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Original Research Article

The Study of Antibiotic Prophylaxis in Clean and Clean Contaminated Surgical Wounds

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Abstract:

Background: Surgical site infections (SSIs) are among the most common postoperative complications, leading to increased morbidity, prolonged hospitalization, and higher healthcare costs. Antibiotic prophylaxis plays a key role in preventing SSIs, particularly in clean and clean-contaminated surgical wounds where microbial exposure varies.

Aim: To evaluate the efficacy of antibiotic prophylaxis in reducing SSIs and postoperative complications in patients undergoing clean and clean-contaminated elective surgeries.

Materials and Methods: A prospective observational study was conducted on 60 patients, divided into two equal groups: Group A received prophylactic antibiotics, and Group B received no antibiotics. Baseline demographics and surgical details were comparable between groups. The primary outcome was the incidence of SSIs within 30 days postoperatively, assessed according to CDC criteria. Statistical analysis was performed using t-test, Chi-square, and Fisher's exact test.

Results: The incidence of SSIs was significantly lower in the antibiotic group (6.7%) compared to the non-antibiotic group (33.3%) ($p = 0.021$). The benefit was most pronounced in clean-contaminated wounds (8.3% vs 53.8%; $p = 0.016$). Mean hospital stay was significantly shorter in the antibiotic group (3.8 ± 1.6 days vs 5.2 ± 2.4 days; $p = 0.01$). No serious antibiotic-related adverse events were reported.

Conclusion: Prophylactic antibiotics significantly reduce the incidence of surgical site infections and shorten hospital stay, particularly in clean-contaminated surgeries. Judicious antibiotic use, appropriate timing, and adherence to evidence-based guidelines are essential for effective infection prevention and antimicrobial stewardship.

Keywords: Antibiotic prophylaxis, Surgical site infection, clean wounds, Clean-contaminated wounds, Elective surgery, Infection prevention, antimicrobial stewardship.

Introduction

Surgical-site infections (SSIs) remain a significant challenge in surgical practice, contributing to increased patient morbidity, prolonged hospital stays and elevated healthcare costs.[1] Among surgical wounds, those classified as clean (no entry into respiratory, gastrointestinal, biliary or genitourinary tracts and primarily closed) and clean-contaminated (controlled entry into such tracts without significant contamination) carry relatively low but non-negligible infection risks. The risk-reduction strategy of perioperative antibiotic prophylaxis has thus evolved as a cornerstone in preventing SSIs in these wound categories.[2]

The fundamental rationale for antibiotic prophylaxis in clean and clean-contaminated surgical wounds is to ensure adequate tissue and serum antibiotic concentrations at the time of incision and throughout the period of intraoperative contamination risk, thereby reducing the microbial burden before infection can establish.[3] International guidelines, such as those developed by the American Society of Health-System Pharmacists (ASHP), Infectious Diseases Society of America (IDSA), Surgical Infection Society (SIS) and Society for Healthcare Epidemiology of America (SHEA) provide evidence-informed recommendations on timing, choice and duration of prophylactic antibiotics for these types of surgeries.[4]

Despite clear guidelines, variability persists in clinical practice regarding antibiotic selection, timing of administration, duration and adherence to recommendations, particularly in the Indian context. This variability may lead either to suboptimal prophylaxis (increasing SSI risk) or to antibiotic overuse (fostering resistance and adverse effects). Moreover, key decision-points—such as whether all clean wounds require prophylaxis, or whether duration beyond wound closure yields additional benefit—remain areas of active investigation.[4]

Given the global emphasis on antimicrobial stewardship coupled with the focus on reducing SSIs, it becomes imperative to systematically study antibiotic prophylaxis in clean and clean-contaminated surgical wounds: assessing current practice patterns, adherence to guidelines, outcomes (SSI incidence, adverse events, cost implications) and factors influencing these. The present study, therefore, aims to evaluate the practice of antibiotic prophylaxis in clean and clean-contaminated surgical wounds, with the objective of identifying gaps between guideline-based recommendations and real-world practice, and to provide evidence towards optimizing antibiotic use in the surgical setting.

Materials and Method

This was a prospective observational study conducted in the Department of General Surgery at a tertiary care teaching hospital over a period of **12 months**. The study evaluated antibiotic prophylaxis practices and postoperative outcomes in patients undergoing surgeries classified as clean and clean-contaminated wounds according to the CDC classification system.

All patients undergoing elective surgical procedures under general or regional anesthesia were considered for inclusion. The study focused on surgeries commonly categorized as clean or clean-contaminated such as hernia repair, thyroidectomy, breast surgeries, laparoscopic cholecystectomy, appendectomy, and bowel resections.

Inclusion Criteria

1. Patients aged ≥18 years of either sex.
2. Patients undergoing elective clean or clean-contaminated surgical procedures as defined by the CDC/NHSN wound classification.
3. Patients who provided written informed consent for participation in the study.

Exclusion Criteria

1. Patients with contaminated or dirty wounds (e.g., gross spillage of gastrointestinal contents or existing infection at the operative site).
2. Emergency surgeries, where timing of antibiotic prophylaxis could not be standardized.
3. Patients with ongoing systemic infection, fever, or preoperative sepsis.
4. Immunocompromised patients, including those on long-term corticosteroids, chemotherapy, or with HIV infection.
5. Patients who had received antibiotic therapy within 48 hours prior to surgery.
6. Patients with known allergy to the antibiotics used for prophylaxis.
7. Patients who were lost to follow-up or whose postoperative wound could not be assessed.

Method

All relevant data were collected using a pretested structured proforma. Information was obtained from patient interviews, operative notes, and postoperative records. Data variables included:

- **Demographic details:** age, gender, comorbidities (e.g., diabetes, hypertension, obesity, smoking).
- **Surgical details:** type and duration of surgery, wound classification, type of anesthesia.
- **Antibiotic prophylaxis details:** name of antibiotic, dose, route, timing of administration (pre-incision or post-incision), and duration of postoperative antibiotic coverage.
- **Postoperative outcomes:** presence or absence of surgical site infection (SSI), duration of hospital stay, and adverse drug reactions.

The timing of antibiotic administration was recorded relative to incision, and prophylaxis given within 60 minutes before skin incision was considered appropriate as per ASHP/IDSA/SHEA guidelines.

Follow Up and Management

Patients were followed for 30 days postoperatively (or until discharge, whichever was later). Wounds were examined on postoperative days 3, 7, and during follow-up visits. Surgical Site Infection (SSI) was diagnosed and classified according to CDC definitions into:

- Superficial incisional SSI,
- Deep incisional SSI, and
- Organ/space SSI.

Statistical Analysis: All collected data were entered into Microsoft Excel 2016 and analyzed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA).

- Descriptive statistics (mean ± SD, frequencies, percentages) were used to summarize demographic and clinical data.
- **Inferential statistics**:
    - Chi-square test or Fisher's exact test for categorical variables.

- Independent t-test for continuous variables. A p-value < 0.05 was considered statistically significant

Observation and Results

Table 1: Distribution of baseline profile among study population

Characteristic	Group A (Antibiotic) n=30	Group B (No antibiotic) n=30	t-test/Chi-square test	p-value
Age, years (mean ± SD)	45.7 ± 13.2	46.9 ± 12.8	-0.36	0.73
Male, n (%)	17 (56.7)	18 (60.0)	1.73	0.79
Diabetes mellitus, n (%)	6 (20.0)	7 (23.3)	0.1	0.75
Smoking, n (%)	5 (16.7)	6 (20.0)	0.11	0.74

This table presents the demographic and baseline clinical characteristics of the study participants. The mean age in Group A (antibiotic) was 45.7 ± 13.2 years, while in Group B (no antibiotic) it was 46.9 ± 12.8 years, with no significant difference (t = –0.36, p = 0.73). The proportion of males was comparable between both groups (56.7% vs. 60.0%, χ^2 = 1.73, p = 0.79). Similarly, there were no statistically significant differences in the prevalence of diabetes mellitus (20.0% vs. 23.3%, p = 0.75) or smoking (16.7% vs. 20.0%, p = 0.74). These findings confirm that both groups were comparable at baseline, eliminating selection bias and allowing valid comparison of postoperative outcomes.

Table 2: Distribution of surgical details among study population

Characteristic	Group A (Antibiotic) n=30	Group B (No antibiotic) n=30	t-test/Chi-square test	p-value
Wound class—Clean, n (%)	18 (60.0)	17 (56.7)	0.07	0.79
Wound class—Clean-contaminated, n (%)	12 (40.0)	13 (43.3)		
Duration of surgery, min (mean ± SD)	92 ± 34	94 ± 37	-0.22	0.83
Laparoscopic procedures, n (%)	14 (46.7)	13 (43.3)	0.07	0.8

Table 2 compares operative factors between the two groups. The distribution of wound classes (clean vs. clean-contaminated) was almost identical in both groups, with no statistical difference (χ^2 = 0.07, p = 0.79). The mean duration of surgery was 92 ± 34 minutes in Group A and 94 ± 37 minutes in Group B (t = –0.22, p = 0.83), indicating comparable surgical complexity. The proportion of laparoscopic procedures was also similar (46.7% vs. 43.3%, p = 0.80). These comparable intraoperative variables suggest that observed differences in infection rates are likely attributable to the antibiotic intervention rather than surgical variability.

Table 3: Distribution of Antibiotic administration in Group A (n=30)

Variable	n (%)
Cefazolin 1–2 g (or equivalent) as first-line	24 (80.0)
Alternative agent (e.g., cefuroxime/metronidazole as indicated)	6 (20.0)
Timing within 60 min before incision	27 (90.0)
Intra-op redosing (procedure >3–4 h or blood loss >1500 mL)	3 (10.0)
Post-op continuation ≤24 h	18 (60.0)
Post-op continuation >24 h	6 (20.0)
No post-op continuation	6 (20.0)
Adverse drug events (mild nausea)	1 (3.3)
Serious reactions	0

This table outlines the antibiotic prophylaxis practices among patients in Group A. Cefazolin (1–2 g) or an equivalent first-generation cephalosporin was used in 80% of cases, while 20% received alternative agents such as cefuroxime or metronidazole. The timing of administration was appropriate in 90% of cases, given within 60 minutes before incision. Postoperative continuation was limited to ≤24 hours in 60%, while 20% received antibiotics beyond 24 hours, reflecting partial deviation from standard recommendations. Only one patient (3.3%) reported a minor adverse reaction (nausea), with no serious adverse events. This demonstrates good adherence to prophylactic guidelines with minimal drug-related complications.

Table 4: Distribution of Surgical site infection within 30 days

Outcome	Group A (Antibiotic) n=30	Group B (No antibiotic) n=30
Any SSI, n (%)	2 (6.7%)	10 (33.3%)
– Superficial incisional	1	6
– Deep incisional	1	3
– Organ/space	0	1
Risk Ratio	0.20	
95%CI	0.048 to 0.837	
Fisher Exact p-value	0.021 (significant)	

This table shows the incidence of surgical site infections (SSIs) within 30 days postoperatively. In Group A (antibiotic), 2 patients (6.7%) developed SSIs compared to 10 patients (33.3%) in Group B (no antibiotic). The difference was statistically significant (Fisher's exact p = 0.021). The calculated risk ratio (RR) = 0.20 (95% CI: 0.048–0.837) indicates that prophylactic antibiotics reduced the SSI risk by approximately 80%. Most infections were superficial incisional, with a few deep incisional or organ/space infections observed in the non-antibiotic group. These findings strongly support the efficacy of antibiotic prophylaxis in reducing postoperative infections.

Table 5: Distribution of Surgical site infection by wound class

Wound class	Group A (n/N, %)	Group B (n/N, %)	Fisher Exact	p-value
Clean	1/18 (5.6%)	3/17 (17.6%)	0.333	0.33
Clean-contaminated	1/12 (8.3%)	7/13 (53.8%)	0.016	0.016

This table stratifies SSI rates by wound class. Among clean wounds, SSIs occurred in 5.6% of patients in Group A and 17.6% in Group B; the difference was not statistically significant (p = 0.333). However, in clean-contaminated wounds, SSIs were significantly higher without antibiotic use (53.8%) compared to those receiving prophylaxis (8.3%) (Fisher's exact p = 0.016). This demonstrates that the benefit of antibiotic prophylaxis is most pronounced in clean-contaminated surgeries, where the bacterial exposure risk is greater.

Table 6: Distribution of Secondary outcomes among study population

Outcome	Group A	Group B	t-test/Fisher Exact	p-value
Length of stay, days (mean ± SD)	3.8 ± 1.6	5.2 ± 2.4	-2.67	0.01
Unplanned return for wound care*, n (%)	2 (6.7)	8 (26.7)	-	0.039
Readmission within 30 days, n (%)	0	2 (6.7)	-	0.49

This table compares postoperative outcomes beyond infection rates. The mean hospital stay was significantly shorter in the antibiotic group (3.8 ± 1.6 days) compared to the non-antibiotic group (5.2 ± 2.4 days) (t = –2.67, p = 0.01). Similarly, unplanned returns for wound care were significantly fewer in Group A (6.7%) than in Group B (26.7%) (p = 0.039). Although readmissions within 30 days were higher in the non-antibiotic group (6.7% vs. 0%), the difference was not statistically significant (p = 0.49). These findings indicate that antibiotic prophylaxis not only reduces SSI but also shortens hospitalization and postoperative wound-related morbidity.

Discussion

In the present study of 60 patients undergoing elective surgeries classified as clean or clean-contaminated, we found a significantly lower incidence of surgical site infections (SSIs) in the group that received prophylactic antibiotics (Group A: 6.7 %) compared with the group without antibiotics (Group B: 33.3 %) (p = 0.021). The benefit was particularly marked in the clean-contaminated wound subgroup (8.3 % vs 53.8 %; p = 0.016). Secondary outcomes also favoured antibiotic prophylaxis: mean hospital stay was shorter (3.8 ± 1.6 vs 5.2 ± 2.4 days; p = 0.01) and unplanned wound-care visits were fewer (6.7 % vs 26.7%; p = 0.039). Baseline characteristics were comparable between groups (all p > 0.05), supporting the internal validity of our findings.

The dramatic reduction in SSI in the prophylaxis group supports the effectiveness of antibiotic prophylaxis in this setting. The fact that the effect was most profound in clean-contaminated procedures aligns with the greater microbial exposure and wound risk inherent in those surgeries. The reduction in hospital stay and wound-care burden further suggests that prophylaxis may confer benefits beyond infection prevention, translating into improved patient recovery and potential cost savings.

Our findings are consistent with a recent large meta-analysis by Antibiotic prophylaxis for surgical wound infections in clean and clean-contaminated surgery: an updated systematic review and meta-analysis (Tang et al., 2024) that included 48 randomized controlled trials (n ≈ 16,189) and found prophylactic antibiotics reduced SSI with a pooled odds ratio (OR) of 0.60 (95% CI 0.53–0.68) when compared to placebo in clean/clean-contaminated surgeries.[5] Their finding of a mean reduction in hospital stay (MD = –0.91 days) also parallels our result of ~1.4 days shorter stay.[5]

Likewise, a review by Prophylactic antibiotics and postoperative surgical-site infections: a review (Lalla 2022) found an approximately 52% reduction in SSI risk with prophylaxis in clean/clean-contaminated cases.[6] These corroborate our observed ~80% reduction (from 33.3% to 6.7%) though our absolute rates are higher—likely due to smaller sample size, case-mix differences (higher SSI baseline in our region) and operational context (resource constraints, varying asepsis).

However, some studies focusing purely on clean wound surgeries report minimal or no significant benefit of antibiotic prophylaxis. For example, a recent observational study from Pakistan in clean cases showed SSI rates of 6.7% vs 7.3% with and without antibiotics, concluding no significant difference (Fisher's exact p = 1.000) [7]. Our data also show a non-significant difference for clean wounds (5.6% vs 17.6%; p = 0.333) although the absolute difference is larger. That aligns with the notion that in low-risk clean procedures (no entry into contaminated tracts, good asepsis) the marginal benefit of antibiotics is less robust.

Conclusion

Our study demonstrates a significant reduction in SSIs, shorter hospital stays and fewer wound-related complications when prophylactic antibiotics were used in clean and clean-contaminated surgical wounds—especially in the latter. These findings align with recent meta-analyses and support evidence-based antibiotic prophylaxis in appropriate surgical contexts. Judicious selection, correct timing, and limiting duration remain essential to balance benefit and stewardship.

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