

Full Length Research Paper

Practice of prophylactic antibiotic use in elective orthopedic procedures at a national teaching and referral hospital in Kenya

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According to the Centers for Disease Control and Prevention (CDC) recommendations, antibiotic prophylaxis should only be used when necessary. The judicious use of prophylactic antibiotics, following evidence-based guidelines, leads to optimal outcomes, including reduced infection rates and the prevention of antimicrobial resistance. This study examines the practice of prophylactic antibiotic use in elective orthopedic procedures at a national teaching and referral hospital in Kenya. A prospective cross-sectional study was conducted in the orthopedic operating theaters of Kenyatta National Hospital (KNH). Participants awaiting elective orthopedic surgery were recruited using a consecutive sampling approach. Data collected from patients in the operating room included age, sex, and orthopedic specialty. Information was gathered from the treatment sheets and antibiotic prescribers. The reasons for the choice of surgical antibiotic prophylaxis were also sought from the prescribers. The collected data was analyzed using SPSS version 24. Out of 161 patients who participated in the study, cefazolin was the most commonly used antibiotic preoperatively, prescribed in 99% of cases. Eighty-seven percent of the antibiotics were administered within one hour of the start of the operation, and all were given before the application of the tourniquet. Sixteen percent of total operations involved the use of intraoperative vancomycin at the wound site. Nineteen percent of the prescribers were not aware of the hospital guidelines postoperatively. Overall, the preoperative prescribing practices of antibiotics in terms of drug choice, dosage, and timing were in line with local and international recommendations. Although the majority of prescribers were aware of the guidelines on surgical antibiotic prophylaxis (SAP), there is a need for increased sensitization regarding these guidelines among antibiotic prescribers.

Key words: Prophylactic antibiotics, orthopedic surgeries, surgical site infections, cefazolin, Kenyatta national hospital.

INTRODUCTION

According to Centers for Disease Control and Prevention (CDC) recommendations, antibiotic prophylaxis should

only be used when necessary (Berríos-Torres et al., 2017). There is a high incidence of antimicrobial

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resistance, evidenced by an increase in cases of methicillin-resistant *Staphylococcus aureus* (MRSA) (Fang et al., 2024). This results in extended illness, higher morbidity and mortality rates, and increased healthcare costs (Ahmed et al., 2024; Holmes et al., 2023). Antimicrobial stewardship is part of the solution, which involves selecting the correct antibiotic type that matches the organism causing the disease, adhering to the timing specified in guidelines, and ensuring the precise dosage and route of administration (Giamarellou et al., 2023; Jordaan et al., 2023). The CDC and the Kenyatta National Hospital (KNH) antibiotic stewardship guidelines state that no antibiotic prophylaxis is needed during closed clean orthopedic operations, such as arthroscopic procedures. However, for clean surgeries such as spinal procedures, implantation of internal fixation devices, or total joint replacement, a single dose of cefazolin or vancomycin should be administered one hour before the incision, depending on the patient's weight. In cases of prolonged procedures lasting more than three hours or involving significant blood loss, dose repetition should be considered intraoperatively (Jordaan et al., 2023; Sartelli et al., 2024; Kenyatta National Hospital, 2023; Aujla et al., 2013). This study aimed to investigate the prescribing practices of prophylactic antibiotics and identify the factors that influence the choice of antibiotics at a national teaching and referral hospital in Kenya.

METHODOLOGY

Study setting and design

A prospective cross-sectional study was conducted at Kenyatta National Hospital, the largest referral hospital in Kenya, located in the capital city of Nairobi. This level 6 tertiary hospital has a bed capacity of 2,400 and is staffed by over 30 orthopedic consultants and approximately 60 orthopedic residents. The study population included all orthopedic patients who were not on antibiotics and were awaiting elective orthopedic surgery at Kenyatta National Hospital. Patients who declined to give consent or were on prolonged postoperative antibiotic use, had persistent osteomyelitis, suffered from open fractures, or required an ICU stay were excluded. Initial recruitment of patients took place in the orthopedic wards while they were waiting for surgery, using a consecutive sampling method until a sample size of 161 was achieved.

Data collection

A formatted data collection tool was utilized to record demographic data, the type of surgery performed, preoperative timing of antibiotic administration, the type of antibiotic used, and tourniquet application. The level of training of the antibiotic prescriber was also indicated. Data on intraoperative duration of the procedure, the use of implants, any topical antibiotics administered, the application of wound drains, and any repeat doses of antibiotics—including timing, dosage, and reasons—were collected. During data collection, the Kenyatta National Hospital guidelines on surgical antibiotic prophylaxis for orthopedic procedures were cross-referenced with the practice. A pilot study was conducted for one week prior to commencing the actual study, ensuring quality in terms of accuracy, validity, and reliability of results.

Informed written consent was obtained from all patients included in the study. For patients under 18 years of age, consent was obtained from a parent, guardian, or next of kin. Information was kept confidential, stored in a locked briefcase, and protected by a password on the computer. Approval from the KNH-UoN Ethics and Research Committee (number P897/12/2022) was obtained prior to the commencement of the study.

Data analysis

Data were collected using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA) and then analyzed using SPSS Version 21 (IBM Corporation, Armonk, NY, USA). Categorical variables, such as the proportion of patients who received perioperative antibiotics, were reported using descriptive statistics. All results were compared to the recommendations outlined in the local guidelines.

RESULTS

Demographic characteristics of the patients

161 patients who were scheduled for elective surgery were interviewed and they comprised of 121 males (75%) and 40 females (25%). The distribution by gender is shown in Figure 1.

As shown in Figure 1, the largest number of patients fell in the middle age group, meaning three in every four were aged 19 to 59. The patients were planned for elective surgery according to different thematic units distributed by gender, as shown in Table 1. The majority (54%) of the patients were managed by the trauma unit, 19 % by the hand unit and 9 % by arthroplasty and sports

Antibiotics prescribed during the entire surgical procedure

Preoperative prescription

The majority (45%) of prescribers were registered clinical officers, followed by registrars at 39%, anesthesiologists at 14%, and clinical officers in training at 2%. Of the 161 patients, 99% (160/161) received cefazolin before the planned surgery, while one patient was prescribed amoxicillin/clavulanic acid. Regarding the recommended timing for antibiotic administration prior to incision, 87% were within the recommended one hour, while 13% received the antibiotic after the recommended one-hour window. This delay may have been due to issues in the central sterile services department, which supplies implants or equipment after sterilization. A tourniquet was used in 30% of all cases, and in 100% of these cases, antibiotics were administered before tourniquet application (Table 2).

Intraoperative prescription

During the surgical procedure, 23 patients (14%) had procedures that lasted longer than 4 h, while the

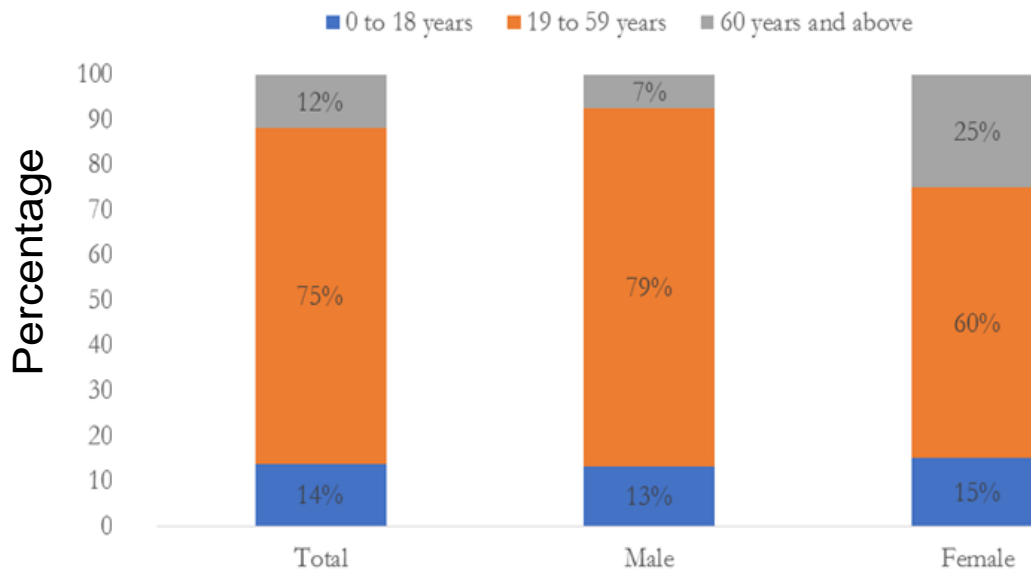


Figure 1. Patient's age category by gender.

Table 1. Total cases by thematic unit showing gender distribution of the patients.

	Total (N)	Total (%)	Male	Female
	161	100%	121 (75%)	40 (25%)
Trauma	87	54	59	40
Hand	30	19	22	8
Arthroplasty and sports	15	9	2	30
Spine	11	7	7	8
Oncology	8	5	3	10
Pediatric	6	4	4	3
Foot and ankle	4	2	2	3

Table 2. Pre-operative parameters of the patients.

	Total (count)	Total (%)
Cadre of prescriber before incision (N=136)		
Anesthesiologist	19	14
Registered Clinical Officer	61	45
Registrar	53	39
Clinical officer in training	3	2
Type of pre-operative antibiotics used		
Cefazolin	160	99
Amoxicillin/clavulanic acid	1	1
Time given before incision (N=155)		
Less than an hour	135	87
More than an hour	20	13
Application of tourniquet (N=159)		
Yes	48	30
No	111	70

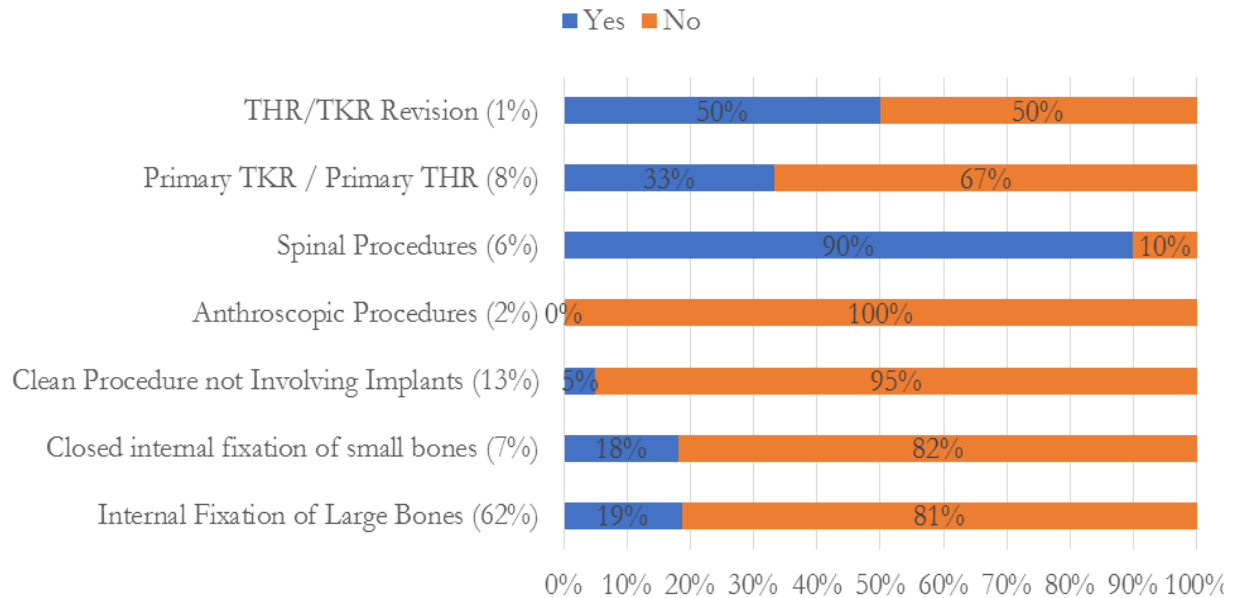


Figure 2. Type of surgery and intraoperative antibiotic use.

Table 3. Postoperative antibiotic use by prescriber.

Antibiotic use by prescriber	Total		Cadre of the prescriber		
	Count	%	Consultant orthopedic (%)	Resident orthopedics (%)	Resident anesthesia (%)
Cefazolin	134	86	43	88	100
Amoxicillin/clavulanic acid	25	16	86	13	0
Cefuroxime	9	6	14	6	0
Ceftriaxone	8	5	0	6	0
Flucloxacillin	5	3	14	3	0
Metronidazole	4	3	0	3	0
Clindamycin	3	2	14	1	0
Gentamicin	1	1	0	1	0
Tazobactam	1	1	0	1	0
Ceftazidime	1	1	0	1	0

remaining 86% had procedures that took less than 4 h. Half of the patients whose surgeries exceeded 4 h received an intraoperative antibiotic, whereas 81% of patients whose operations lasted less than 4 h received an intraoperative antibiotic. This disparity in practice indicates a significant departure from the recommendations, which was statistically significant ($\chi = 9.45$, $p = 0.002$). Among those given an intraoperative antibiotic, 84% (26/31) received vancomycin, and 16% (5/31) received cefazolin. The prescription of intraoperative antibiotics was investigated across the surgical procedures, and the results are shown in Figure 2. The results indicate that 90% of spinal procedures received an intraoperative antibiotic, while none of the arthroscopic procedures did.

Dose

It was found that 68% of patients received 2 g of cefazolin preoperatively, 21% received 1 g, and only one case received 3 g. Less than 10% received less than 1 g.

Postoperative prescription

The results indicate that cefazolin was prescribed by all resident anesthetists, 88% of resident orthopedic surgeons, and 43% of consultant orthopedic surgeons (Table 3).

The analysis on type of procedure and postoperative antibiotic prescription indicates that one in every three of

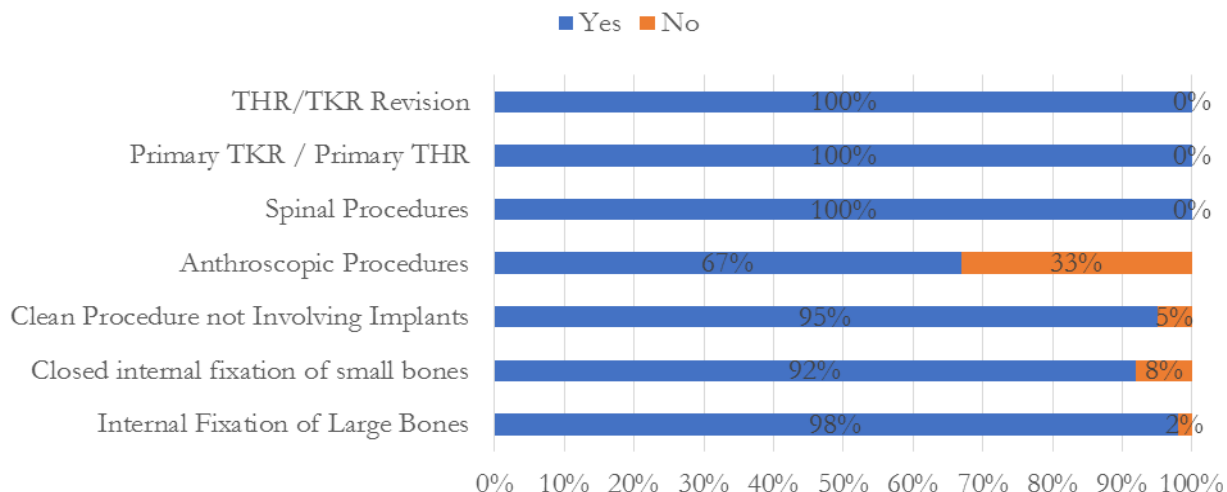


Figure 3. Postoperative prescription by type of procedure.

Table 4. Factors associated with the choice of antibiotics.

Choice of antibiotics	Total respondents	
	Count	%
Case complexity	22	18
Cefazolin not available	10	8
Surgeon Preference	13	10
Prevent surgical site infection control	33	27
Long duration in surgery	10	8
Multiple procedures	7	6
No response	29	23

patients with arthroscopic procedures was not prescribed with post-operative antibiotics as shown in Figure 3.

An assessment of awareness of guidelines for surgical antibiotic prophylaxis (SAP) revealed that 77% (124/161) were aware of the KNH guidelines, while 19% (30/161) of prescribers were not familiar with them, and 4% (7/161) were non-responsive. The 124 prescribers who were knowledgeable about SAP were asked their reasons for using the antibiotics. The reasons given included the need to prevent surgical site infection (27%), case complexity (18%), surgeons' preference (10%), unavailability of cefazolin (8%), long duration of surgery (8%), and multiple procedures (6%) (Table 4).

DISCUSSION

The choice of surgical antibiotic prophylaxis

Antibiotic prophylaxis in orthopedic surgery has been recognized as one of the cornerstones of infection prevention (Holmes et al., 2023; Jordaan et al., 2023;

Oladeji et al., 2024). A large majority (99%) of patients received cefazolin in the preoperative stage of prophylactic antibiotic use, which aligns with local and international guidelines (Sartelli et al., 2024; Kenyatta National Hospital, 2023; Aujla et al., 2013). These findings are consistent with studies conducted in the UK, Iran, Indonesia, and South Africa, which reported cefazolin use at 96, 97.3, 92, and 78.3%, respectively (Jordaan et al., 2023; Gans et al., 2017; Shabanian et al., 2018; Nizar and Ariyanto, 2024).

In contrast, a previous local study conducted at KNH showed that cefazolin was administered in only 28.6% of patients, despite being the antibiotic of choice (Ligogo, 2020). The drastic change in practice is attributed to a revamped antibiotic stewardship committee at the hospital that provides cefazolin exclusively for prophylaxis; any other antibiotic must be ordered, and the reasons for the change in practice documented.

However, in the two cases of total hip replacement/total knee replacement revisions, the recommendation is to use a single dose of 1 g IV vancomycin in addition to cefazolin, which was not administered. For arthroscopic

procedures, no prophylaxis is recommended according to KNH and CDC guidelines; however, in this study, three arthroscopic procedures were performed, and all patients received cefazolin preoperatively, which is not in accordance with the guidelines. Twenty-six patients received intrawound vancomycin powder despite the controversy surrounding its use at the surgical site. Despite a lack of high-level evidence, orthopedic surgeons frequently apply vancomycin locally, especially in arthroplasty and spine instrumentation cases. The U.S. Preventive Services Task Force advocates its use on the basis that it reduces the risk of surgical wound infection (Kanj et al., 2013). In contrast, pharmaceutical companies and the Food and Drug Administration do not endorse its use (Takahashi et al., 2018).

In this study, antibiotics such as gentamicin and ceftriaxone were used in a few cases, although these are not recommended as they do not cover the most common organisms, and their broad coverage can contribute to antimicrobial resistance (AMR) (Rafati et al., 2014). However, this represents a much lower percentage compared to a previous local study, which showed ceftriaxone used for antibiotic prophylaxis in the majority of cases (Ligogo, 2020). The use of non-standard antibiotics by clinicians may be attributed to a lack of knowledge of current SAP guidelines. One reason for the declining use of ceftriaxone could be resistance patterns, as well as adherence to the KNH guidelines.

Dosage of surgical antibiotic prophylaxis

The majority of patients received the correct dose of prophylactic antibiotics. These findings are consistent with the existing literature (Mikwar et al., 2013). In contrast, a study in South Africa reported incorrect dosing in 27.4% of patients weighing less than 60 kg or more than 120 kg (Jordaan et al., 2023). Intraoperative cefazolin was administered to five patients, primarily as a 1-g intravenous single dose, while vancomycin was used in all cases for local wound site application, most commonly at a dose of 2 g (88%). No intravenous vancomycin was used despite its recommendation for revision total hip replacement (THR) and total knee replacement (TKR) procedures. Consistent with most studies using topical vancomycin powder in spine procedures, vancomycin was utilized in 90% of spine procedures, followed by arthroplasty, where it was used in every two out of three cases (Kanj et al., 2013). In the postoperative period, cefazolin was the most commonly prescribed antibiotic, as previously discussed, which aligns with the existing literature (Yeap et al., 2006).

The duration of surgical antibiotic prophylaxis

In this study, preoperative antibiotics were administered within 60 min before incision in 84% of cases, which aligns with most guidelines (Mikwar et al., 2013). This

finding is similar to other studies that reported 84.6% compliance with guidelines (Jordaan et al., 2023; Oladeji et al., 2024). In all cases involving tourniquet use, antibiotics were administered prior to application, as recommended by the Kenyatta National Hospital (KNH) guidelines (Kenyatta National Hospital, 2023). An assessment of awareness regarding surgical antibiotic prophylaxis (SAP) guidelines revealed that most clinicians were familiar with the hospital guidelines, which is consistent with findings from other studies (Binown et al., 2021; Tefera et al., 2019).

Conclusion

Cefazolin was the most commonly used drug for surgical antibiotic prophylaxis (SAP), aligning with local and international guidelines. The dosage administered was consistent with the guidelines and appropriate for the patients' ages. Vancomycin was used intraoperatively despite concerns regarding its impact on antimicrobial resistance (AMR), which may be attributed to ongoing controversies and a lack of solid evidence. Although most prescribers were aware of the SAP guidelines, additional sensitization efforts are needed to enhance understanding among antibiotic prescribers.

LIMITATIONS

Challenges were encountered in obtaining the exact weight and height of patients, as most were trauma patients undergoing elective fixation, making it difficult to accurately assess weight. However, patient weights were estimated to calculate antibiotic dosages.

RECOMMENDATIONS

Further investigations into prescribers' knowledge, attitudes, and practices are needed to identify the key elements that govern antibiotic prescribing. The reasons for surgeons' deviations from hospital guidelines should also be explored in future studies. Educational initiatives on surgical antibiotic prophylaxis (SAP) for surgeons and anesthesia professionals should be implemented through training workshops and regular medical education to improve compliance. Additionally, conducting routine audits, either quarterly or biannually can help determine whether policies are being followed.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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