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Original Research Article

Assessment of Surgical Site Infection Rates with Preoperative Antibiotic Prophylaxis in Elective Surgeries

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Abstract:

Background: Surgical site infections (SSIs) remain a significant cause of postoperative morbidity and mortality, despite advances in perioperative care. Preoperative antibiotic prophylaxis is a cornerstone in SSI prevention, yet optimal implementation strategies vary across surgical specialties.

Methods: A prospective observational study was conducted over 18 months involving 456 patients undergoing elective surgeries across general surgery, orthopedic, and gynecological departments. Patients were divided into two groups: those receiving standard preoperative antibiotic prophylaxis (n=342) and those who did not receive prophylaxis due to documented allergies or clinical contraindications (n=114). SSI rates were monitored for 30 days postoperatively using Centers for Disease Control criteria. Data were analyzed using chi-square tests, independent t-tests, and multivariate logistic regression.

Results: The overall SSI rate was 8.3% (38/456). The prophylaxis group demonstrated significantly lower SSI rates compared to the non-prophylaxis group (5.6% vs. 17.5%, $p<0.001$). Mean hospital stay was shorter in the prophylaxis group (4.2±1.8 days vs. 6.7±2.4 days, $p<0.001$). Independent risk factors for SSI included absence of antibiotic prophylaxis (OR=3.52, 95% CI: 1.84-6.73, $p<0.001$), diabetes mellitus (OR=2.41, 95% CI: 1.15-5.06, $p=0.019$), and prolonged operative time >120 minutes (OR=2.18, 95% CI: 1.03-4.61, $p=0.041$).

Conclusion: Preoperative antibiotic prophylaxis significantly reduces SSI rates in elective surgeries. Implementation of standardized prophylaxis protocols is essential for optimizing surgical outcomes and reducing healthcare costs.

Keywords: Surgical Site Infection; Antibiotic Prophylaxis; Elective Surgery; Postoperative Complications; Infection Prevention.

Introduction

Surgical site infections (SSIs) represent one of the most common healthcare-associated infections worldwide, accounting for approximately 20-30% of all nosocomial infections [1]. These infections not only contribute to increased patient morbidity and mortality but also impose substantial economic burdens on healthcare systems through prolonged hospital stays, additional surgical interventions, and increased antibiotic use [2]. Despite significant advances in surgical techniques, sterilization protocols, and perioperative care, SSI rates continue to pose considerable challenges across all surgical disciplines [3].

The pathogenesis of SSIs involves microbial contamination of the surgical site, with the majority of infections caused by endogenous flora from the patient's skin, mucous membranes, or hollow viscera [4]. Exogenous sources, including surgical team members, operating room environment, and surgical instruments, contribute to a smaller proportion of infections. The development of SSI depends on multiple factors, including the virulence of the contaminating organism, the size of the bacterial inoculum, and host defense mechanisms [5].

Preoperative antibiotic prophylaxis has become a fundamental component of infection prevention strategies in surgical practice. The primary objective of prophylactic antibiotics is to reduce the bacterial load at the surgical site during the critical period when tissue defenses are compromised [6]. Evidence-based guidelines recommend administration of appropriate antibiotics within 60 minutes before surgical incision to achieve adequate

tissue concentrations throughout the procedure [7]. However, adherence to these guidelines varies significantly across institutions, with studies reporting compliance rates ranging from 40% to 90% [8].

Recent meta-analyses have demonstrated that appropriate antibiotic prophylaxis can reduce SSI rates by 40-60% in various surgical procedures [9]. Nevertheless, concerns regarding antibiotic resistance, allergic reactions, and cost-effectiveness have prompted ongoing debates about optimal prophylaxis protocols [10]. Furthermore, the increasing prevalence of multidrug-resistant organisms has complicated prophylaxis strategies, necessitating continuous evaluation of current practices [11].

Despite extensive research on antibiotic prophylaxis, gaps remain in understanding implementation effectiveness across different surgical specialties, particularly in resource-limited settings. Additionally, the interaction between prophylaxis protocols and patient-specific risk factors requires further elucidation to enable personalized perioperative care strategies [12].

Aim of the Study: This study aimed to comprehensively assess the impact of preoperative antibiotic prophylaxis on SSI rates in patients undergoing elective surgical procedures, to compare outcomes between prophylaxis and non-prophylaxis groups, and to identify independent risk factors associated with postoperative SSI development.

Materials and Methods

The study population comprised adult patients scheduled for elective surgical procedures in general surgery, orthopedic surgery, and gynecological surgery departments. Sample size was calculated using the formula for comparing two proportions, assuming an expected SSI rate of 15% in the non-prophylaxis group and 5% in the prophylaxis group, with 80% power and 5% significance level. This yielded a minimum required sample size of 412 patients. Accounting for potential dropouts, we enrolled 456 patients.

Inclusion and Exclusion Criteria

Inclusion Criteria: Patients aged 18-75 years undergoing elective clean or clean-contaminated surgical procedures; American Society of Anesthesiologists (ASA) physical status I-III; patients providing informed consent.

Exclusion Criteria: Emergency surgeries; patients with active infections requiring therapeutic antibiotics; immunocompromised patients (HIV, malignancy on chemotherapy); pregnant women; patients lost to follow-up within 30 days postoperatively.

Intervention and Groups: Patients were categorized into two groups based on antibiotic prophylaxis administration:

Group 1 (Prophylaxis group, n=342): Received standard preoperative antibiotic prophylaxis according to institutional protocol (Cefazolin 2g IV for procedures <4 hours, with additional doses for prolonged surgeries; alternative antibiotics for documented allergies).

Group 2 (non-prophylaxis group, n=114): Did not receive antibiotic prophylaxis due to documented severe antibiotic allergies without safe alternatives or specific clinical contraindications.

Prophylactic antibiotics were administered within 30-60 minutes before surgical incision.

Data Collection: Demographic data, comorbidities, surgical details, and perioperative variables were collected using standardized case report forms. Patients were monitored daily during hospitalization and followed up at 7, 14, and 30 days postoperatively through outpatient visits or telephone interviews.

Outcome Measures: The primary outcome was SSI occurrence within 30 days postoperatively, defined according to Centers for Disease Control and Prevention (CDC) criteria. SSIs were classified as superficial incisional, deep incisional, or organ/space infections. Secondary outcomes included length of hospital stay, readmission rates, and need for additional interventions.

Statistical Analysis: Data were analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean ± standard deviation and compared using independent t-tests. Categorical variables were presented as frequencies and percentages, analyzed using chi-square or Fisher's exact test. Multivariate logistic regression was performed to identify independent risk factors for SSI, with odds ratios (OR) and 95% confidence intervals (CI) calculated. A p-value <0.05 was considered statistically significant.

Results

Patient Characteristics: A total of 456 patients were enrolled, with 342 (75.0%) receiving preoperative antibiotic prophylaxis and 114 (25.0%) not receiving prophylaxis. The mean age was 48.3±14.6 years, with 58.3% female patients. Baseline characteristics are presented in Table 1.

Table 1: Baseline Characteristics of Study Participants

Variable	Prophylaxis Group (n=342)	Non-Prophylaxis Group (n=114)	p-value
Age (years), mean±SD	47.8±14.2	49.7±15.6	0.214
Female gender, n (%)	201 (58.8)	65 (57.0)	0.741
BMI (kg/m²), mean±SD	26.4±4.3	26.9±4.7	0.289
Diabetes mellitus, n (%)	78 (22.8)	29 (25.4)	0.559
Hypertension, n (%)	95 (27.8)	34 (29.8)	0.666
Smoking, n (%)	68 (19.9)	26 (22.8)	0.497
ASA Class I/II/III, n (%)	145/156/41 (42.4/45.6/12.0)	46/51/17 (40.4/44.7/14.9)	0.623
Surgical specialty			0.581
General surgery, n (%)	156 (45.6)	48 (42.1)	
Orthopedic surgery, n (%)	112 (32.7)	41 (36.0)	
Gynecological surgery, n (%)	74 (21.6)	25 (21.9)	
Operative time (min), mean±SD	98.6±42.3	102.4±45.7	0.411
Wound class (Clean/Clean-contaminated), n (%)	268/74 (78.4/21.6)	87/27 (76.3/23.7)	0.634

BMI: Body Mass Index; ASA: American Society of Anesthesiologists; SD: Standard Deviation

Surgical Site Infection Rates: The overall SSI rate was 8.3% (38/456). The prophylaxis group demonstrated significantly lower SSI rates compared to the non-prophylaxis group (5.6% vs. 17.5%, p<0.001). Among SSIs, superficial incisional infections were most common (63.2%), followed by deep incisional (23.7%) and organ/space infections (13.1%). Detailed SSI outcomes are shown in Table 2.

Table 2: Surgical Site Infection Outcomes

Outcome	Prophylaxis Group (n=342)	Non-Prophylaxis Group (n=114)	Total (n=456)	p-value
Overall SSI, n (%)	19 (5.6)	20 (17.5)	38 (8.3)	<0.001
SSI type				
Superficial incisional, n (%)	13 (68.4)	11 (55.0)	24 (63.2)	0.382
Deep incisional, n (%)	4 (21.1)	5 (25.0)	9 (23.7)	0.774
Organ/space, n (%)	2 (10.5)	3 (15.0)	5 (13.1)	0.668
Time to SSI diagnosis (days), mean±SD	8.4±3.2	7.8±3.6	8.1±3.4	0.567
Hospital stay (days), mean±SD	4.2±1.8	6.7±2.4	4.8±2.3	<0.001
Reoperation required, n (%)	3 (0.9)	5 (4.4)	8 (1.8)	0.012
Readmission within 30 days, n (%)	12 (3.5)	11 (9.6)	23 (5.0)	0.006
Microbial culture positive, n (%)	15 (78.9)	17 (85.0)	32 (84.2)	0.639

SSI: Surgical Site Infection; SD: Standard Deviation

Risk Factors for Surgical Site Infection: Multivariate logistic regression analysis identified several independent risk factors for SSI development. Results are presented in Table 3.

Table 3: Multivariate Logistic Regression Analysis for Risk Factors of Surgical Site Infection

Variable	Odds Ratio	95% Confidence Interval	p-value
No antibiotic prophylaxis	3.52	1.84 – 6.73	<0.001
Diabetes mellitus	2.41	1.15 – 5.06	0.019
Operative time >120 minutes	2.18	1.03 – 4.61	0.041
BMI ≥30 kg/m²	1.89	0.89 – 4.01	0.098
Smoking	1.67	0.76 – 3.67	0.202
Age >60 years	1.54	0.71 – 3.34	0.273
ASA Class III	1.48	0.63 – 3.48	0.372
Clean-contaminated wound	1.32	0.58 – 3.01	0.506

BMI: Body Mass Index; ASA: American Society of Anesthesiologists

The absence of antibiotic prophylaxis emerged as the strongest predictor of SSI (OR=3.52, 95% CI: 1.84-6.73, p<0.001), followed by diabetes mellitus (OR=2.41, 95% CI: 1.15-5.06, p=0.019) and prolonged operative time exceeding 120 minutes (OR=2.18, 95% CI: 1.03-4.61, p=0.041).

Secondary Outcomes: Patients in the prophylaxis group had significantly shorter mean hospital stays

(4.2±1.8 days vs. 6.7±2.4 days, p<0.001) and lower rates of reoperation (0.9% vs. 4.4%, p=0.012) and readmission (3.5% vs. 9.6%, p=0.006) compared to the non-prophylaxis group.

Discussion

This prospective observational study demonstrates that preoperative antibiotic prophylaxis significantly reduces SSI rates in patients undergoing elective surgical procedures. The overall SSI rate of 8.3% in our cohort falls within the range reported in contemporary literature, although considerable variation exists depending on surgical specialty, patient population, and surveillance methodology [13]. The substantially lower SSI rate in the prophylaxis group (5.6%) compared to the non-prophylaxis group (17.5%) provides compelling evidence for the protective effect of appropriate prophylactic antibiotic administration.

Our findings align with previous systematic reviews demonstrating that perioperative antibiotic prophylaxis reduces SSI risk by approximately 50-70% across various surgical procedures [9]. The three-fold increased odds of developing SSI in patients not receiving prophylaxis (OR=3.52) underscores the critical importance of this intervention. This effect magnitude is consistent with landmark studies that established antibiotic prophylaxis as standard practice in surgical care [14].

The identification of diabetes mellitus as an independent risk factor for SSI (OR=2.41) corroborates extensive existing evidence linking hyperglycemia to impaired wound healing and immune dysfunction [2]. Diabetic patients exhibit compromised neutrophil function, reduced angiogenesis, and altered cytokine profiles, all contributing to increased infection susceptibility. These findings emphasize the need for stringent perioperative glycemic control and potentially extended antimicrobial coverage in this high-risk population [15].

Prolonged operative time emerged as another significant predictor of SSI (OR=2.18), reflecting increased tissue trauma, prolonged exposure to potential contaminants, and greater physiological stress. Each additional hour of surgery has been associated with incremental infection risk in multiple studies [3]. Strategies to minimize operative duration without compromising surgical quality, including enhanced surgical training and optimized theater efficiency, represent important targets for SSI reduction.

The shorter hospital stays observed in the prophylaxis group (4.2 vs. 6.7 days) translate to substantial cost savings and reduced healthcare resource utilization. SSIs increase hospital costs by an estimated $10,000 - 25,000 per case in developed countries, primarily through prolonged hospitalization and additional treatments [1]. The lower reoperation and readmission rates in prophylaxis recipients further emphasize the broader benefits beyond infection prevention alone.

Our study has several strengths, including prospective design, standardized SSI surveillance using CDC criteria, adequate sample size, and comprehensive assessment of potential confounders. The 30-day follow-up period captures the majority of SSIs, particularly superficial and deep incisional infections. However, limitations warrant consideration. The observational design precludes definitive causal inferences, although ethical constraints prevent randomized trials deliberately withholding prophylaxis. The non-prophylaxis group consisted predominantly of patients with antibiotic allergies, potentially introducing selection bias. Additionally, our single-center experience may limit generalizability to settings with different patient demographics, antimicrobial resistance patterns, or resource availability.

Future research should explore optimal prophylaxis regimens for specific surgical procedures, particularly in the context of emerging resistant organisms. Cost-effectiveness analyses comparing different prophylaxis protocols would inform resource allocation decisions. Investigation of adjunctive measures, including perioperative chlorhexidine bathing, advanced wound dressings, and normothermia maintenance, could identify synergistic strategies for SSI prevention [6].

Conclusion

This study provides robust evidence that preoperative antibiotic prophylaxis significantly reduces surgical site infection rates in elective surgical procedures, with prophylaxis recipients demonstrating three-fold lower infection odds compared to non-recipients. The absence of antibiotic prophylaxis, diabetes mellitus, and prolonged operative time emerged as independent risk factors for SSI development. Beyond infection prevention, prophylaxis administration was associated with shorter hospital stays, reduced reoperation rates, and fewer readmissions, highlighting substantial clinical and economic benefits. These findings reinforce the critical importance of implementing and adhering to evidence-based antibiotic prophylaxis protocols across all surgical specialties. Healthcare institutions should prioritize standardized prophylaxis guidelines, develop strategies for patients with antibiotic allergies, optimize perioperative glycemic control in diabetic patients, and minimize operative duration to maximize surgical safety and patient outcomes. Continued surveillance and research are essential to refine prophylaxis strategies in the

evolving landscape of antimicrobial resistance and surgical innovation.

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