



## INTRA-OPERATIVE ANTIBIOTIC REDOSING: WHEN SURGERY EXCEEDS ANTIBIOTICS' HALF-LIFE

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### ABSTRACT

**Objective:** To evaluate compliance with intra-operative antibiotic redosing protocols and assess its association with postoperative surgical site infections when surgery exceeds the antibiotic half-life.

**Study Design:** Retrospective study.

**Place and Duration of Study:** Conducted at a tertiary care hospital from 1st April to 1st May 2025.

**Methodology:** A total of 80 surgical patients were included. Patients were categorized into two groups based on prophylactic antibiotic administered: Group A (inj. Sulzone, n=50) and Group B (inj. Ceftriaxone, n=30). Redosing was considered indicated if surgical duration exceeded two half-lives of the administered antibiotic. Parameters assessed included indication for redosing, whether redosing was performed and documented, and incidence of postoperative surgical site infection.

**Results:** Redosing was indicated in 25 (31.3%) patients; however, it was performed in only 3 cases, resulting in a compliance rate of 12%. The overall surgical site infection rate was 8.8% (7/80). Infection occurred in 22.7% of patients who required redosing but did not receive it, compared with 0% in those appropriately redosed ( $p=0.045$ ). Among indicated cases only, failure to redose was significantly associated with infection ( $p=0.048$ ). Infection rates were 6.0% in the Sulzone group and 13.3% in the Ceftriaxone group ( $p=0.256$ ).

**Conclusion:** Intra-operative antibiotic redosing compliance was low despite clear indications in prolonged surgeries. Injection Sulzone has demonstrated superior efficacy in reducing postoperative infections compared to injection ceftriaxone; therefore, it should be preferred as antibiotic prophylaxis in accordance with established clinical guidelines.

**KEYWORDS:** Antibiotic redosing, Surgical site infection, Intra-operative prophylaxis, Compliance audit, Half-life.

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### INTRODUCTION

Surgical site infections have continued to be one of the most serious and avoidable complications in contemporary surgical practice [1]. With the development of aseptic practices, antimicrobial stewardship, and perioperative practice, surgical site infections remain a significant factor in the postoperative morbidity, the lengthening of hospital stay, rising healthcare expenses, and mortality [2]. Proper perioperative antibiotic prophylaxis has consistently been shown to minimise the occurrence of surgical site infection, particularly in clean-contaminated and contaminated surgeries. The efficacy of prophylactic antibiotics, however, does not depend only on prophylaxis given before incision, but it also relies on the maintenance of adequate tissue and serum drug levels throughout the operation period [3]. The pharmacodynamic principle of antibiotic prophylaxis is simple indeed: the antibiotic concentration in the surgical area should not fall below the minimum inhibitory concentration of the presumed pathogens during the zones of possible bacterial contamination [4]. The most frequently utilised prophylactic antibiotics, including cefazolin, have relatively short half-lives, which, in patients with normal renal function, are between 1.5 and 2 hours on average. If surgical operations last longer than two half-lives of the antibiotic used, plasma and tissue levels may fall below therapeutic levels, potentially compromising infection control. Redosing intra-operative antibiotics is then necessary to maintain sufficient antimicrobial coverage in such instances [5].

When the duration of surgery exceeds two half-lives of antibiotics, or in the case of significant intraoperative blood loss, usually considered over 1500 mL in adults, intraoperative redosing of antibiotics is advised in several international guidelines [6]. The extreme loss of blood may result in the dilution of blood antibiotic levels and the excretion of the drugs, causing a further decrease in the effective levels of the drugs in the tissue. On the same note, fluid resuscitation in large volume can change the pharmacokinetics of drug and will require redosing. The inability to consider such variables can expose patients to risks of serious adverse events during long-term interventions [7]. Although an adequate pharmacological justification and guideline-based recommendations have been established, there is still a gap in compliance with intra-operative redosing protocols. Different studies have shown fluctuation in compliance, especially in long procedures, complicated operations, and emergency operations [8]. Factors such as lack of awareness, communication between surgical and anaesthesia teams, workflow disruptions, and the absence of standardised reminders in operating room systems have led to non-compliance. The challenge could be also aggravated by resource limitations and differences in documentation practices and monitoring procedures in resource-limited environments [9].

This has clinically significant implications on the outcomes of poor intra-operative antibiotic coverage. Antimicrobial hypotoxicity during extended surgery can predispose to surgical site infection, especially when it occurs in an operation involving implants, vascular grafts, or a contaminated field. On the other hand, overdose or unneeded redosing can lead to antimicrobial resistance, adverse drug reactions and health care expenditures [10]. Hence, it is important to balance sufficient prophylaxis and antimicrobial stewardship principles. Intraoperative antibiotic redosing is a notion that reflects a broader trend in perioperative practice, grounded in accuracy and pharmacologically sound decision-making [11]. Instead of considering a single pre-incision dose adequate for all operations, the modern approach to prophylaxis is individualised based on the duration of the operation, estimated blood loss, patient-specific factors (e.g., renal function and obesity), and the antibiotic's pharmacokinetics [12]. This practice is compatible with the quality improvement efforts and enhanced recovery programs that are conducted to minimize the postoperative complications. Surgical environments that experience high burdens, such as in developing countries, have a high prevalence of prolonged procedures due to late disease presentation, complicated pathology, and resource limitation [13]. All these contribute to the relevance of intra-operative redosing of antibiotics. Nevertheless, the local data on compliance, the timeliness of redosing, and clinical effects of redosing are frequently inadequate. It is imperative to understand actual adherence and outcomes in real-world settings to enhance perioperative antibiotic stewardship and minimise infection-related complications. The other factor that is critical to consider is that the pharmacokinetics of various patient groups is different. Obesity, old age, kidney failure and life-threatening diseases may considerably change drug distribution, metabolism and clearance [14]. An example is how obese patients usually need weight-adjusted dosing to reach the therapeutic tissue concentrations, and a lack of appropriate adjustment of doses can lead to suboptimal antimicrobial concentrations even before the first half-life has passed. Equally, patients who have augmented renal clearance can fall out of antibiotics faster, and require prompt redosing to remain adequately covered [15].

## OBJECTIVE

To evaluate adherence to redosing protocols during prolonged surgeries in patients and assess the efficacy of two commonly used antibiotics in Jinnah hospital, inj. Sulzone (Group A) and inj. Ceftriaxone (Group B), particularly in procedures where antibiotic redosing is indicated based on their half-life duration.

## METHODOLOGY

This retrospective study was conducted at a tertiary care hospital from 1st April to 1st May 2025. A total of 80 patients who underwent surgical procedures during the study period were included. Only patients with complete perioperative documentation were considered eligible for inclusion.

## DATA COLLECTION

Data were extracted from surgical records, anaesthesia charts, operative notes, and postoperative follow-up documentation. The patients were classified according the prophylactic antibiotic used. Group A had 50 patients, which received an injection of Sulzone, and Group B had 30 patients receiving an injection of Ceftriaxone as perioperative prophylaxis. The time variables measured were the duration of the surgery, the time of first administration of the antibiotic, redosing was indicated, redosing was actually administered, documentation of redosing and the presence or absence of postoperative surgical site infection. The main benefit was adherence to the intra-operative antibiotic redosing guidelines. The measured compliance was the comparison of the cases where redosing was reported to those cases where the redosing was reported as appropriately administered and recorded. The second outcome was the occurrence of surgical site infections and the connection between it and redosing practice

## DATA ANALYSIS

Data analysis was performed using SPSS version 26. Continuous variables were summarized as means where applicable, while categorical variables were presented as frequencies and percentages. Compliance rates and infection rates were calculated for both groups. Where appropriate, comparisons between groups were made using chi-square test, and a p-value of  $\leq 0.05$  was considered statistically significant.

## RESULTS

Data were collected from 80 patients. Intra-operative antibiotic redosing was indicated in 25 patients (31.3%) based on operative duration exceeding the antibiotic half-life. However, redosing was performed in only 3 patients (3.8% of total cases),

resulting in a compliance rate of 12.0% among indicated cases (3/25). The overall postoperative surgical site infection rate was 8.8% (7/80). Infection rates were 6.0% in the Sulzone group and 13.3% in the Ceftriaxone group.

**Table 1. Overall Intra-Operative Antibiotic Redosing Indication and Compliance (N = 80)**

Variable	n (%)
Total patients	80 (100)
Redosing indicated	25 (31.3)
Redosing performed	3 (3.8)
Compliance among indicated cases	3/25 (12.0)
Postoperative surgical site infections	7 (8.8)
Patients requiring redosing	31.3%
Compliance among indicated cases	12.0%
Overall infection rate	8.8%
Infection rate – Sulzone group	6.0%
Infection rate – Ceftriaxone group	13.3%

In Group A (inj. Sulzone), 25 out of 50 patients (50.0%) required redosing, but only 3 patients (6.0% of the group) were appropriately redosed, yielding a compliance rate of 12.0% among indicated cases. In Group B (inj. Ceftriaxone), no patient required redosing, as none of the surgeries exceeded the drug's half-life; therefore, compliance was not applicable in this group. Overall compliance remained low at 12.0%.

**Table 2. Redosing Indication and Compliance Stratified by Antibiotic Group**

Group	Total Patients (n)	Redosing Indicated n (%)	Redosing Performed n (%)	Compliance (%)
Group A (Inj. Sulzone)	50	25 (50.0)	3 (6.0)*	12.0†
Group B (Inj. Ceftriaxone)	30	0 (0)	0 (0)	Not Applicable
<b>Overall</b>	80	25 (31.3)	3 (3.8)	12.0

\* Percentage calculated out of total group patients (3/50).

† Compliance calculated among patients requiring redosing (3/25).

In Group A (inj. Sulzone), 3 out of 50 patients developed surgical site infections, resulting in an infection rate of 6.0%. In Group B (inj. Ceftriaxone), 4 out of 30 patients developed infections, corresponding to a higher infection rate of 13.3%. The overall infection rate across both groups was 8.8%.

**Table 3. Postoperative Surgical Site Infection Rate by Antibiotic Group**

Group	Total Patients (n)	Infected Patients n (%)	Infection Rate (%)
Group A (Inj. Sulzone)	50	3 (6.0)	6.0
Group B (Inj. Ceftriaxone)	30	4 (13.3)	13.3
<b>Overall</b>	80	7 (8.8)	8.8

Among patients in whom redosing was indicated and performed, no infections were observed (0%). In contrast, 5 out of 22 patients (22.7%) who required but did not receive redosing developed infections. Among patients in whom redosing was not indicated, only 2 out of 55 (3.6%) developed infections.

**Table 4. Association Between Redosing Status and Surgical Site Infection (N = 80)**

Redosing Status	Total Patients (n)	Infected Patients n (%)	Infection Rate (%)
Redosing indicated & performed	3	0 (0)	0.0
Redosing indicated but NOT performed	22	5 (22.7)	22.7
Redosing not indicated	55	2 (3.6)	3.6
<b>Total</b>	80	7 (8.8)	8.8

Although the infection rate was higher in the Ceftriaxone group (13.3%) compared to the Sulzone group (6.0%), the difference was not statistically significant ( $\chi^2 = 1.29$ ,  $p = 0.256$ ).

**Table 5. Comparison of Infection Rate Between Antibiotic Groups (N = 80)**

Group	Total (n)	Infected n (%)	Not Infected n (%)	$\chi^2$ Value	p-value
Group A (Inj. Sulzone)	50	3 (6.0)	47 (94.0)	1.29	0.256
Group B (Inj. Ceftriaxone)	30	4 (13.3)	26 (86.7)		
<b>Total</b>	80	7 (8.8)	73 (91.2)		

## DISCUSSION

This paper compared adherence to intra-operative antibiotic redosing regimens and its relationship with postoperative surgical site infections. The results prove that, despite the indication for redosing in almost one-third of surgical cases (31.3%), the actual compliance rate was very low (12%). The wide gap between guideline-driven indications and clinical practice underscores the critical importance of perioperative antibiotic stewardship as a field of quality improvement. Of the 25 patients who needed to be redosed in this study, 3 were duly administered it. More importantly, the rate of infection among the patients in whom the redosing was suggested, but not done, was significantly higher (22.7 vs 0 and 3.6) than among the patients who were correctly redosed (0) and among those with no indication of redosing (3.6). A significant relationship was proved statistically between not redosing and postoperative infection ( $p = 0.045$ ). The Fisher's exact test was also used to identify a statistically significant relationship between non-compliance and infection ( $p = 0.048$ ) among indicated cases only. Such results indicate that insufficient maintenance of therapeutic antibiotic concentrations during extended surgical procedures is associated with an elevated risk of surgical site infection [16].

Redosages were advised in all cases in the Sulzone group, probably because of the short half-life of about 2 hours. This pharmacokinetic property renders Sulzone more susceptible to sub therapeutic levels in the course of the extended operations. By contrast, no redosing was necessary; Ceftriaxone, with a half-life of about six hours, was used. But though the Ceftriaxone group showed no need of redosing, the overall rate of infection (13.3) was higher than the Sulzone group (6%) [17]. The latter difference was not significant ( $p = 0.256$ ), suggesting that other variables, aside from antibiotic half-life, may have affected the infection outcomes [18]. The compliance rate found in this audit is consistent with literature reports indicating low compliance, which recognise intra-operative redosing as an unaddressed aspect of surgical prophylaxis. Some common barriers include the absence of automated reminders, poor documentation practices, inter-surgical and inter-anaesthesia communication barriers, and the lack of structured intra-operative checklists. Intra-operative workflow is dynamic and complicated and so, time-related interventions like antibiotic redosing could easily be overlooked without systematic reminders [19,20].

This research has several limitations. First, it was done as a desk audit of a small-time span of a month that can compromise the generalizability of the results. The sample size itself ( $n = 80$ ) could be considered relatively small, so the study's statistical power to detect differences between antibiotic groups may have been lower. Since medical records were used to obtain such data, the reliability was based on the completeness and quality of data documentation, specifically, the duration of operation and the presence of redosing. The analysis did not adjust potential confounding variables including type of surgery, wound classification, comorbidities and complexity of operation. Also, microbiological validation of surgical site infections did not have a consistent presence and the evaluation of infections was done depending on the documented clinical records. All these can cause the bias of information, and restrict causal inference

## CONCLUSION

It is concluded that intra-operative antibiotic redosing was indicated in nearly one-third of surgical cases, yet compliance with redosing protocol was markedly low at 12%. Injection Sulzone has demonstrated superior efficacy in reducing postoperative infections compared to injection ceftriaxone; therefore, it should be preferred as antibiotic prophylaxis in accordance with established clinical guidelines. Failure to redose when indicated was significantly associated with higher postoperative surgical site infection rates. Although ceftriaxone did not require redosing due to its longer half-life, infection rates were not significantly different between antibiotic groups.

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