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ORIGINAL ARTICLE

ADHERENCE TO SURGICAL ANTIBIOTIC PROPHYLAXIS GUIDELINES BEFORE SURGERY IN CANCER PATIENTS: A RETROSPECTIVE OBSERVATIONAL STUDY CONDUCTED IN A TERTIARY HOSPITAL OF OMAN

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ABSTRACT

Background: Surgical antibiotic prophylaxis (SAP) is the administration of antibiotics before surgery to prevent incidences of surgical site infections (SSI) post-operatively. This study aimed to assess the level of adherence to SAP guidelines at tertiary hospital in Oman. It also aimed to investigate whether there was a relation between adherence to SAP guidelines and incidences of SSIs.

Materials & Methods: The methodology consisted of retrospectively reviewing the patient files from August 2022 to August 2023. The primary data collected consisted of antibiotics used, the timing of administration, redosing, and dosage. The secondary objective investigated the impact of non-adherence on SSI incidences and assessed adherence rate across different surgical programme.

Results: The adherence rate of the institute was found to be 18.6% and there was no statistical significance between adherence to SAP guidelines and prevalence of SSIs ($p = 0.3$). Cefazoline is found to be the most commonly prescribed (94.4 %) antibiotic due to its cost-effectiveness and safety profile.

Conclusion: The study highlights variations in adherence to SAP guidelines and concludes that non-adherence is not always the primary cause of SSIs among cancer patients. Other patient-related and operational factors also play significant roles in the occurrence of SSIs.

KEYWORDS: Adherence; Antibiotics; Cancer; Guidelines; Prophylaxis; Surgery.

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INTRODUCTION

Surgical site infections (SSIs) are among the most frequently occurring hospital-acquired infections and contribute substantially to patients' morbidity and mortality. These infections are classified as those arising at or near the surgical incision within 30 days following a procedure, or up to 90 days in cases involving implants such as breast or joint surgeries.[1,2] SSIs are associated with an estimated mortality rate of around 3 %, with nearly three-quarters of related deaths directly resulting from the infection itself. Research conducted in India indicates that SSI prevalence globally varied between 19.4 % and 36.5 %. The increasing burden of antimicrobial resistance is largely fuelled by inappropriate or excessive use of antibiotics, inadequate infection control measures, and the transmission of resistant microorganisms within health care environment.[3,4]

Clinician guidelines have been developed to assist

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healthcare professionals in making informed decisions regarding the appropriate selection, dosing, and duration of antimicrobial therapy, ensuring treatment remains effective while minimizing potential risks[5]. These recommendations are designed to promote consistency in prescribing practices and support optimal patient outcomes by encouraging the judicious use of antibiotics. Despite the availability of such well-established, evidence-informed frameworks, studies from various regions of the world have consistently highlighted suboptimal compliance among clinicians. This gap between recommended practices and real-world implementations continues to undermine the efforts aimed at improving antimicrobial stewardship and controlling the emergence of resistance.[6-12] SSIs may occur after multiple types of surgical interventions, including tumour resections and reconstructive procedures, and they impose a considerable negative impact on healing, prolong recovery, and adversely affect treatment outcomes.[13]

Different cancer surgeries have varying SSI prevalences; for instance, breast cancer patients have SSI rates of 0.5-3.0% while colorectal patients have rates of 7.65%. These differences in SSI prevalence across different cancer surgeries could be rationalised to be so due to the complexity of surgery, which may increase the chances for SSIs to develop; hence, the importance of strict adherence to SAP guidelines.[14] Lack of adherence to SAP guidelines could be a cause for high SSI incidences.[15] Reasons for this low compliance rate are believed to be due to lack of awareness of these guidelines by some healthcare professionals, their reliance on clinical habits rather than evidence-based practices and general lack of institutional enforcement of these guidelines.[16] Therefore, assessing the level of adherence to SAP guidelines in hospitals may provide insight as to why SSI rates are on the rise.

This study aimed to evaluate compliance with surgical antibiotic prophylaxis(SAP) guidelines among cancer surgery patients at the Sultan Qaboos Comprehensive Cancer Centre, Muscat, Oman.

MATERIAL AND METHODS

A retrospective cohort study was carried out at the Sultan Qaboos Comprehensive Cancer Care and Research (SQCCCRC), a 120-bed tertiary referral facility in Muscat, Oman, dedicated to the management of patients with solid malignancies. The investigation covered a one-year period from August 2022 to August 2023. Before commencement, the study protocol was reviewed and approved by the institutional review board of SQRCCCRC (approval no. CCRC -52-2023) and the Ethics and Biosafety Committee of the College of Pharmacy, National University of Science and Technology (NU), with approval no. EBS/PRES0601-CoP/MSc/6/23-24) dated 23rd October 2023

The data is extracted from hospital records for the patients who underwent surgery during the mentioned period. Each surgery performed during the study period is considered a separate entry, regardless of whether a patient undergoes multiple surgeries. This approach allows for a comprehensive analysis of adherence to SAP for each surgical event, ensuring that the data accurately reflects adherence rates and associated outcomes for every procedure performed.

Inclusion Criteria: Intraoperative records of cancer patients aged 18 years or older who underwent general, orthopaedic, gynaecological, and urological surgical procedures involving a skin incision between August 1st, 2022, and 31st August 2023, who received an antibiotic prophylactic dose were eligible for inclusion.

Exclusion criteria: Patients with pre-existing infections at the time of surgery, who lost follow up 90 days after surgery, emergency procedures and non-listed surgeries in the guidelines were excluded from the study.

After applying exclusion criteria, a total of 269 cases were included into study from the original 300. The primary objective of this study is to determine the proportion of adherence to the hospital guidelines in terms of the following four (4) parameters:

Appropriateness of antibiotic choice:

Determined based on the procedure identified in the hospital guidelines.

Weight-Based dose adjustment was considered adherent if at least 90% of the calculated dose per kilogram was administered as of guideline statement.

Timing of antibiotic administration was considered successful if it was recorded within the time window established by the guidelines (i.e, 60 minutes before the incision is made).

Timing of intraoperative redosing: Instances where antibiotics needed to be given again were identified, especially when the surgery lasted longer than the recommended time or blood loss was more than 1500 ml.

Adherence was considered successful if all necessary additional doses were given and recorded before the surgery ended. If any expected redosing was missed, it was considered a failure. The secondary endpoint of this study includes identifying the effect of non-adherence to SAP guidelines on the incidence of SSIs.

The analysis was conducted using SPSS version 26 for statistical calculations and Microsoft Excel for chart visualizations. Inferential statistical tests were applied to assess relationships between variables. A t-test was used to compare the mean ages of adherence and non- adherence groups, while chi-squared tests examined the association between adherence and categorical variables such as gender, procedure category, and SSI rates. Pearson's correlation analysis was also performed to evaluate the relationship between age and adherence. all statistical tests were conducted using a significance level of $\alpha = 0.05$.

RESULT

A total of 269 patients were included in the study, with females comprising 78.4 % of the cohort, largely reflecting the predominance of breast cancer surgeries, which accounted for 50.9 % of procedure. Other surgical programs included gastrointestinal (17.5%), women's Health (13.8 %) and genitourinary (11.9 %). The mean patient age was 52± 15 years, indicating a predominantly middle-aged population (Table 1).

Table 1: Patient and program (surgical event) demographics

Variable	Frequency	%age
Sample size	269	100
Age		
Mean (SD)	52 (15)	
18-30	11	4.1
31- 45	90	33.5
46-59	86	32.0
60 or older	82	30.5
Total	269	100.0
Gender		
Male	58	21.6
Female	211	78.4
Total	269	100.0
Program		
Breast	137	50.9
Gastrointestinal	47	17.5
Women health	37	13.8
Genitourinary	32	11.9
Head, neck & thorax	14	5.2
Rare tumour	1	0.4
Genetics	1	0.4
Total	269	100.0

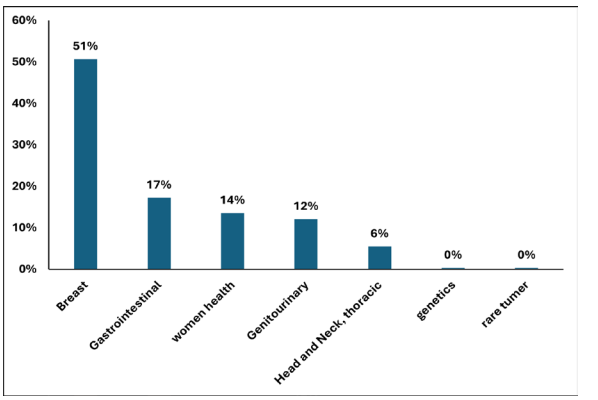

Figure 1: The distribution of surgical cases across medical programs.

Table 2 summarizes the adherence level data for various parameter studied. Overall adherence to the SQCCCRC institutional surgical antibiotic prophylaxis guidelines varied across evaluated parameters. While appropriate antibiotic selection (89.6%), weight-based dosing (97.0%), and redosing when indicated (100%) showed high compliance, adherence to the recommended timing of administration was notably low (19.3%). Consequently, complete adherence to all four parameters was achieved in only 18.6 % of surgical cases. The overall incidence of surgical site infections (SSIs) was 11.2%. Breast cancer and gastrointestinal cancer programs included the highest number of surgical cases and demonstrated similarly high non-adherence rates to SAQ guidelines (78.8% and 78.7 %, respectively) (Figure 1). Elevated non-adherence was also noted in women's health (83.8 %), Genitourinary (87.5%), and head neck and thorax programs. While factors such as the perceived simplicity of certain procedures may partially explain this trend, the consistently high non-adherence across multiple specialities suggests a broader systemic issue rather than program-specific variation. This pattern was further supported by statistical analysis, which showed no significant association between surgical program type and SAP guidelines adherence (p=0.8).

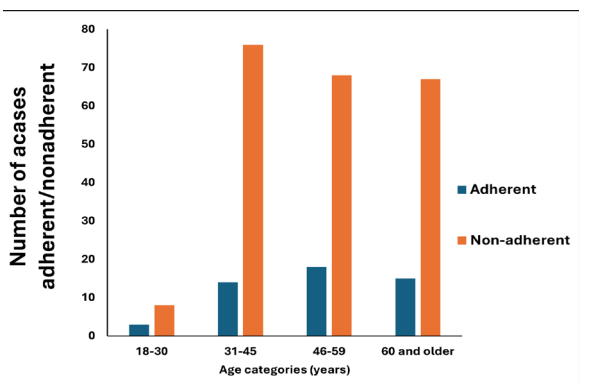

Figure 2: Adherence rates by age (p = 0.7)

Table 2: Individual adherence for various parameters and overall adherence to SAP guidelines

Variable	Number of patients	Adherent	Non adherent	P value
Gender				
Male Female	58 211	13 37	45 174	0.7
Program				
Breast Gastrointestinal Women health Genitourinary Head, neck, thorax Rare tumour Genetics	137 47 37 32 14 1 1	29 (21.2%) 10 (21.3%) 6 (16.21%) 4 (12.5%) 1 (7.14%) 0 (0%) 0 (0%)	108 (78.8%) 37 (78.7%) 31 (83.8%) 28 (87.5%) 13 (92.9%) 1 (100%) 1 (100%)	0.8
Total	269	50	219	
Antibiotic choice	269	241 (89.6%)	28 (10.4 %)	0.6
Timing of Administration	269	52 (19.3)	217 (80.7 %)	-
Weight-based dosing	269	261 (97.0 %)	8 (3 %)	-
Surgical site infections (SSIs)				
Yes No	27 242	7 (25.9%) 43 (17.8%)	20 (74.1%) 199 (82.2%)	0.3
Full Adherence (all Parameters)	269	50 (18.58 %)	219 (81.42 %)	-

The adherence to SAP guidelines also varied across age groups, with non-adherence consistently high in all age categories. The 31-45 years group included the highest number of cases and demonstrated notably high non-adherence similar trends were observed among patients aged 46-59 years and those 60 years and older, where adherence was present but substantially lower than non-adherence. Although the 18-30 years group had the fewest cases overall, non-adherence still predominated. These findings further reinforce the overall trend of widespread non-adherence to SAP guidelines across patient demographics. (Figure 2).

Table 3 summarizes the list of antibiotics that were administered to the patient for SAP. Cefazolin was the most administered antibiotic for SAP, accounting for 94.4% of cases, likely due to its broad-spectrum activity and favourable safety profile.

Table 3: Frequency of antibiotics administered preoperatively

Antibiotic	Frequency	%age
Cefazolin	254	94.4
Cefazolin + Metronidazole	3	1.1
Not given	3	1.1
Ciprofloxacin	2	0.7
Deoxycycline	2	0.7
Tazocin	2	0.7
Amoxillin / Clavulanic acid	1	0.4
Ceftazidime + Avibactam	1	0.4
Metronidazole	1	0.4
Total	269	100

DISCUSSION

The results of this study reveal low adherence to SAP guidelines at SQCCCRC, with only 18.6% of surgical cases adhering. The primary reason for this could be attributed to the SAP parameter 'timing of administration' where only 19.3% of surgical cases adhered (80.7% non-adhered). Failure to meet any one of the four adherence parameters, like such, would lead to the surgical case failing to pass the "full adherence (all parameters)" criteria – affecting the overall adherence rate. The published studies report wide variation in adherence to SAP guidelines, with compilation rates ranging from as low as 9 % to approximately 70 % [17,18,19]. For example, Bardia et al[18], observed an overall adherence rate of 64.1 % in a multicentre cohort, noting excellent compliance with the timing of the initial dose but comparatively lower adherence to intraoperative re-dosing. Likewise an Italian hospital reported marked improvement after introducing antimicrobial stewardship measures, with adherence rising from 36.6 % to 57.9 % alongside gains in appropriate indication, antibiotic selection, and duration of prophylaxis.[20] In contrast, research from low- and middle-income settings frequently documents lower compliance, often below 50 % and occasionally as low as 9 %.[21] In this context, our result is toward the lower end of the reported spectrum, indicating the severe need for focused improvement in overall adherence.

The primary factor contributing to non-adherence was the lack of documentation for antibiotic timing, as only a few surgical cases had accurately recorded procedure start times or antibiotic administration. This may reflect poor communication among the surgical team, insufficient SAP protocol training, or delays in antibiotic delivery. Additional factors included incorrect antibiotic selection, with 10.4 % of cases non-adherent, potentially due to limited awareness of recommended options, restricted availability of guideline antibiotics, or individual surgeon preferences and clinical considerations. Adherence was high for other parameters, with redosing when indicated at 100 % and weight-based dosing at 97 %. Only 7 % of cases required redoing, and all were compliant, likely due to continuous intraoperative supervision and predominance of short surgeries that did not meet the interval for redosing. High adherence to weight-based dosing was supported by pharmacy oversight, standardized protocol, and proper training, while 3 % non-adherence may reflect individualized dose adjustment based on clinical needs.

Despite the institutions' relatively low adherence to SAP guidelines (18.6), this rate remain comparable to those reported by other regional institutions. For example, a study conducted by Tolba et al, conducted at King Faisal Specialist Hospital and Research Centre reported guidelines compliance in only 15.3 % of cases. Such findings indicate the possible presence of underlying systemic challenges that may be influencing overall adherence to SAP protocols across institutions; therefore, further evaluation of demographic and statistical variables may be valuable in identifying significant associations with SAP guidelines compliance .[22]

Demographic variables were analysed to explore potential factors contributing to low adherence to SAP guidelines. The mean patient age was 52 ± 15 years, representing a predominantly middle-aged population. However, no statistically significant association was observed between age categories and SAP adherence ($p=0.7$), suggesting that age did not influence compliance.

Cefazolin was the predominant prophylactic antibiotic, administered in 94.4 % of cases, reflecting its broad-spectrum efficacy and favourable safety profile. It was occasionally combined with agents such as metronidazole, while alternative antibiotics were used selectively based on clinical indications. This prescribing pattern highlights cefazolin as the primary prophylactic agent at SQCCCRC and indicates alignment with recommended antibiotic selection practices. Non-adherence to SAP guidelines was hypothesized to contribute to elevated SSI rates; however, the observed SSI rate was 11.2 % with no statistically significant association between SAP adherence and SSI incidence ($p=0.3$).

These finding suggests that adherence to SAP guidelines alone is not adequate in reducing the prevalence of SSIs. Comparable SSI rates have been reported in other studies,[23] For instance, a study conducted by Naros et al, which retrospectively examined antibiotic prophylaxis and surgical site infections in orthognathic surgery, found the SSI rate to be 12.4% ($n = 36$). It also could not find a direct correlation between adherence to SAP and SSIs.[24] On the contrary, a meta-analysis conducted by Tang et al. (2024) on the efficacy of SAP concluded that sap adherence positively reduces the incidence of SSIs.[25]

Limitations of the study:

The study was subjected to several limitations that may have affected the strength of its conclusions. The scope of available data was limited, restricting the ability to identify meaningful patterns. Key clinical variables such as ASA scores were unavailable, preventing assessment of procedural complexity and its potential influence on SAP adherence. Additionally, important factors, including wound classification (clean vs contaminated) and procedural acuity (elective vs emergency), were not documented[25]. These gaps, likely stemming from incomplete documentation and recordkeeping, constrained the study's capacity to perform a more comprehensive analysis.

Furthermore, non-compliance with SAP guidelines may have various underlying factors that may not be

immediately apparent to the researcher. Surgeons, with their clinical experience, might have valuable insights into the reasons behind deviations from protocols. These deviations could be due to patient-specific factors, surgical complexities, or unforeseen intraoperative events.[26,27] Therefore, it is crucial to cross-check data with surgeons to understand the rationale behind such deviations and ensure the validity of the study findings

CONCLUSION

This study was successfully able to assess the level of adherence to SAP guidelines at SQCCCRC. Full adherence to SAP guidelines was found to be 18.6%. The study also successfully considered the significance of adherence to SAP guidelines and SSI rates. It found that there was no statistical significance between adherence to SAP guidelines and SSI rates ($p = 0.3$). These results are somewhat short of international guidelines, but should the study be repeated with thorough surgical documentation, it could align more closely with such studies.

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CONFLICT OF INTEREST
Authors declare no conflict of interest.
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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design:	GMMS, MJQ
Acquisition, Analysis or Interpretation of Data:	GMMS, MJQ, AKAH, OMAH, ZAS, AA
Manuscript Writing & Approval:	GMMS, MJQ, AKAH, OMAH, ZAS, SJ

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.