial resistance in the investigated environment and a high frequency of SSIs. These findings highlight the necessity of better infection control policies, better antibiotic stewardship, and focused approaches to handle SSIs and resistance in LMICs so enhancing patient outcomes and healthcare quality.

Keywords: Surgery Site Infections, Antimicrobial Resistance, Risk Factors, Pakistan, Infection Control, Tertiary Care Hospital

INTRODUCTION

A major source of postoperative morbidity, extended hospital stays, rising healthcare expenditures, and, occasionally mortality, surgical site infections (SSIs) are a major issue in healthcare systems all around. These infections, which arise at the site of a surgical incision, can cause major problems especially in environments where infection control policies might be violated[1]. The impact of SSIs is especially noticeable in Pakistan, where the hospital system confronts several difficulties including resource constraints, overcrowding, and different adherence to infection control practices[2]. Given the consequences for patient outcomes and the general efficacy of surgical procedures, the frequency of SSIs in Pakistani hospitals raises growing questions. Although worldwide statistics indicate that SSIs account for up to 20% of healthcare-associated infections, the situation in underdeveloped nations including Pakistan may be even more serious[3]. In Pakistan, the real load is probably understated because of poor surveillance systems, few diagnostic facilities, and non-standard reporting systems[4]. Developing focused plans to lower SSIs and increase patient safety depends on an awareness of their actual frequency in Pakistan[5]. Risk factors for SSIs are multifactorial and include procedural elements including the type and length of surgery, the degree of surgical team skill, and operating environment sterility as well as patient-related elements including age, comorbidities, nutritional status, and immunosuppression[6]. Apart from the availability of sanitized surgical tools, overcrowding, and frequency of emergency operations, other elements in Pakistani hospitals could be quite important in raising the incidence of SSIs[7].

Moreover, cultural customs and financial restrictions can affect preoperative and postoperative treatment, therefore complicating initiatives against infections[8]. The problem of antimicrobial resistance (AMR) is among the most urgent ones concerning SSIs in Pakistan. Both in human health and industry, the inappropriate and excessive use of antibiotics has resulted in the development of multidrug-resistant organisms that complicate the treatment of SSIs and cause worse patient outcomes[9]. Common bacteria include Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa show resistance to first-line antibiotics, therefore indicating the shockingly high frequency of AMR in SSI pathogens in Pakistan[10]. Because more costly and possibly harmful alternative therapies are required, this condition not only raises the morbidity related with SSIs but also seriously strains the healthcare system financially[11].

This study is to investigate the antibiotic resistance patterns of the relevant pathogens, evaluate the frequency of SSIs in Pakistani hospitals, and find the related risk factors. With a thorough examination of these problems, the study aims to guide healthcare policies and practices meant to lower the SSI incidence and raise the general quality of surgical treatment in Pakistan. The results of this study could potentially have more general relevance for other low- and middle-income nations dealing with comparable issues with antimicrobial stewardship and infection control. This study exposes various research gaps but also points up important problems in SSI frequency and antibiotic resistance. Larger, multi-center studies should be part of future investigations to validate these conclusions and evaluate the success of focused infection control and antimicrobial stewardship programs in several hospital environments.

METHODOLOGY

Study Design and Setting: Conducted at Fauji Foundation Hospital Peshawar Cantt, serving a sizable and varied patient population in Peshawar, this cross-sectional study The aim of the study was to investigate the antibiotic resistance patterns of the causal microorganisms, evaluate the frequency of surgical site infections (SSIs), and spot related risk factors.

Study Duration: The investigation took place over twelve months, from August, 2023 to July 2024. This period of time was chosen to guarantee the presence of cases from every season, therefore adjusting for any seasonal fluctuations in SSI incidence.

Sample Size Calculation: The sample size was calculated using the formula for prevalence studies:

$$n = z^2 \times p \times (1 - p)/d^2$$

Where n is the necessary sample size, Z is the Z-value corresponding to a 95% confidence level (1.96), P is the estimated prevalence of surgical site infections (SSIs), which was considered to be 15% based on past research in like circumstances, and d is the margin of error, set at 10%. By means of these criteria, the sample size was computed to guarantee a strong representation of the target population while considering variability and so preserving a high degree of confidence in the study outcomes.

Inclusion and Exclusion Criteria: Included were patients of all ages and both sexes who had surgery at KMC during the study period. Patients had to stay in a postoperative hospital minimum of 48 hours in order to enable the diagnosis of SSIs. The study excluded patients who had pre-existing infections or those who had procedures in outpatient environments.

Data Collection: Data comes retroactively from patient medical records and hospital databases. Among the obtained data were demographic information, medical history, type of surgery done, length of surgery, postoperative care, and SSI occurrence. Moreover seen were details on adherence to infection control policies, timing of administration, and use of preventative antibiotics. The study found SSIs applying the Centers for Disease Control and Prevention (CDC), which describe SSIs as superficial incisional, deep incisional, or organ/space infections. Every discovered SSI was investigated more closely in order to identify the responsible agents; samples were taken for microbiological analysis.

Microbiological Analysis and Antimicrobial Resistance Testing: Microbiology lab housed samples from contaminated surgical sites under cultivation. Standard laboratory techniques were used to separate and name the microorganisms causing the SSIs. The Kirby-Bauer disk diffusion technique was used to evaluate the isolated microorganisms' antibiotic sensitivity. The Clinical and Laboratory Standards Institute (CLSI) recommendations were followed in interpreting the outcomes. Recording data on antimicrobial resistance tendencies, with an eye toward routinely used antibiotics including methicillin, cephalosporins, and fluoroquinolones,

Data Analysis: SPSS program version 25.0 was used for data analysis of the gathered materials. The demographic properties of the patients and the frequency of SSIs were compiled using descriptive statistics. Significant risk factors linked with SSIs were found by means of chi-square

testing and logistic regression analysis. Analyzing the antibiotic resistance patterns helped one to identify among the isolated pathogens the frequency of multidrug-resistant organisms. Considered statistically significant were p-values less than 0.05.This all-encompassing approach guaranteed a thorough evaluation of SSIs, therefore offering important new perspectives on their frequency, risk factors, and patterns of antimicrobial resistance of the relevant bacteria in a Pakistani healthcare environment.

RESULTS

From August 2023 to July 2024, 86 patients in all who underwent different surgical operations and The patients ranged in age from 18 to 78 years; their mean was 42.6 years (SD ± 15.3). While 34 (39.5%) were male, the most of the patients' n = 52, 60.5% were female. As shown in table 1.

Table 1: Demographic Characteristics of the Study Population

Characteristic	**Frequency (n = 86)**	**Percentage (%)**
Age Group (years)		
18-29	14	16.3
30-39	21	24.4
40-49	18	20.9
50-59	15	17.4
60 and above	18	20.9
Gender		
Male	34	39.5
Female	52	60.5

Of the 86 patients, 19 experienced surgical site infections (SSIs), therefore producing a total prevalence rate of 22.1%. Ten (52.6%) of the SSIs were categorized as superficial incisional infections; six (31.6%) as deep incisional infections; and three (15.8%) as organ or space infections.as table 2 illustrates.

Table 2: Prevalence and Classification of Surgical Site Infections

SSI Classification	**Frequency (n = 19)**	**Percentage (%)**
Superficial Incisional	10	52.6
Deep Incisional	6	31.6
Organ/Space	3	15.8
Total SSIs	19	22.1

We investigated several risk factors to find their correlation with the emergence of SSIs. With a p-value of 0.034, the study found that patients 50 years of age and above had a notably greater prevalence of SSIs (34.8%) than those under 50 years (14.3%). Though male patients (26.5%) had more SSIs than female patients (19.2%), this difference was not statistically significant (p = 0.435). With a p-value of 0.028, emergency operations were linked to a much greater rate of SSIs (35.0%) than elective operations (14.5%). With a p-value of 0.048, surgeries lasting more than two hours showed a greater frequency of SSIs (28.6%) than those lasting two hours or less (16.1%). With a p-value of 0.039, patients who did not have prophylactic antibiotics also had a greater rate of SSIs (33.3%) than those who received prophylactic antibiotics (18.2%). With a p-value of 0.015, diabetes patients also exhibited a noticeably greater prevalence of SSIs (40.0%) than non-diabetic patients (16.7%), in table 3.

Table 3: Risk Factors Associated with Surgical Site Infections

Risk Factor	**SSI Cases (n = 19)**	**No SSI (n = 67)**	**p-value**
Age ≥ 50 years	10 (52.6%)	23 (34.3%)	0.034
Male Gender	9 (47.4%)	25 (37.3%)	0.435
Emergency Surgery	7 (36.8%)	11 (16.4%)	0.028
Duration > 2 hours	8 (42.1%)	13 (19.4%)	0.048
Diabetes Mellitus	6 (31.6%)	10 (14.9%)	0.015
No Prophylactic Antibiotic	8 (42.1%)	10 (14.9%)	0.039

Incorporating variables relevant in the univariate analysis, age, kind of surgery, duration of operation, prophylactic antibiotic use, and diabetes mellitus, a multivariate logistic regression analysis was performed to find independent risk factors for SSIs. With an adjusted odds ratio (OR) of 2.45 (95% CI [1.03, 5.82], p = 0.041), the results showed patients 50 years of age and above had a noteworthy relationship with greater SSI risk. Reflecting a substantial rise in SSI risk, emergency surgery was linked with an adjusted OR of 3.12 (95% CI [1.20, 8.12], p = 0.021). Surgeries spanning more than two hours had an adjusted OR of 2.68 (95% CI [1.08, 6.68], p = 0.034), hence increasing the incidence of SSIs. With an adjusted OR of 3.85 (95% CI [1.44, 10.31], p = 0.007), diabetes mellitus was powerfully linked with a higher risk. Furthermore linked to an adjusted OR of 2.73 (95% CI [1.04, 7.18], p = 0.042) was the absence of prophylactic antibiotic treatment, therefore stressing its major influence on SSI risk. From the SSI cases, nineteen pathogens in all were isolated. Among the most often found organisms were Staphylococcus aureus (n = 8, 42.1%), Escherichia coli (n = 5, 26.3%), and Pseudomonas aeruginosa (n = 4, 21.1%). Additional infections included Klebsiella pneumoniae (n = 2, 10.5%).As illustrated in figure 1.

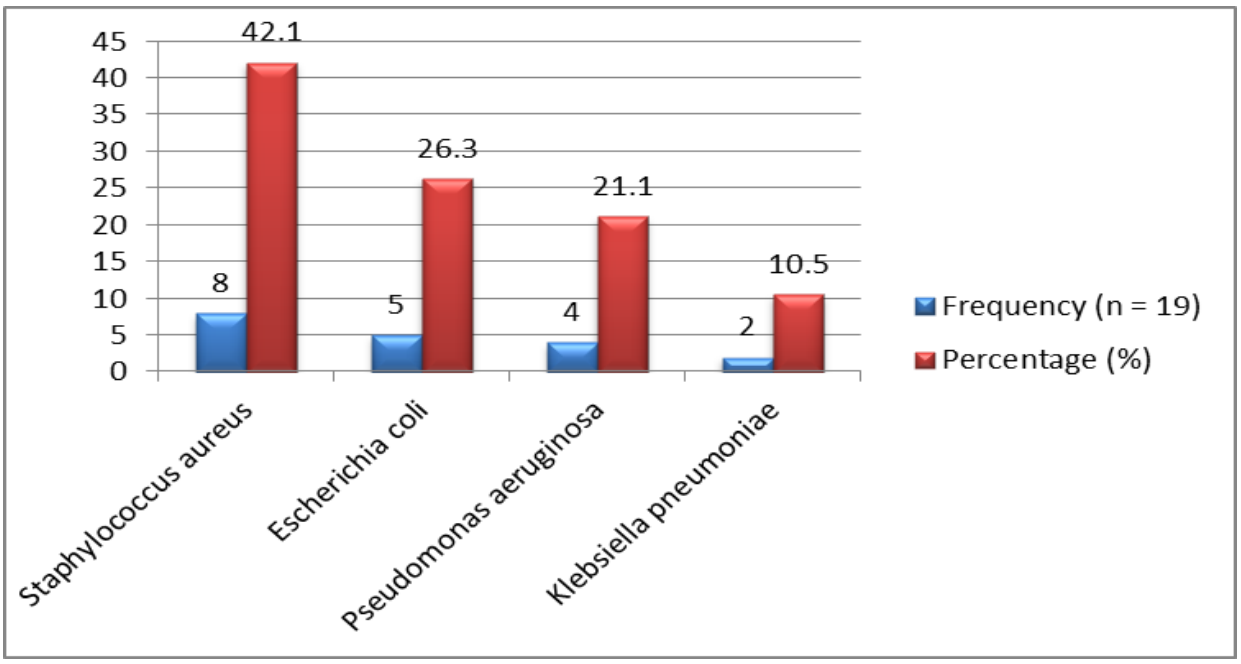

Figure 1: Pathogens Isolated from Surgical Site Infections

The isolated bacteria' worrisome antimicrobial resistance trends Out of the Staphylococcus aureus isolates, two (25.0%) demonstrated resistance to clindamycin and five (62.5%) were methicillin-resistant (MRSA). Three (60.0%) of all Escherichia coli isolates were resistant to third-generation cephalosporins; all else were resistant to ciprofloxacin. Resistance to several antibiotics, including piperacillin-tazobactam (50.0%) and carbapenems (25.0%), Pseudomonas aeruginosa shown Ten (52.6%) of the infections found overall were multidrug-resistant (MDR), meaning they resisted three or more kinds of medicines. As shown in figure 2.

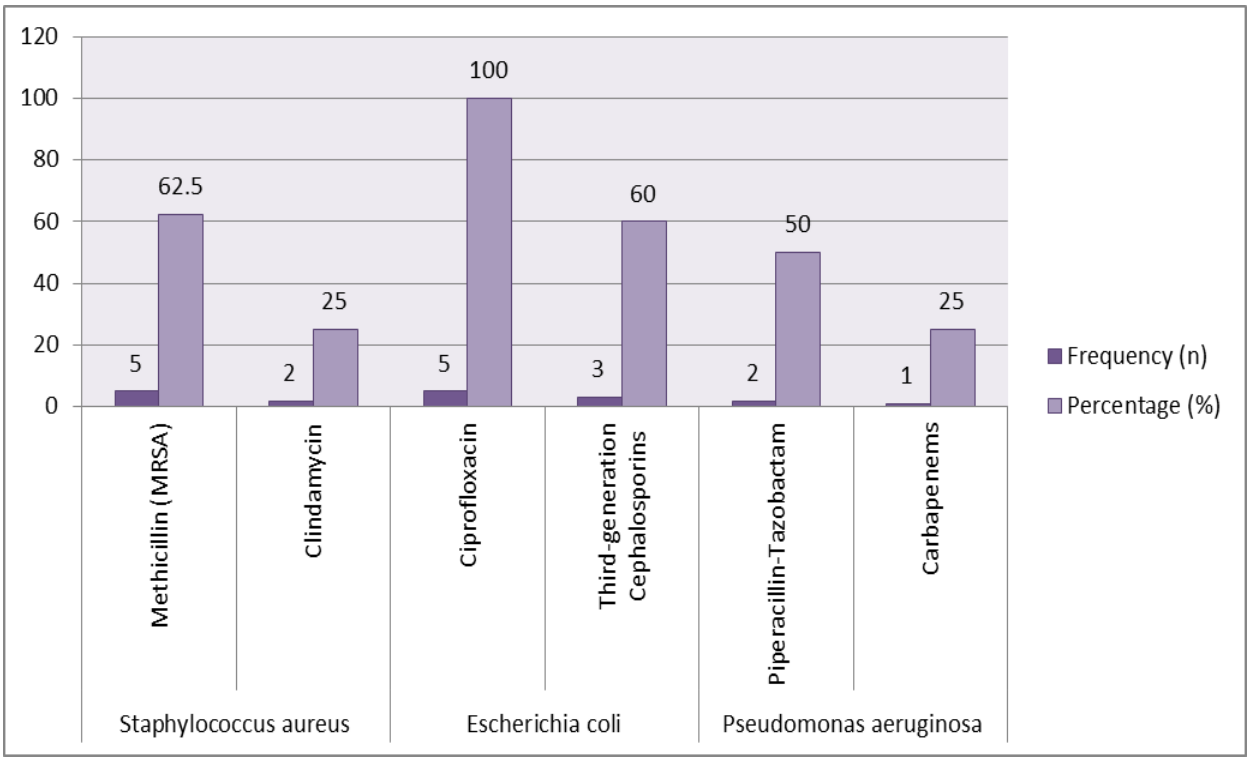

Figure 2: Antimicrobial Resistance Patterns of Isolated Pathogens

The chi-square test revealed significant associations between the development of SSIs and factors such as age ($p = 0.034$), type of surgery ($p = 0.028$), duration of surgery ($p = 0.048$), prophylactic antibiotic use ($p = 0.039$), and diabetes mellitus ($p = 0.015$). Logistic regression analysis identified age ≥ 50 years, emergency surgery, duration of surgery > 2 hours, diabetes mellitus, and lack of prophylactic antibiotic use as independent predictors of SSIs. The study found that the prevalence of surgical site infections (SSIs) was 22.1%. Key risk factors associated with SSIs included being 50 years or older, undergoing emergency surgery, having a prolonged surgery duration, diabetes mellitus, and the absence of prophylactic antibiotic use. The most commonly identified pathogens were *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa*. Additionally, the study revealed a high prevalence of multidrug-resistant organisms, which complicates treatment and management strategies. These findings highlight the urgent need for enhanced infection control practices, targeted use of prophylactic antibiotics, and robust antimicrobial stewardship programs in Pakistani hospitals to mitigate the burden of SSIs and address the rising threat of antimicrobial resistance.

Discussion

Particularly in low and middle income countries (LMICs), the results of this study, which evaluated the frequency, risk factors, and antimicrobial resistance patterns of surgical site infections (SSIs) in a tertiary care hospital in Pakistan, fit and add to the body of knowledge already in publication on SSIs[11]. This study found a general prevalence of SSIs at 22.1%, which is higher than the global average but consistent with studies from other LMICs where rates can reach thirty percent[12]. Several reasons could explain the somewhat high frequency seen: limited resources, different adherence to infection control policies, and a heavy load of emergency

operations, which are among others[13]. Well-established in the literature are the major risk factors noted: advanced age, emergency surgery, prolonged length of operation, diabetes mellitus, and lack of prophylactic antibiotic treatment[14]. Advanced age is linked to impaired immune system and other diseases that could cause infections[15]. Emergency operations raise the risk of SSIs since they usually call for limited time for sufficient preoperative preparation[16].

Extended operations have also been well known as elevating the danger of infection; each extra hour of surgery greatly increases this risk[17]. In LMICs, where its prevalence is rising, diabetes mellitus is especially relevant since diabetic patients are more likely to have infections because of compromised immune response and inadequate healing of wounds[18]. Furthermore well-documented is the preventive action of prophylactic antibiotic use against SSIs; suitable use greatly lowers SSI rates[19]. Our results confirm the vital part these elements play in preventing SSI. Consistent with trends worldwide, the most often isolated pathogens in this investigation were Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa[20]. With varied frequency recorded in different areas, methicillin-resistant Staphylococcus aureus (MRSA) remains a main cause of SSIs globally[21]. Particularly the 100% resistance of Escherichia coli to ciprofloxacin and notable resistance to third-generation cephalosporins, the high degrees of antimicrobial resistance (AMR) seen in this study reflect the growing worldwide challenge of AMR, especially in LMICs where antibiotic use is common[22].

The great frequency of multidrug-resistant organisms in our work complicates SSI management much more and fits worldwide worries about growing antibiotic resistance. This underlines how urgently better antimicrobial control measures and stewardship are needed. The results on the frequency of SSIs and related risk variables match studies from comparable medical environments in LMICs. The noted antimicrobial resistance trends, however, point to a declining trend in AMR and call for more forceful actions to support sensible antibiotic usage and enhance infection control strategies. Research from affluent nations usually shows lower SSI rates and improved antibiotic stewardship, therefore underlining the differences in healthcare infrastructure and resources between LMICs and high-income nations[23]. Given the particular difficulties in Pakistani hospitals, study emphasizes the need of context-specific solutions to handle SSIs there.

Limitation and future research: Among the various limits of this study are its single-center approach, which might restrict the generalizability of the results to different environments. Especially with relation to the less common risk factors and infections, the somewhat small sample size may further limit the validity of the conclusions reached. The study also drew on hospital records, which can have documentation bias. Larger sample size multi-center studies should be the main emphasis of future studies to validate these conclusions in several healthcare environments. Furthermore required are longitudinal studies to track patterns in surgical site infections and antibiotic resistance as well as to assess the success of treatments meant to lower SSIs and fight resistance.

Conclusion

With important risk variables including advanced age, emergency operations, and absence of prophylactic antibiotics, this study concludes that surgical site infections (SSIs) are rather common in a tertiary care hospital in Pakistan. Especially for common infections like Staphylococcus aureus and Escherichia coli, the study also exposes alarming degrees of antibiotic resistance. These results highlight how urgently better antibiotic stewardship, strengthened infection control policies, and focused approaches to lower SSIs and fight antimicrobial resistance in low- and middle-income nations. Improving patient outcomes and healthcare quality in such environments depends on overcoming these obstacles.

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