

Assessment of Surgical Antimicrobial Prophylaxis Practices in a Tertiary Hospital in Iraq

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ABSTRACT

Aim: Surgical Antimicrobial Prophylaxis (SAP) is critical in reducing surgical site infections (SSIs). However, inappropriate antibiotic use remains common concern in many healthcare settings. Therefore, the aims was to assess the use of surgical antibiotic prophylaxis.

Materials and Methods: A retrospective cross-sectional study was conducted among 419 discharged surgical and gynecological patients at Al-Salam Teaching Hospital, Mosul, Iraq, during August 2023. Patient records were analyzed for SAP indication, antibiotic selection, timing, and duration according to international guidelines. This study aimed to assess both the prescribing patterns and the appropriateness of surgical antimicrobial prophylaxis practices.

Results: SAP was indicated for most patients; however, appropriate antibiotic selection was documented in only 35.1%. Ceftriaxone was predominantly prescribed (73.0%), followed by amoxicillin (8.6%), and cefotaxime (6.2%). Furthermore, most patients received antibiotics after surgical incision, and the duration exceeded 7 days in a significant proportion of cases, contrary to standard recommendations. Of 419 patients, 117 (27.9%) received appropriate prophylaxis and 302 (72.1%) inappropriate prophylaxis. The mean antibiotic cost per patient was 2.16 USD in the appropriate group compared with 4.85 USD in the inappropriate group. Inappropriate prophylaxis accounted for 85.3% of the total antibiotic expenditure.

Conclusions: The study highlights substantial gaps in adherence to SAP guidelines, emphasizing inappropriate antibiotic selection, timing, and excessive duration. These findings underscore the urgent need for implementing antimicrobial stewardship interventions to optimize SAP practices and reduce potential antibiotic resistance and SSIs.

KEY WORDS: surgical site infections, prescribing patterns, surgical antibiotic prophylaxis, inappropriate antibiotic use

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INTRODUCTION

Effective Surgical Antimicrobial Prophylaxis (SAP) significantly reduces surgical site infections (SSI) incidence, which are infections occurring at or near surgical incisions within 30 days or up to one year post-operation [1, 2]. SSI rank third among all nosocomial infections in hospitals; therefore, optimal prophylaxis should be used, involving correct indication based on microbiological evidence, precise timing (within 60 minutes prior to surgical incision), selection of antibiotics covering likely pathogens, and maintaining adequate bactericidal concentrations throughout the surgical procedure [3, 4].

Multiple factors contribute to the development of SSIs, including type and duration of the surgical procedure, appropriate antimicrobial prophylaxis, and patient-related risk factors such as advanced age, diabetes mellitus, cigarette smoking, and immunocompromised states [5, 6]. Surgical wound classifications, ranging from

clean and clean-contaminated to contaminated and dirty, directly influence infection risk [7, 8].

Irrational antibiotic prescribing practices is a major contributor to the high burden of surgical site infections (SSIs) in low- and middle-income countries, where the World Health Organization (WHO) estimates SSI rates to range from 1.2% to 23.6% [9-11]. Inappropriate prophylactic antibiotic use, characterized by incorrect drug choice, delayed timing, or excessive duration, exacerbates medical costs, prolongs hospital stays, increases superinfection risk, promotes antibiotic resistance, and raises adverse drug reactions [12, 13].

Data regarding SAP utilization in Iraq, particularly in Al-Salam Teaching Hospital, Mosul, remain scarce. Hence, this retrospective study aimed to assess SAP practices, including antibiotic selection, timing, duration, and adherence to international guidelines among patients discharged after surgical operations. Investigating these parameters at the hospital level will provide essential

insights into current prescribing patterns, identify gaps in antibiotic stewardship, and inform targeted interventions to enhance patient care outcomes [14-16]. The results from this study will serve as a baseline for future interventions, aiding policymakers and healthcare professionals in optimizing SAP protocols.

AIM

The primary aim of this study was to evaluate the utilization and appropriateness of surgical antimicrobial prophylaxis (SAP) among patients admitted to the surgical and gynecological wards at Al-Salam Teaching Hospital in Mosul, Iraq. Specifically, the study sought to:

1. Assess the indications for SAP in relation to the type and class of surgical procedures performed.
2. Evaluate the selection of antibiotics used for prophylaxis against established clinical guidelines.
3. Examine the timing and duration of antimicrobial administration in the perioperative period.
4. Identify patterns of inappropriate SAP use, including overuse of broad-spectrum antibiotics.

MATERIALS AND METHODS

STUDY DESIGN AND SETTING

A retrospective cross-sectional study was conducted at Al-Salam Teaching Hospital, located in Mosul, Iraq. The study included patients admitted to the surgical and gynecological wards who underwent surgical procedures and were subsequently discharged. The data collection covered a period of one month, specifically August 2023.

STUDY POPULATION

All patients who underwent surgical intervention and received antimicrobial therapy during hospitalization were considered eligible. Patients with incomplete medical records or non-surgical admissions were excluded. A total of 419 patient files were reviewed and included in the final analysis.

DATA COLLECTION

Data were extracted from physical patient records using a structured data collection form. The following variables were recorded:

- **Demographics:** age, sex, and residence
- **Surgical data:** diagnosis, type of surgery (elective/emergency), wound classification (according to CDC), duration of surgery

- **Antibiotic prophylaxis details:** name, timing (relative to incision), duration, and combination use
- **Clinical data:** comorbidities, smoking history, and penicillin allergy status

ASSESSMENT OF SAP APPROPRIATENESS

The appropriateness of Surgical Antimicrobial Prophylaxis (SAP) was evaluated based on ASHP 2013 and WHO 2015 guidelines. Four components were assessed:

- 1. Indication:** SAP should be given for clean-contaminated, contaminated, or selected clean procedures
- 2. Antibiotic selection:** Use of narrow-spectrum antibiotics like cefazolin was preferred; broad-spectrum agents (e.g., ceftriaxone, meropenem) were considered inappropriate when not indicated
- 3. Timing:** Antibiotics were considered timely if administered within **60 minutes before surgical incision**
- 4. Duration:** SAP was deemed appropriate if limited to a single preoperative dose or discontinued within 24 hours postoperatively.

ETHICAL CONSIDERATIONS

The study protocol was approved by the ethical committee of Al-Salam Teaching Hospital. All data were handled with strict confidentiality.

DATA ANALYSIS

Data were entered and analyzed using Microsoft Excel. Descriptive statistics such as mean standard deviation, frequencies and percentages were used to summarize demographic data, surgical characteristics, and SAP compliance indicators. A cost analysis was conducted from the hospital perspective. Only direct acquisition costs of antibiotics were considered. Unit prices were obtained from the official pharmacy procurement list and converted to U.S. dollars at the official exchange rate. For each patient, the total cost of antibiotic prophylaxis was calculated as the number of units administered multiplied by the unit price. Mean cost per patient and total cost were calculated separately for the appropriate and inappropriate prophylaxis groups. Indirect costs, such as staff time, infusion materials, and costs related to complications, were not included.

RESULTS

In this study (Table 1), a total of 419 patients were included in the study. The mean age was 39 ± 19 years, and the average duration of hospital stay was 2.1 ± 2.5 days. The majority of patients were male

Table 1. Socio-demographic and clinical characteristics of patients (N = 419)

Characteristic	Number of cases	Percent (%)
Number of Patients	419	
Male / Female	204 / 115	73 / 17
Age (Mean±SD)	39 ± 19	
Duration of hospital stay (Mean SD)	2.1 ± 2.5	
Residence (Urban/Rural)	252 / 167	60 / 40
Fever	23	5
Smoking	17	4
Penicillin Allergy	14	3
Chronic disease		
Cardiovascular disease	41	10
Diabetes Mellitus	24	6
Past surgical history	39	9
Past caesarean section	16	4

Source: compiled by the authors of this study

Table 2. Classification of surgical procedures by type: elective vs emergency among hospitalized patients (N = 419)

Surgery Type	Number of Cases	Percent (%)
Elective	140	33.4 %
Emergency	279	66.6 %
Total	419	100.0%

Source: compiled by the authors of this study

Table 3. Classification of surgical procedures by duration

Surgery Duration	Number of Cases	Percent (%)
< 1 hour	184	43.9 %
> 1 hour	235	56.1 %

Source: compiled by the authors of this study

Table 4. Frequency and percentage of surgical diagnoses among hospitalized patients (N = 419)

Diagnosis	Number of Cases	Percent [%]
C-section	141	33.7%
Appendicitis	51	12.2%
Cholecystitis	24	5.7%
Renal stone	23	5.5%
Abscess	10	2.4%
Acute abdomen	10	2.4%
Fracture	9	2.1%
Circulage	9	2.1%
Cystoscopy	7	1.7%
Hernia	7	1.7%
Thyroidectomy	7	1.7%
Abortion	7	1.7%
Diabetic foot	6	1.4%
Ureteroscopy	6	1.4%
Tonsillitis	6	1.4%
Hydatid cyst	5	1.2%
Road Traffic Accident (RTA)	5	1.2%
Ectopic pregnancy	5	1.2%
Others	81	19.3%
Total	419	100%

Source: compiled by the authors of this study

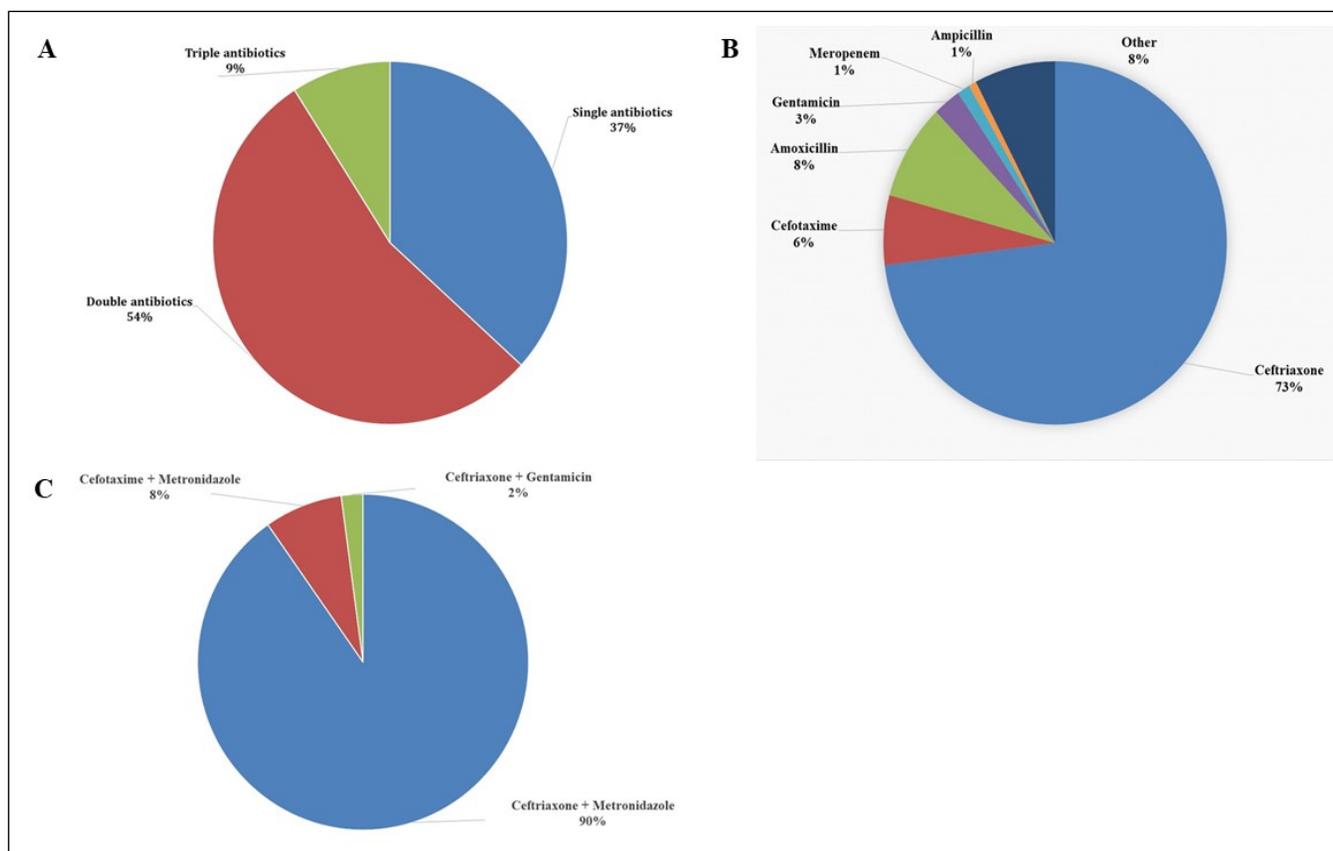


Fig. 1. (A) Distribution of Antibiotic Regimens Among Hospitalized Patients. (B) Distribution of Commonly Prescribed Antibiotics Among Hospitalized Patients. (C) Distribution of Common Dual Antibiotic Combinations Used in Hospitalized Patients

Source: compiled by the authors of this study

(204 patients, 73%) and residents of urban areas (252 patients, 60%).

Regarding the Clinical characteristics of patients, revealed that 5% had fever, 4% were smokers, and 3% reported a penicillin allergy. Regarding comorbidities, 10% had cardiovascular disease and 6% had diabetes mellitus. Additionally, 9% of patients had a history of previous surgery, while 4% had a past caesarean section.

Out of 419 surgical procedures analyzed (Table 2), 279 (66.6%) were classified as emergency surgeries, while 140 procedures (33.4%) were categorized as elective surgeries. This indicates that the majority of surgical interventions were performed under urgent or unplanned clinical circumstances. The high proportion of emergency surgeries may reflect the nature of hospital admissions, with acute conditions such as trauma, obstetric emergencies, or infections being common triggers for surgical intervention.

The distribution of surgical duration (Table 3) revealed that 235 procedures (56.1%) lasted more than one hour, whereas 184 procedures (43.9%) were completed within one hour. These findings suggest that a substantial proportion of surgeries performed in this hospital setting involve complex or time-intensive procedures.

Duration of surgery is a critical factor associated with the risk of postoperative complications, wound classification, and resource utilization in the operating room.

The most frequently recorded diagnosis (Table 4) among hospitalized surgical patients was cesarean section (C-section), accounting for 141 cases (33.7%). This was followed by appendicitis (12.2%), cholecystitis (5.7%), and renal stones (5.5%). Other less common diagnoses included abscesses, fractures, and various elective surgical conditions such as hernias, thyroidectomy, and cystoscopy. Collectively, these findings highlight the diversity of surgical conditions managed, with a predominance of emergency and obstetric-related cases.

Based on the CDC surgical wound classification system (Table 5), 259 procedures (61.8%) were categorized as Class II (Clean-Contaminated), indicating controlled entry into sterile body cavities such as the gastrointestinal, genitourinary, or respiratory tracts. Class I (Clean) wounds accounted for 50 cases (11.9%), while Class III (Contaminated) and Class IV (Dirty-Infected) comprised 78 (18.6%) and 31 (7.6%) cases, respectively. This distribution reflects the high prevalence of intra-abdominal and obstetric surgeries, which inherently involve entry

Table 5. Surgical wound classification of procedures performed in hospitalized patients according to CDC criteria (N = 419)

Wound Class	Class Description	Total Cases	Percent [%]
Class I	Clean (no entry into GI, GU, or respiratory tracts)	50	11.9%
Class II	Clean-Contaminated (controlled entry into GI, GU, respiratory, or genital tracts)	259	61.8 %
Class III	Contaminated (open wounds, spillage, or major sterile break)	78	18.6%
Class IV	Dirty-Infected (existing infection, pus, or perforation)	31	7.6%
Total	—	419	100.0%

Source: compiled by the authors of this study

Table 6. Appropriateness and mean cost of antibiotic selection for SAP

Antibiotic Use	No. of Patients	Percent [%]	Mean Cost/patient	Total Cost USA [\$]	Percent [%]	Justification
Appropriate	117	27.9 %	2.16\$	253	14.7%	Narrow-spectrum (e.g., cefazolin-equivalent, gentamicin, appropriate metronidazole use)
Inappropriate	302	72.1 %	4.85\$	1,464.9	85.3%	Broad-spectrum agents (e.g., ceftriaxone, cefotaxime, meropenem) used without indication
Total	419	100%		1,717.9	100%	—

Source: compiled by the authors of this study

into body tracts, thereby increasing the risk of contamination and postoperative infection.

Antibiotic prescribing patterns among hospitalized patients showed a predominant use of combination therapy. As illustrated in Figure 1 A, dual antibiotic therapy was the most frequently prescribed regimen, accounting for 67% of patients, followed by single antibiotic use in 31%, while triple therapy was used in only 2%. This reflects a strong reliance on empirical broad-spectrum coverage.

The patient included in the current study was given SAP with one, two or even triple antibiotics for the prevention of SSI. In terms of individual antibiotic use (Figure 1 B), Ceftriaxone was the most frequently prescribed antibiotic, administered in 73.0% of patients, followed by Amoxicillin at 8.6%, and Cefotaxime at 6.2%. Gentamicin and Meropenem were prescribed in 2.6% and 1.2% of cases, respectively. Ampicillin was used in 0.7%, while other antibiotics collectively accounted for 7.6% of prescriptions.

Among the dual antibiotic combinations (Fig. 1 C), the most commonly used regimen was Ceftriaxone plus Metronidazole, representing 90% of dual therapy cases. This was followed by Cefotaxime plus Metronidazole (8%), and Ceftriaxone plus Gentamicin (2%). These findings highlight a practice of using broad-spectrum agents targeting both Gram-negative organisms and anaerobes, particularly in abdominal and surgical infections.

Although SAP was indicated in most patients (Table 6), the antibiotic selection was appropriate in only 27.9% of cases. The widespread use of ceftriaxone (73%) and cefotaxime (6.2%), both broad-spectrum antibiotics not recommended for standard prophylaxis, signifi-

cantly contributed to inappropriate use. In addition to poor antibiotic choice, other critical deviations were observed. The timing of administration was inappropriate in the majority of cases, with antibiotics often given after surgical incision, reducing their preventive effectiveness. Moreover, the duration of prophylaxis frequently exceeded 7 days, far beyond the recommended single-dose or ≤ 24 -hour regimen advised by international guidelines such as WHO and ASHP. These combined issues - broad-spectrum overuse, delayed administration, and prolonged duration - reflect major gaps in antimicrobial stewardship and highlight the urgent need for protocol adherence to reduce antimicrobial resistance and surgical site infections.

The cost analysis revealed substantial differences in expenditure between the two groups (Table 6). The mean antibiotic cost per patient in the appropriate prophylaxis group was 2.16 USD, whereas patients in the inappropriate group incurred a mean cost of 4.85 USD. The total expenditure on surgical antimicrobial prophylaxis amounted to 1,717.9 USD, of which 1,464.9 USD (85.3%) was attributable to inappropriate use. Thus, although inappropriate prophylaxis was administered to 72.1% of patients, it consumed more than four-fifths of the total antibiotic budget.

DISCUSSION

This retrospective evaluation identified significant deviations from recommended SAP practices. While SAP was indicated for most patients, appropriate antibiotic selection occurred in only 27.9% of cases. The frequent use of broad-spectrum antibiotics such as ceftriaxone (73%) and cefotaxime (6.2%) illustrates a common yet

inappropriate practice due to their unnecessary broad coverage and potential for resistance development. The inappropriate use of antibiotics observed in this study is consistent with findings from other studies conducted in Asian and neighboring countries, where inappropriateness rates range from 40% to 100%, and is notably higher compared to rates reported in other developing countries, which range from 20% to 50% [17-20]. According to guidelines from ASHP and WHO, cefazolin or equivalent narrow-spectrum antibiotics are recommended as first-line choices for most surgical procedures, reflecting a clear gap in local practice adherence [21-23].

In addition to antibiotic selection issues, timing was identified as significantly suboptimal, with most antibiotics administered after surgical incision, substantially diminishing their prophylactic efficacy. Evidence strongly supports administering antibiotics within 60 minutes prior to incision to achieve optimal tissue concentrations during surgery [24]. Furthermore, antibiotic prophylaxis duration commonly exceeded seven days in this study, contrary to recommended guidelines, which emphasize prophylaxis limited to a single dose or less than 24 hours postoperatively. Prolonged prophylaxis increases the risk of adverse events, antibiotic resistance, and healthcare costs without offering additional protection against SSIs [25].

These findings are consistent with other international reports highlighting poor adherence to SAP guidelines in resource-limited settings [17, 18, 20, 25]. Contributing factors may include inadequate training, lack of standardized hospital protocols, and limited awareness of antimicrobial stewardship principles among healthcare providers. Therefore, targeted educational interventions, implementation of hospital-specific guidelines, and ongoing audit-feedback mechanisms are strongly recommended to enhance compliance and improve clinical outcomes [26]. One limitation of this study is that it was conducted in a single tertiary hospital, which may limit the generalizability of the findings to other healthcare settings. Future prospective studies assessing the impact of stewardship interventions are warranted. Additionally, strategies to strengthen institutional oversight and continuous professional training on evidence-based SAP practices could significantly mitigate these issues, optimizing patient outcomes and preserving antibiotic efficacy.

Beyond clinical implications, our findings demonstrate the considerable financial impact of inappropriate prophylaxis. The mean cost per patient receiving inappropriate prophylaxis was more than double that of patients who received guideline-concordant regimens. Inappropriate use accounted for 85% of total antibiotic expenditure despite being administered to fewer than three-quarters of patients. Extrapolating the observed excess cost to an annual scale suggests that a large and preventable financial burden is imposed on the institution.

These results underscore the importance of implementing regular audits and reinforcing adherence to evidence-based guidelines. Restricting the use of broad-spectrum and costly agents, such as ceftriaxone and meropenem, to appropriate indications would not only improve clinical outcomes but also result in substantial cost savings.

CONCLUSIONS

This study revealed a high rate of inappropriate SAP practices at Al-Salam Teaching Hospital, particularly concerning the misuse of broad-spectrum antibiotics. In addition, most patients did not receive prophylactic antibiotics within the recommended preoperative window, and the duration of antibiotic administration frequently exceeded the guideline-recommended limit of 24 hours. These deviations from standard SAP protocols contribute to heightened antimicrobial resistance and unnecessary healthcare expenditures.

The findings underscore the urgent need to develop and implement standardized, evidence-based local guidelines for SAP. Moreover, the establishment of an effective Antimicrobial Stewardship Program (ASP) is essential to monitor and improve antibiotic prescribing practices. Such measures will help optimize antibiotic use, reduce SSIs, and mitigate the growing threat of antimicrobial resistance. Future studies with larger, multicenter data are recommended to better assess SAP practices across various surgical disciplines and settings in Iraq. In addition to its clinical risks, inappropriate surgical antimicrobial prophylaxis imposes a significant and avoidable economic burden. Adherence to guideline-recommended regimens would reduce both patient harm and unnecessary institutional costs.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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