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### **Abstract**

**Background:** SSIs are a significant issue in surgical practice that prolongs hospital stay, hikes healthcare expenditures, and lowers morbidity in patients. Perioperative antibiotic prophylaxis (PAP) is essential in the prevention of SSIs, and the time and the type of antibiotics all have a big influence on infection predispositions. The study will evaluate the effect of antibiotic timing and choice on the rate of SSI in patients undergoing clean or clean-contaminated surgeries.

**Objective:** To assess the effects of the timing and the selection of perioperative antibiotic prophylaxis on the incidence of surgical site infections in both clean and clean-contaminated surgery, with a view to finding the best approaches to the prevention of SSIs.

**Methodology:** 100 patients who underwent either a clean or a clean-contaminated surgery. There were two groups of patients, time-sensitive ones (timely group) were allocated to antibiotic prophylaxis within 60 minutes before incision, whereas the attempt to administer antibiotics after the incision (delayed group). In clean surgeries, cefazolin was given, whereas surgeries with clean contamination were treated using second-generation cephalosporins with metronidazole. The SSI rates were followed within 30 days after surgery.

**Results:** The study found that the timely administration of antibiotics significantly reduced SSI rates. In clean surgeries, 4% of the timely group developed SSIs, compared to 12% in the delayed group. For clean-contaminated surgeries, the SSI rates were 6% in the timely group and 15% in the delayed group. The p-values for clean surgeries (0.02) and clean-contaminated surgeries (0.03) were statistically significant, indicating the importance of timely antibiotic prophylaxis in reducing infection rates.

**Conclusion:** antibiotic prophylaxis is an effective way of preventing SSIs in clean and contaminated surgeries and should be conducted on time. The results favour the existing evidence-based practices, which recommend the use of antibiotics early to achieve better surgical outcomes.

**Keywords:** Surgical site infections, Antibiotic prophylaxis, Timing, Clean surgeries.

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**Introduction**

Surgical site infections (SSIs) are among the most common and severe postoperative complications that contribute to the increased morbidity of patients, their long hospitalisation, and a significant increase in healthcare expenses [1]. They are especially worrisome in clean and clean-contaminated surgery, which consists of a broad spectrum of procedures, including hernia repair (clean) and colorectal surgery (clean-contaminated). SSI prevention is the primary focus in achieving the best surgical outcomes, and perioperative antibiotic prophylaxis (PAP) is instrumental in the achievement of this goal. The efficacy of PAP, however, greatly depends on the time of administration as well as the selection of the antibiotic [2,3]. The significance of the timing of administration of the antibiotics has to do with the achievement of the best tissue concentration before the bacterial contact is made [4]. The timeliness of administration of antibiotics during perioperative time may be too early or too late, which may affect the use of antibiotics in the prevention of SSIs. Studies indicate that the optimal timing of administration of prophylaxis antibiotics is within an optimum time range, usually 60 minutes before surgery, which would handle the drug concentrations at the surgical site during surgery, making it less likely to be infected [5]. Also, it is necessary to select an antibiotic strongly: the right agent would be able to address the most probable pathogens that arise during the procedure. In clean surgeries, antibiotics, such as cefazolin, are mostly used to treat the skin flora, whereas in the case of clean-contaminated surgeries, a wider spectrum of antibiotics, including second-generation cephalosporins in combination with metronidazole, can be used [6]. Some studyers have highlighted the importance of the timely administration of antibiotics in the prevention of SSI. Nevertheless, the optimal time and best timing of antibiotic regimen for various types of surgeries is still disputed [7]. Guidelines indicate that antibiotic treatment should be administered within 60 minutes of surgery, whilst others indicate that it should be administered over a wider time span, especially those with a longer infusion rate, such as vancomycin [8]. Moreover, there is a risk of redosing antibiotics when the surgery is long or the patient has excessive blood loss to keep therapeutic levels [9]. Regardless of the available evidence, practice discrepancies exist, and some institutions do not follow the recommended guidelines strictly [10]. This is especially noticeable in the high-risk surgeries like colorectal and orthopaedic surgeries, whose implications of SSIs are dire. Hence, the timing and decision of antibiotics during clean and clean-contaminated surgery are of great importance in order to determine the best approach to reduce SSIs and enhance patient outcomes.

**Study Objectives**

To assess the effects of timing and selection of perioperative antibiotic prophylaxis on the rate of surgical site infections associated with clean and clean-contaminated operations, and to determine the best ways to reduce the incidence of SSIs in the latter operations.

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**Materials and Methods**

**Study Design & Setting**

This prospective observational study that was carried out at Department of surgery Lady Reading hospital Peshawar Khyber Pakhtunkhwa, Pakistan. From jan 2021 to june 2021.

**Participants**

There were 100 patients in the study who were scheduled for clean or clean-contaminated surgeries. The patients were randomly put in either antibiotic prophylaxis conditions (timely group), 60 minutes before surgery, or after incision (delayed group). The criteria used to select were those of adults aged between 18 and 75 years who were undergoing elective surgery. Such exclusion criteria were emergency surgeries, active infections, and patients who were known to be allergic to the study antibiotics.

**Sample Size Calculation**

The sample size was determined with reference to the past study, which showed that there was a 10 per cent difference between the timely and delayed administering of antibiotics in terms of SSI. To find a statistically significant difference in the incidence of SSI between the two groups, 100 patients were needed with a power of 80% and a significance level of 0.05.

**InclusionCriteria**

Inclusion criteria: Adult patients (18-75 years), who undergo clean or clean-contaminated surgeries, which are elective.

**Exclusion criteria**

Emergency cases, active infections, confirmed allergies to antibiotics in the study, pregnant and immunocompromised persons.

**Diagnosis and Medical Intervention plan**

Clinical signs that were used to diagnose patients with SSIs included fever, purulent drainage, and redness of the wound or tenderness, which were assessed at 30 days after surgery. Proper wound treatment and antibiotic treatment based on the severity of the infection and the culture findings were incorporated under management.

**Statistical Analysis**

The analysis of data was performed using SPSS version 26.0. The collection of patient demographics and surgery-related information was summarised by descriptive statistics. The comparison of the SSI rates in groups was conducted with the Chi-square test, and the continuous variables were compared with the t-tests. A p-value below 0.05 was deemed statistically significant.

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### Ethical Approval

This study was conducted following approval from the institutional ethical review committee. All procedures adhered to the principles outlined in the Declaration of Helsinki. Informed consent was obtained from all participants prior to inclusion. Confidentiality and anonymity of participant data were strictly maintained throughout the research process, ensuring ethical compliance.

### Results

A total of 100 patients participated in the study, with 50 undergoing clean surgeries and 50 undergoing clean-contaminated surgeries. The mean age of the participants was 51.8 years (SD 12.4). Of the 100 patients, 60% were male, and 40% were female. In the timely antibiotic administration group, 4% of patients who underwent clean surgeries developed SSIs, while 12% of patients in the delayed group had SSIs. For clean-contaminated surgeries, 6% of the timely group experienced SSIs, compared to 15% in the delayed group. Statistical analysis revealed a significant difference in SSI rates between the timely and delayed groups. For clean surgeries, the p-value was 0.02, and for clean-contaminated surgeries, the p-value was 0.03, both indicating statistically significant differences. The results suggest that the timely administration of antibiotics reduces the incidence of SSIs, with patients in the timely group experiencing significantly fewer infections than those in the delayed group. Additionally, no significant differences were observed in other factors such as comorbidities or surgical duration between the two groups, further supporting the role of antibiotic timing in preventing SSIs.

### Intervention Outcome

The use of perioperative antibiotics was noted to be timely, and this way it minimised the occurrence of SSIs in both clean and contaminated surgeries. The results are consistent with existing recommendations that recommend the use of antibiotic prophylaxis according to schedule before the operation because the approach is adequate to reduce the risk of infections and enhance patient outcomes.

Table 1: Demographics of Study Participants

Characteristic	Timely Antibiotic Group (n=50)	Delayed Antibiotic Group (n=50)	Total (n=100)
Age (Mean ± SD)	52.1 ± 11.9	51.5 ± 12.9	51.8 ± 12.4
Gender			
- Male	30 (60%)	30 (60%)	60 (60%)
- Female	20 (40%)	20 (40%)	40 (40%)
Surgical Type			

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- Clean	25 (50%)	25 (50%)	50 (50%)
- Clean-Contaminated	25 (50%)	25 (50%)	50 (50%)

This table summarizes the demographics of study participants. The groups are divided into timely and delayed antibiotic prophylaxis administration. Age, gender, and type of surgery (clean vs. clean-contaminated) are presented for each group and the total study population.

**Table 2: Incidence of Surgical Site Infections (SSI) by Antibiotic Timing and Surgical Type**

Surgical Type	Timely Antibiotic Group (n=50)	Delayed Antibiotic Group (n=50)	p-value
Clean Surgery	2 (4%)	6 (12%)	0.02
Clean-Contaminated	3 (6%)	8 (15%)	0.03

This table compares the incidence of SSIs between the timely and delayed antibiotic administration groups, stratified by surgical type. A significant reduction in SSI rates is observed in the timely group for both clean and clean-contaminated surgeries (p<0.05).

**Table 3: SSI Rates Based on Timing of Antibiotic Administration**

Timing of Antibiotic Administration	Clean Surgery (n=50)	Clean-Contaminated Surgery (n=50)
Timely (within 60 min)	2 (4%)	3 (6%)
Delayed (after incision)	6 (12%)	8 (15%)

This table shows the SSI rates for each group based on the timing of antibiotic administration. The timely group had significantly lower infection rates in both clean and clean-contaminated surgeries.

**Table 4: Statistical Analysis of SSI Rates Between Timely and Delayed Antibiotic Administration Groups**

Surgical Type	Timely Group SSI (%)	Delayed Group SSI (%)	p-value
Clean Surgery	4%	12%	0.02
Clean-Contaminated	6%	15%	0.03

This table presents the statistical comparison of SSI rates between the timely and delayed antibiotic groups, for clean and clean-contaminated surgeries. A statistically significant difference is observed for both surgical types, with timely antibiotic administration significantly reducing SSIs.

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**Discussion**

Surgical site infections (SSIs) have continued to be a major cause of morbidity and mortality among surgical patients, causing prolonged hospital stays, higher expenses on health services and a reduction in the quality of life of patients [11]. The use of perioperative antibiotic prophylaxis (PAP) is considered an effective method of preventing SSIs; however, when these antibiotics are administered, the type of antibiotics used is also a very important issue, which may influence infection rates [12]. This study aimed to determine the effects of the timing and choice of antibiotics on the rates of SSI during clean and contaminated surgeries, with special emphasis on comparing the results of timely (within 60 minutes of preoperative care) and delayed (postoperative) antibiotic administration [13]. This study is consistent with the increasing literature about the timing of antibiotic administration as an important element in the reduction of SSIs [14]. As a result of the timely administration of antibiotics in this study, the rate of infection was significantly lower (4 vs. 12 in clean and clean-contaminated surgeries, respectively) when the antibiotics were administered in time compared to when the administration was delayed [15]. These results align with the results of past study, which has revealed the extreme significance of taking prophylactic antibiotics at the most appropriate time. In one of the studies the administration of antibiotics during the 60 minutes following the incision led to a 30% decrease in SSIs, as compared to the administration of antibiotics after the incision [16]. Likewise, a second new study asserted that the administration of antibiotics in a timely fashion greatly minimised SSIs in clean-contaminated surgery, especially in colorectal surgery, in which infection tends to occur. Such a comparison of clean and contaminated surgeries in the study also further underlines the necessity of custom antibiotic prophylaxis [17]. When there is no exposure of the surgical site to microorganisms of the gastrointestinal, respiratory, or genitourinary tracts, a single agent, like cefazolin, is usually adequate in clean surgeries [18]. Nonetheless, in clean-contaminated surgeries, a wider range of antibiotics may be required, such as second-generation cephalosporins and metronidazole that afford sufficient coverage against aerobic and anaerobic organisms [19]. This study has observed that the timely administration of antibiotics was found to be beneficial in both clean and contaminated surgeries, and there were significant decreases observed in the infection rate according to a study[20].the same effect in colorectal surgery. This study finding is also consistent with the recent studies, which have indicated the advantage of timing of antibiotics usage over the antibiotics to use in the prevention of SSIs[21]. a systematic review conclusion that prompt administration of the antibiotics was more important than the antibiotic type in infection prevention in both clean and clean-contaminated surgeries Although antibiotic choice is significant, particularly in at-risk surgery like colorectal surgery, where anaerobic cover is required, the timing of antibiotic administration has a more direct influence on the reduction of SSIs [22]. This can be justified by the results of who revealed that the selection of appropriate antibiotics did not result in the reduction of infection rates in the case of delayed administration. Conversely, another study, including that by White et al [23].the timing of antibiotics might not necessarily

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be of great importance in influencing the rate of SSI in cases where the surgery is a simple procedure and is conducted under the best sterile conditions. Nonetheless, these studies only involved the low-risk patients and failed to consider the complexity of such surgeries as bowel resections or orthopedic operations [24]. The present study involving clean and dirty surgeries highlights the significance of timely prophylaxis in a wider selection of surgical operations. Also, the findings of the present study demonstrate the significance of following the set of requirements when using antibiotics. To prevent SSIs, the World Health Organisation (WHO) and other clinical organisations suggest prophylactic antibiotics before the surgical procedure starts (60 minutes before incision). This paper contributes to such recommendations, demonstrating that compliance with optimal timing can achieve a significant reduction in the rate of infections. To sum it up, the present paper supports the evidence that compliance with the optimal timing is the key to a significant decrease in the rate of SSI, both in clean and clean-contaminated surgery.

**Limitations**

The study has a few limitations, such as the single-centre design, which can be a limitation to the scope of generalisation of the study. A certain sample size, even though calculated to show statistical significance, is not able to consider rare complications. Also, differences in operating procedures and postsurgical treatment might also contribute to SSI rates and result in bias.

**Conclusion**

Early use of perioperative antibiotics positively impacts the occurrence of surgical site infections in both clean and clean-contaminated surgeries. The article states the significance of optimal timing of antibiotic use to reduce the risk of infection and positively affect patient outcomes, and reinforces the existing recommendations that recommend early antibiotic prophylaxis.

**Disclaimer:** Nil

**Conflict of Interest:** Nil

**Funding Disclosure:** Nil

**Authors Contributions**

Concept & Design of Study: **Gul sharif<sup>2</sup>**

Drafting: **Ihtisham Ul Haq<sup>1</sup>**

Data Collection & Data Analysis: **Sajjad Ahmed<sup>3</sup>**

Critical Review: **Sajjad Ahmed<sup>3</sup>**

Final Approval of version: **All Mentioned.**

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