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EVALUATING THE EFFICACY OF ANTIBIOTIC PROPHYLAXIS ON INFECTION OUTCOMES AND MICROBIAL PATTERNS IN DEGLOVING INJURIES RESULTING FROM ROAD TRAFFIC ACCIDENTS: A PROSPECTIVE STUDY AT A TERTIARY CARE INSTITUTION IN PAKISTAN

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Abstract

Objectives: *This study aimed to evaluate the impact of different antibiotic prophylaxis regimens (preoperative only vs. combined pre- and postoperative) on the severity and type of surgical site infections, as well as to identify the microbial pathogens associated with SSIs in patients with degloving injuries.*

Methodology: *This prospective cohort study was conducted at the Pakistan Ordnance Factories (POF) Hospital, Wah Cantt, from January 2023 to January 2025. A total of 69 adult surgical patients were enrolled and categorized into two groups based on antibiotic regimen: those receiving preoperative antibiotics only and those receiving both pre- and postoperative antibiotics. Demographic and clinical variables were collected from hospital records, including age, gender, comorbidities, smoking status, type and duration of surgery, wound contamination level, and microbial profile. SSI severity and type were recorded. Data were analyzed using IBM SPSS version 25. Descriptive statistics were used for frequencies and proportions, and associations were tested using chi-square analysis, with significance set at $p < 0.05$.*

Results: *Of the 69 patients, 85.5% were male, with 42.0% aged 41–60 years. Hypertension (44.9%) and diabetes mellitus (36.2%) were common comorbidities. Emergency surgeries accounted for 76.8% of cases. A significant association was found between antibiotic regimen and SSI severity ($\chi^2(1) = 8.87$, $p = .00$), with more severe SSIs in the combined prophylaxis group (100%) compared to the preoperative-only group (0%). No significant association was observed with SSI type ($\chi^2(2) = 2.28$, $p = .31$). Escherichia coli (83.3%) and*

Staphylococcus aureus (68.8%) predominated in the combined group, suggesting a link between extended prophylaxis and resistant pathogens.

Conclusion: *This study highlights a significant link between the antibiotic prophylaxis regimen and SSI severity, though not SSI type. The high prevalence of gram-negative pathogens, particularly E. coli, underscores the need to adapt prophylactic protocols to local microbial trends. Implementing evidence-based antibiotic strategies that prioritize appropriate timing, spectrum, and patient-specific risk factors is essential for enhancing SSI prevention and reducing antimicrobial resistance.*

INTRODUCTION

Surgical site infections (SSIs) represent one of the most common postoperative complications, significantly contributing to increased patient morbidity, hospital stay, and healthcare costs, particularly in low- and middle-income countries (LMICs) like Pakistan. The World Health Organization estimates that up to 20% of patients in LMICs may develop SSIs, compared to 2–5% in high-income settings.[1] This burden is even greater in cases of trauma-related surgeries such as degloving injuries, which are typically caused by road traffic accidents (RTAs) and are associated with severe tissue damage, contamination, and delayed wound healing.[2] Degloving injuries present a unique clinical challenge due to the need for complex reconstructive procedures and the risk of repeated infections.

Surgical antibiotic prophylaxis (SAP) has long been considered a cornerstone in the prevention of SSIs, with guidelines emphasizing timely administration, appropriate selection, and minimal duration of use. A review by Polistena A et al. concluded that preoperative antibiotic administration, particularly with first-generation cephalosporins, significantly reduces SSI risk, while postoperative prophylaxis did not provide additional benefit and may lead to increased complications such as urinary tract infections.[3] Goldman AH et al. similarly emphasized the importance of precise antibiotic timing and selection, warning against the overuse of broad-spectrum antibiotics in the context of antimicrobial resistance (AMR).[4]

In trauma-related surgeries, the role of SAP becomes even more critical. However, in Pakistan, the pattern of antibiotic usage in degloving injuries remains largely undocumented. A study by Eskenazi A et al. from a tertiary hospital reported SSI rates of 16.5%, with predominant pathogens being *Staphylococcus aureus* (including MRSA), *Klebsiella pneumoniae*, and *Escherichia coli*—many of which exhibited multi-drug resistance.[5] Furthermore, another study from these findings, with high rates of MRSA and ESBL-producing organisms in postoperative infections. [6] Global efforts to optimize prophylactic strategies continue to evolve. For example, a trial by Futier et al. demonstrated that combining oral antimicrobial prophylaxis (OAP) with intravenous antibiotic prophylaxis (IVAP) significantly reduced SSI rates in elective colorectal surgeries.[7] While Futier E et al. showed no added benefit of antibiotics in thyroid and parathyroid surgeries.[8]

Antimicrobial stewardship (AMS) interventions have been shown to reduce unnecessary postoperative antibiotic use without compromising surgical outcomes. A study by Calderwood MS et al. involving 767 patients found a significant reduction in total antibiotic days and inappropriate indications following AMS implementation.[9] Additionally, advanced therapies such as bacteriophage-antibiotic combinations have shown promise in managing infections caused by pandrug-resistant organisms, offering novel avenues for tackling deep tissue infections, as demonstrated by Jayant D et al.[10]

Despite the global discourse on SAP optimization, Pakistan lacks focused research on prophylactic antibiotic patterns in degloving injuries, particularly in terms of comparing preoperative versus pre- and postoperative strategies and their impact on SSI severity and microbial profile. Addressing this gap is essential for improving surgical outcomes, reducing resistance, and guiding evidence-based practice in trauma surgery. This study, therefore, aims to evaluate antibiotic prophylaxis patterns in degloving injuries

following RTAs and assess their association with SSI severity and microbial distribution.

METHODOLOGY:

This prospective cohort study was conducted at the Pakistan Ordnance Factories (POF) Hospital, Wah Cantt, over a period of two years from January 2023 to January 2025. A total of 69 patients were enrolled based on a sample size calculated using a 95% confidence level, 80% power, and an assumed 20% difference in surgical site infection (SSI) incidence between antibiotic groups. Patients aged between 21-80 years undergoing surgical procedures were included. Inclusion criteria involved all adult surgical patients after road traffic accidents, received either preoperative antibiotics alone or a combination of pre- and postoperative antibiotic prophylaxis. Exclusion criteria included immunocompromised patients, those undergoing chemotherapy, patients with incomplete records, and those who declined participation. Ethical approval was obtained from the Institutional Ethical Review Committee of POF Hospital, and patient anonymity and data confidentiality were ensured throughout the study.

Patient data were collected from hospital records, operative notes, and microbiology reports. Recorded variables included demographics, comorbidities (diabetes, hypertension, others), smoking status, type of surgery (emergency or elective) and wound contamination level (clean-contaminated, contaminated, dirty). The timing of antibiotic prophylaxis was noted and participants were divided into two groups: those who received preoperative antibiotics only and those who received both pre- and postoperative antibiotics. Surgical site infection severity (less severe or more severe), SSI type (superficial incisional, deep incisional, organ/space), and microbial profiles were also recorded. Data analysis was carried out using IBM SPSS Statistics version 25. Descriptive statistics, including frequencies and percentages, were used to summarize demographic data, comorbidities, microbial isolates. The association between antibiotic regimen and SSI severity and type was analyzed using the chi-square test, with a significance level set at $p < 0.05$.

Table 1

Demographic and Clinical Characteristics of Study Participants (n=69)

Variable	Category	Frequency (%)
Age Group (years)	21–40	19 (27.5%)
	41–60	29 (42.0%)
	61–80	21 (30.4%)
Gender	Male	59 (85.5%)
	Female	10 (14.5%)
Comorbidities	Diabetes Mellitus	25 (36.2%)
	Hypertension	31 (44.9%)
	Other Comorbidities	10 (14.5%)
Smoking Status	Smoker	12 (17.4%)
	Non-smoker	57 (82.6%)
Type of Surgery	Emergency	53 (76.8%)
	Elective	16 (23.2%)

A total of 69 patients were included in the study. The majority of participants were aged between 41 and 60 years (42.0%), followed by 61–80 years (30.4%) and 21–40 years (27.5%), indicating a middle-aged to elderly patient population. Male patients dominated the sample, accounting for 85.5% while only 14.5% were female. Regarding comorbidities, 44.9% of patients had hypertension, 36.2% had diabetes mellitus, and 14.5% reported other comorbid conditions. Smoking was present in 17.4% of patients, with the majority being non-smokers (82.6%). Most surgeries were conducted on an

emergency basis (76.8%), while 23.2% were elective procedures. A large proportion of emergency cases were related to trauma, including degloving injuries sustained from road traffic accidents. These characteristics reflect a predominantly male, comorbid, and acutely presenting surgical population, which may influence both antibiotic prophylaxis decisions and the risk of developing surgical site infections.

Table 2
Association Between Antibiotic Regimen and SSI Severity & SSI Type (n=69)

Variable	Categories	Antibiotic Group		χ^2(df)	p-value
		Preoperative only n(%)	Pre + Postoperative n(%)		
SSI Severity	Less Severe	2 (15.4%)	11 (84.6%)	8.87 (1)	.00
	More Severe	0 (0.0%)	56 (100%)		
SSI Type	Superficial	6 (46.2%)	27 (48.2%)	2.28 (2)	.31
	Deep	6 (46.2%)	16 (28.6%)		
	Organ/Space	1 (7.7%)	13 (23.2%)		

The association between antibiotic regimen and SSI severity was found to be statistically significant ($\chi^2(1) = 8.87$, $p = .00$), indicating a strong relationship between the type of antibiotic use and the severity of surgical site infections. In the preoperative-only group, 15.4% of patients had less severe SSIs and none experienced more severe infections, while in the pre- and postoperative group, 84.6% had less severe and 100% had more severe SSIs. This pattern may suggest that patients receiving extended antibiotic coverage were already at higher risk, possibly due to more complex surgeries or existing comorbidities, influencing both the choice of prophylaxis and infection outcome. On the other hand, the association between antibiotic regimen and SSI type (superficial, deep, organ/space) was not statistically significant ($\chi^2(2) = 2.28$, $p = .31$), indicating that the type of antibiotics administered did not significantly affect the classification of infection type.

Table 3
Distribution of Microbial Pathogens Isolated from Surgical Site Infections Among Patients Receiving Antibiotic Prophylaxis (n=69)

Microbial Profile	Antibiotic Group	
	Preoperative only n(%)	Pre + Postoperative n(%)
Staphylococcus aureus	5 (31.3%)	11 (68.8%)
Streptococcus spp.	0 (0.0 %)	3 (100.0%)
Escherichia coli	6 (16.7%)	30 (83.3%)
Pseudomonas aeruginosa	2 (20.0%)	8 (80.0%)
Others	0 (0.0%)	4 (100.0%)

Among 69 patients with surgical site infections (SSIs) receiving antibiotic prophylaxis, *Staphylococcus aureus* and *Escherichia coli* were the most common pathogens, with 68.8% and 83.3% of cases, respectively, in the preoperative plus postoperative group compared to 31.3% and 16.7% in the preoperative-only group. *Pseudomonas aeruginosa* (80.0%) and *Streptococcus spp.* (100.0%) were also more prevalent in the combined group, with other pathogens exclusively in this group (100.0%). These findings suggest that extended

prophylaxis may not prevent SSIs effectively and could contribute to resistant strains, warranting optimized antimicrobial strategies.

RESULTS:

This study aimed to evaluate the relationship between different antibiotic prophylaxis strategies and surgical site infection (SSI) characteristics and microbial patterns in a prospective cohort at a tertiary care hospital. Our results showed a significant association between antibiotic regimen and SSI severity, with all cases of more severe infections occurring in patients who received both preoperative and postoperative antibiotics. This suggests that extended antibiotic coverage was likely given to more complicated cases, which may inherently carry a higher risk of severe infections. Lai et al. (2023) reported similar observations, indicating that the use of postoperative antibiotics is often guided by the clinical judgment of higher-risk cases, which may also be more prone to complications regardless of the antibiotic duration.[11] However, no statistically significant association was found between antibiotic regimen and the type of SSI (superficial, deep, or organ/space). This finding aligns with a study by Navarro et al. (2025), which found that the classification of SSI type was more influenced by surgical and anatomical factors than by the antibiotic timing or regimen used.[12]

The microbial analysis of surgical site infections (SSIs) among 69 patients receiving antibiotic prophylaxis identified *Escherichia coli* as the predominant pathogen. The preoperative plus postoperative antibiotic group showed a higher proportion of *E. coli* and *S. aureus* compared to the preoperative-only group indicating a potential influence of extended prophylaxis on microbial distribution. This trend aligns with recent studies noting the rise of gram-negative organisms in SSIs, particularly in trauma and abdominal surgeries. Chatterjee et al. (2025) and N Samreen et al. similarly reported rising *E. coli* prevalence in postoperative infections, highlighting an evolving microbiological landscape and the necessity of local antibiogram-based planning.[13,14] Munawar S et al. (2023) also noted *E. coli* as the leading SSI pathogen in South Asia, often resistant to standard prophylactic regimens. [15]

The efficacy of extending antibiotic prophylaxis postoperatively remains controversial, as our data suggest higher infection rates with resistant pathogens like *E. coli* and *P. aeruginosa* in the combined prophylaxis group. Hrynyshyn et al. (2024) found that prolonged postoperative antibiotics do not significantly reduce SSI rates and may promote antimicrobial resistance, a concern supported by our findings.[16] Samargandi (2025) further advocated focusing on optimal antibiotic timing and selection rather than extended duration, particularly in trauma surgery, to limit resistance development.[17] These observations suggest that prolonged prophylaxis may not enhance SSI prevention and could exacerbate resistance, necessitating a shift toward more targeted approaches.

Our findings endorse international guidelines by Sartelli et al. (2021), which recommend the shortest effective prophylactic course tailored to surgical type, contamination risk, and local resistance patterns.[18] The high *E. coli* prevalence in our cohort underscores the importance of periodic microbial surveillance, as advocated by Khan et al. (2025), to adapt prophylaxis protocols to local trends.[19] Additionally, the WHO consensus by Khanina et al. (2022) emphasizes integrating hospital-based microbial surveillance into prophylaxis planning, especially in trauma centers, to address evolving resistance profiles.[20] These insights highlight the critical need for evidence-based, locally informed prophylactic strategies to reduce SSIs while mitigating resistance risks.

CONCLUSION

This prospective cohort study reveals a notable link between antibiotic prophylaxis regimens and the severity of surgical site infections (SSIs), with more severe infections observed in patients receiving both preoperative and postoperative antibiotics, though the type of SSI remained consistent across regimens. The predominance of *Escherichia coli* underscores a shift toward gram-negative pathogens, despite prophylaxis efforts. These findings highlight the need to tailor antibiotic strategies to local microbial patterns and individual patient risk factors to optimize SSI prevention while reducing unnecessary antibiotic use and mitigating resistance risks.

LIMITATIONS AND RECOMMENDATION

This study was conducted at a single tertiary care hospital with a relatively small sample size, which may limit the generalizability of the results. The classification of antibiotic groups was based on documentation and may not account for compliance or timing accuracy. Additionally, factors such as surgical technique, intraoperative sterility, and postoperative wound care were not controlled, which could influence SSI outcomes. Future research should include larger, multicenter studies to validate these findings across diverse populations and surgical disciplines. There is also a need to incorporate microbiological surveillance into routine clinical protocols to ensure that prophylactic antibiotics align with prevalent pathogens. Strengthening antimicrobial stewardship and refining SSI prevention guidelines to focus on evidence-based duration and spectrum of antibiotics is essential to minimize resistance and improve patient outcomes.

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