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Consumption Patterns of Antibiotic Prophylaxis Regimens among Patients Presenting to the Surgical Wards at Bu-Ali Sina Medical and Educational Services Center in Sari,Iran: A retrospective cross-sectional study

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Abstract

Background:
In the context of modern healthcare, surgical interventions are essential yet pose inherent risks, including postoperative infections. Antibiotic prophylaxis plays a pivotal role in mitigating these risks, aiming to prevent surgical site infections (SSIs) and associated complications. This study focuses on the consumption patterns of antibiotic prophylaxis regimens among patients admitted to the surgical wards at Bu Ali Sina Medical and Educational Services Center in Sari, Iran.

Materials and Methods:
This retrospective cross-sectional study involved 970 participants undergoing clean or clean-contaminated surgical procedures. Data were collected between May 2020 and August 2022, utilizing a descriptive-analytical cross-sectional approach. The research employed a researcher-made questionnaire covering demographic information, antibiotic details, side effects, duration of administration post-operation, adherence to guidelines, and compliance with ASHP 2013 antibiotic prophylaxis guidelines. Statistical analyses included central tendency and dispersion indicators, Chi-squared test, Fisher's exact test, one-sample Kolmogorov-Smirnov, Mann-Whitney U test, and T-test.

Results:
The predominant antibiotic categories were cephalosporins, with ceftriaxone and cefazolin accounting for 65.2% and 61.8% of prescriptions, respectively. Comparison between orthopedic and ENT surgery groups did not reveal significant differences in antibiotic regimens (P=0.085). However, a noteworthy difference emerged in the duration of antibiotic prophylaxis, with a significant distinction between orthopedic and ENT surgery groups (P=0.650). Compliance with ASHP 2013 guidelines was observed in 84% of cases regarding the timing and type of prescribed antibiotic prophylaxis regimen.

Conclusion:
This study provides crucial insights into the consumption patterns of antibiotic prophylaxis among surgical patients, emphasizing the prevalence of cephalosporins and revealing distinctions in duration between orthopedic and ENT surgery groups. The findings contribute to optimizing patient outcomes and addressing antimicrobial resistance challenges. As the healthcare community navigates the delicate balance between prophylactic benefits and resistance concerns, these results offer valuable information for policy-making and clinical practices.

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Introduction

In the realm of modern healthcare, surgical interventions are indispensable for the management of various medical conditions. While these procedures play a crucial role in improving patient health, they are not without inherent risks, including the potential for postoperative infections. Antibiotic prophylaxis has emerged as a pivotal strategy to mitigate these risks by preventing surgical site infections and associated complications. Antibiotic prophylaxis, a cornerstone of perioperative care, has evolved over the years as a crucial strategy to prevent surgical site infections (SSIs). The judicious use of antibiotics in the preoperative period not only reduces the incidence of postoperative infections but also contributes to improved patient outcomes and healthcare resource utilization. (1,2)

The selection of antibiotic prophylaxis regimens is guided by several key principles. First and foremost is the consideration of the spectrum of pathogens commonly associated with specific surgical procedures. Empirical antibiotic choices aim to cover the anticipated range of pathogens while minimizing the risk of resistance development. Secondly, the timing of administration is critical, with antibiotics ideally administered within a defined window before surgical incision to achieve optimal tissue concentrations during the procedure.(1, 3) Finally, the duration of prophylaxis is typically limited to the immediate perioperative period to mitigate the risk of antibiotic resistance, Common Regimens around the world included

Cefazolin often regarded as the first-line choice for many surgical procedures, cefazolin provides broad-spectrum coverage against Gram-positive bacteria, including Staphylococcus aureus and Streptococcus species(4, 5). It is frequently employed in clean and clean-contaminated surgeries such as orthopedic, cardiovascular, and ENT surgical procedures (6).

Cefoxitin and Cefotetan, These second-generation cephalosporins are favored in procedures involving the lower gastrointestinal tract(7), where coverage against anaerobic bacteria is essential.Commonly used in colorectal surgeries to address the unique microbial flora associated with the bowel.(8)

Clindamycin particularly valuable in scenarios where patients exhibit allergies to beta-lactam antibiotics(9), clindamycin provides effective coverage against Gram-positive cocci.It is often considered in procedures involving penicillin-allergic patients or those at risk for methicillin-resistant Staphylococcus aureus (MRSA) infection(10).

4-Gentamicin or Tobramycin with Cefazolin or Cefuroxime

Combining an aminoglycoside with a cephalosporin provides a synergistic effect, broadening the spectrum of coverage against both Gram-positive and Gram-negative bacteria.This combination is employed in certain orthopedic and cardiac surgeries, where dual coverage is deemed beneficial The use of antibiotic prophylaxis before orthopedic and ENT (Ear, Nose, and Throat) surgeries is intended to prevent surgical site infections. The timing of antibiotic administration is crucial to maximize its effectiveness. The goal is to achieve adequate drug levels in the tissues at the time of incision and during the surgical procedure.(11)

While these regimens represent common practices, it's important to note that antibiotic prophylaxis guidelines can vary based on regional antimicrobial resistance patterns(12), local epidemiology, and institutional preferences. Additionally, the emergence of multidrug-resistant organisms and the imperative to curb antibiotic resistance continue to influence the landscape of antibiotic prophylaxis, prompting ongoing research and adaptations in clinical practices worldwide.(13) Iran, with its diverse healthcare landscape, presents a unique setting for investigating antibiotic usage practices.(14) The insights gained from this study are expected to contribute not only to the local healthcare practices but also to the broader scientific discourse surrounding antibiotic stewardship and infection prevention in surgical settings The present retrospective cross-sectional study delves into the intricate landscape of antibiotic prophylaxis regimens adopted by patients referred to the surgical wards at Bu Ali Sina Medical and Educational Services Center in Sari, Iran. Understanding the consumption patterns of antibiotics in this specific clinical context is of paramount importance for optimizing patient outcomes, enhancing healthcare delivery, and addressing the global challenge of antimicrobial resistance As the global healthcare community grapples with the challenge of balancing the benefits of antibiotic prophylaxis with the imperative to curb antimicrobial resistance, this study contributes valuable insights that could inform policy-making and clinical practices. By shedding light on the current landscape of antibiotic prophylaxis regimens, this research aims to foster a deeper understanding of the complex interplay between surgical interventions, antimicrobial agents, and patient well-being.

Methods

a descriptive-analytical cross-sectional study was conducted among 970 participants using random sampling from two surgical departments of the hospital in sari, between May 2020 to August 2022; The inclusion

criteria - male Patients presenting to Bo Ali Sina Educational and Medical Center, Candidates for clean or clean-contaminated surgical procedures, and Candidates receiving prophylactic antibiotic regimen. Data were collected by a researcher-made checklist using the complete enumeration method. The checklist consisted of Demographic data included Name, age, gender, weight, height, type of surgery, duration of surgery, blood pressure, heart rate, respiratory rate ,Antibiotic details: type, timing of administration, dosage ,Side effects: diarrhea, allergic reactions, other adverse effects , and Duration of antibiotic administration post-operation, , prescribed antibiotic type, prescription method, antibiotic initiation time, postoperative infection occurrence, Adherence to standard guidelines ,and compliance with the ASHP 2013 antibiotic prophylaxis guidelines were recorded and evaluated in patients receiving antibiotic prophylaxis. A specific form was designed for patient registration and assessment (37). Additionally, the prescribing physician's instructions and the nurse's actions were reviewed to ensure the correct execution of the physician's orders by the nurse. In case of non-compliance, it was documented as a healthcare team error, were assessed.

TABLE 1. Characteristics of study population (n=970)

Variable		No. of respondents
Gender	Male	650 (67%)
	Female	320(33)
Age group	< 20 years	109 (11.3%)
	20-29 years	337(34.8%)
	30-39 years	403 (41.6%)
	40-49 years	90(9.3%)
	50-59 years	24 (2.5%)
	60 years≥	36 (3.8%)
Body-Mass-Index	Underweight	36 (3.8%)
	Normal	671 (69.2%)
	Overweight	213 (22%)
	Obese	48 (5%)
Past medical history	No underlying disease	690 (71.2%)
	Hypertension	135 (14%)
	Hypothyroidism or hyperthyroidism	17 (1.8%)
	Allergies	10 (1.1%)
	Diabetes Mellitus	87(9%)
	Chronic neurological disease	2 (0.2%)
	Chronic kidney disease	1 (0.1%)
	Chronic respiratory disease	2(0.2%)
	Chronic Dermatologic disease	4 (0.5%)
	Chronic cardiac disease	3 (0.3%)
	Chronic liver disease	2 (0.2%)
	Addiction	4 (0.5%)
	Others	8 (0.9%)
Previous hospital Admission	In last six months	154 (15.9%)
	More than six month or no admission	816 (84.1%)
Department	ENT surgery	271 (28%)
	Orthopedics	699 (72%)

The instrument was carefully examined by four faculty members, clinical infections, and allergy immunity specialists, and the necessary changes were made. For the validity of the questionnaire, the questions were evaluated using the content validity index, the questions with CVI less than 0.7 were omitted, and the questions with CVI between 0.72 and 0.78 were reviewed. In order to confirm the reliability, the internal consistency was examined using Cronbach's alpha coefficient, and good reliability (α =0.87) was found.

The researcher obtained the necessary permits, entered the medical center, and distributed the questionnaire among patients who met the inclusion criteria. Before distributing the questionnaires, the study's objectives were explained, the confidentiality of the subjects was ensured, and the issues were signed on a consent form. The collected data were analyzed by SPSS version 16. To analyze the data, central tendency and dispersion indicators including mean, standard deviation, tables and diagrams, and Chi-squared test,

Fisher's exact test, one-sample Kolmogorov-Smirnov, Mann-Whitney U test, and T-test were used. The significance level was considered less than 0.05.

Results

Study population characteristics

Participants in this study included 650 males (67%) and 320 female(32%) who admitted for orthopedics or ENT surgery((Ear, Nose, and Throat) department in Bua Ali Sina center hospital in Sari (north of Iran), 71.2% of the samples had no coexisting conditions, although about 1.8% of the samples had hypothyroidism or hyperthyroidism, 14% high blood pressure and 9% diabetes and 15.9% (154 patients) had a history of previous admission to hospital in the last six months. Furthermore, the mean and SD of age were 36.1±9. The mean BMI was 23.5 ± 3.4 and 69% of the subjects (669 subjects) had normal BMI and 31% (301 subjects) were overweight and obese. Out of 970 participants, 698 participants (72%) had admitted to orthopedics department, 272 participants (28%) admitted to ENT surgery department (TABLE 1)

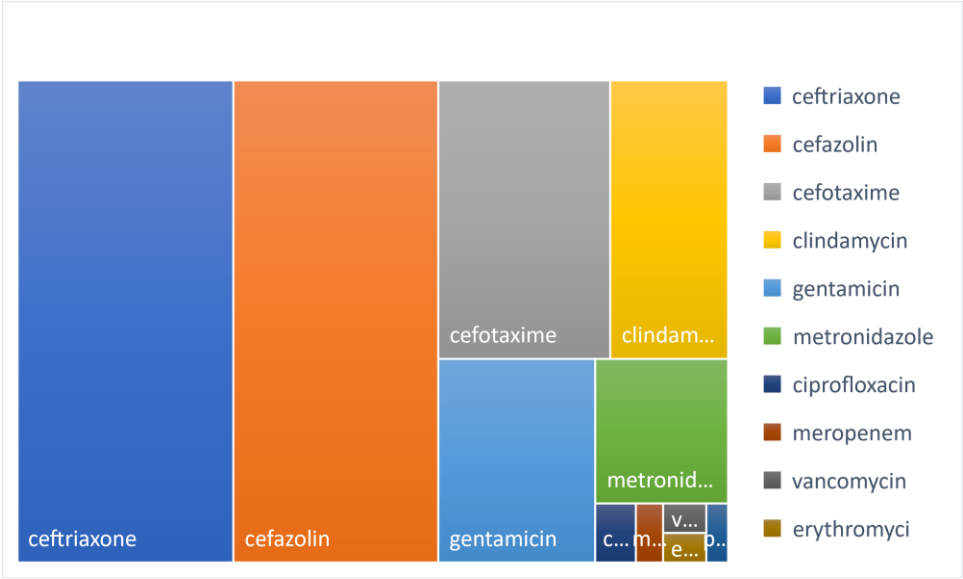

Figure 1: The frequency of prescribed medications in this medical center

In antibiotic prophylaxis regimens, the most prescribed drug category for patients is cephalosporins. Specifically, ceftriaxone was prescribed for 632 individuals (65.2%), cefazolin for 601 individuals (61.8%), and cefotaxime for 291 individuals (30%). Other prescribed antibiotics include clindamycin for 198 individuals (20.5%), gentamicin for 194 individuals (20%), metronidazole for 116 individuals (12%), ciprofloxacin for 14 individuals (1.5%), meropenem for 10 individuals (1%), vancomycin for 7 individuals (0.8%), erythromycin for 7 individuals (0.8%), and penicillins, including penicillin G for 7 individual (0.8%). (figure 1)

Table 2. illustrates the accuracy of the type and timing of prescribed drugs in the prophylactic antibiotic regimens for eligible patients.

			Correct dose		Total
			no	yes	
Compliance Drug with the ASHP guidelines	no	Count	159	5	164
		% within Correct Drug	96.7%	3.2%	100.0%
	yes	Count	75	731	806
		% within Correct Drug	9.2%	90.8%	100.0%

"Compliance of the timing and type of prescribed antibiotic prophylaxis regimen with the ASHP 2013 guidelines."

According to ASHP 2013 guideline, the appropriate time to start the prophylactic antibiotic regimen using antibiotics was correct in 814 individuals (84%), and it was incorrectly prescribed in 156 individuals (16%) of

the patients. Regarding the type of prescribed drug in prophylactic regimens, it was correctly chosen in 806 individuals (83.1%) and incorrectly in 164 individuals (16.7%). In 731 patients, both the correct type and appropriate dose were prescribed.in both orthopedics and ENT procedures are start to administered within 60 minutes before the surgical incision. (Table 2).

In this study, we compared the antibiotics regime which used in orthopedics surgery and ENT surgery however our data did not showed significant differences(P=0.085) we also assess The duration of antibiotic prescription which were 48±12 in both orthopedics and ENT surgery group and There was a significant difference between these two groups in terms of duration of antibiotics prophylaxis duration(P=0.650)

Discussion

Nowadays, one of the most common and significant hospital-acquired infections is postoperative infections. It has been established that more than 2 to 5 percent of patients undergoing non-abdominal surgery and over 20 percent of patients undergoing intra-abdominal surgery develop infections resulting from surgery . Surgical site infections are among the most common hospital-acquired infections reported in high-prevalence areas. Despite their low prevalence in developed countries like the United States and Europe, surgical site infections remain the second most common cause of hospital-acquired infections. Surgical site infections lead to increased mortality, costs, and the duration of hospitalization for patients in hospitals (15). Therefore, prescribing antibiotics as prophylaxis before surgery is an effective factor in reducing the occurrence of surgical wounds, and its use is necessary in most cases. Proper selection of the type of drug with appropriate intervals, dosage, prescription method, suitable start time, and correct duration of use makes it possible to achieve this goal (16) however According to studies, 60% of microorganisms obtained from surgical sites are resistant to prescribed antibiotics. According to the Centers for Disease Control and Prevention (CDC) definition, surgical site infections appear to account for 38% of hospital-acquired infections. Many risk factors are involved in the occurrence of infections resulting from surgical procedures, studies show a considerable prevalence of microbial resistance in Iran., the resistance of Escherichia coli to third-generation cephalosporins is 41%, resistance of Escherichia coli to fluoroquinolones is 54%, resistance of Klebsiella pneumoniae to third-generation cephalosporins is 48%, resistance of Klebsiella pneumoniae to carbapenems is 54%, resistance of Staphylococcus aureus to methicillin is 53%, resistance of Streptococcus pneumoniae to penicillin is 33.9%, resistance of non-typhoidal Salmonella to fluoroquinolones is 6.3%, and resistance of Shigella species to fluoroquinolones is 7.2%(۱۹-۱۷). but the crucial point is that many of these infections are preventable. Antibiotic prophylaxis refers to the prescription of antibiotics before surgery to prevent surgical site infections. Important considerations in prescribing antibiotic prophylaxis before surgery include proper use, selection of the appropriate antibiotic type, appropriate drug dosage, prescription method, appropriate timing of prescription, and appropriate duration of drug use. Excessive use of antibiotics is a major factor in the emergence of antibiotic resistance. The duration of antibiotic use has a direct relationship with the occurrence of infections resistant to antibiotics. One of the main goals of rational prescription and use of antibiotics is to reduce the incidence of this type of drug resistance and also drug-related side effects, such as antibiotic-associated diarrhea resulting from the emergence of Clostridium difficile. Prescribing narrow-spectrum antibiotics in prophylaxis regimens and prescribing them at the right time (neither too early nor delayed) are all effective factors that should be considered during the prescription of microbial agents to prevent infections during surgery. Although the use of antibiotic prophylaxis reduces the rate of postoperative infections, improper use of antibiotics leads to side effects, the spread of antibiotic-resistant infections, and unnecessary costs to the healthcare system(20).

Our study revealed cephalosporins, particularly ceftriaxone and cefazolin, as the predominant antibiotic categories prescribed for surgical patients. This aligns with global practices, where cephalosporins are often considered first-line choices for prophylaxis due to their broad-spectrum coverage against Gram-positive bacteria, including Staphylococcus aureus and Streptococcus species. The observed high utilization of cephalosporins suggests adherence to standard practices, emphasizing their efficacy in preventing surgical site infections (SSIs) across various surgical procedures, such as orthopedic, cardiovascular, and ENT surgeries. however some of the studies which conducted in iran indicate same results : Nouri et al. conducted a descriptive cross-sectional study at Taleghani Hospital, Tehran, evaluating ceftriaxone prescription before and after introducing guidelines. While the correct indication didn't significantly change post-intervention, appropriate ceftriaxone prescription improved significantly ($P < 0.001$).(21) and Mohammadi et al. investigated managing vancomycin and carbapenems in PICU at Dr. Sheikh Hospital, Mashhad. After a controlled intervention, three months of management reduced vancomycin and carbapenem usage significantly, lowering the average hospital stay and mortality rate.(22) and also Panahande et al. studied

antibiotic use in the pediatric ward of Hajar Hospital, Shahrekord. They found a high rate of inappropriate antibiotic use (37%), notably exceeding industrialized country standards (20%). Like our study they also found Ceftriaxone was the most commonly prescribed antibiotic, and empirical prescriptions dominated despite microbial cultures. (23) also in the study conducted In 2008, Ebrahimzadeh et al. investigated the pattern of antibiotic consumption in different departments of Imam Khomeini Hospital in Sari. This study analyzed the pattern of antibiotic use in various departments of Imam Khomeini Hospital in Sari during the first six months of the years 1379 and 1384 using the ATC/DDD (Anatomical Therapeutic Chemical, Defined Daily Dose) method. After completing the study period, it was found that the highest increase was related to vancomycin and clindamycin. The consumption of cotrimoxazole and aminoglycosides remained relatively unchanged, but the use of penicillin G had decreased. The ICU and women's and maternity departments had the highest antibiotic consumption in the first six months of 1384. Cefazolin was the most consumed drug throughout the study (24).Therefore, rational use of antibiotics is essential. Drug Utilization Evaluation (DUE) or the assessment of drug prescription and use is an effective program for identifying differences in drug use that can lead to interventions to improve patient outcomes . The aim of DUE studies is to evaluate factors related to prescription, distribution, delivery, and drug use, along with associated beneficial and adverse events (25). Studies indicate that more than 50% of prescribed drugs worldwide are rarely prescribed, distributed, or sold. In developed countries, 10 to 20 percent of the health budget is spent on drugs, while in developing countries, it ranges from 20 to 40 percent (26)

While our study did not identify significant differences in antibiotic regimens between orthopedic and ENT surgery groups, the notable dissimilarity in the duration of antibiotic prophylaxis is intriguing. Despite a lack of statistical significance (P=0.650), the observed difference prompts further exploration. This finding may stem from the distinct microbial flora associated with different surgical procedures, however in the study of Raeisdana et al. investigated the pattern of antibiotic prescription in the surgical departments of Shahid Rahnamoun Hospital in Yazd compared to standard methods in 1393. This analytical study was conducted on patients undergoing surgery in four ENT surgery, urology, neurosurgery, and orthopedic surgery departments of Shahid Rahnamoun Hospital in Yazd in 1393. The study population consisted of 154 of these patients, and the tool used in the study was a form prepared by the researcher. It was ultimately determined that 24% of patients had used ceftriaxone, 1.72% cefalotin, and 9.3% cefazolin. Based on the results, 87% of prescriptions were in compliance with guidelines in terms of dosage, and 86% of prescriptions were in compliance with guidelines in terms of prescription method. Overall, 68% of antibiotic prescriptions in all cases were in compliance with guidelines , Similar to our study, Raeisdana et al. highlighted challenges in antibiotic prescription adherence, emphasizing the importance of improving compliance rates(27).

our study revealed that 84% compliance rate with the ASHP 2013 guidelines concerning the timing and type of prescribed antibiotic prophylaxis regimen. This level of adherence is noteworthy, indicating a substantial commitment to evidence-based practices. However, the 16% non-compliance rate prompts reflection on potential contributing factors. Further investigation into the reasons behind deviations from guidelines could reveal opportunities for targeted interventions to enhance adherence and optimize prophylactic outcomes,in this issue Shahrti et al. conducted the study they evaluated the rational use of ceftriaxone in the internal and surgical departments of Baqiyatallah Hospital in Tehran. This cross-sectional descriptive study was conducted in two six-month periods in 1387 and 1388 on 300 hospitalized patients in the surgical and internal departments of Baqiyatallah Hospital. Initially, guidelines based on the Ministry of Health's guidelines for the prescription and rational use of ceftriaxone were developed. Data were collected using researcher-designed forms, and after data collection, the degree of alignment of ceftriaxone usage patterns with the mentioned guidelines was measured. At the end of the study, it was found that out of 300 studied patients, 266 had taken ceftriaxone as surgical prophylactic antibiotic. In 32% of cases, it was in accordance with the guidelines, and in 68% of cases, there was incomplete compliance with the guidelines. Among 34 patients who received ceftriaxone for purposes other than surgical infection prevention, 14% were in compliance with the guidelines, and 85.3% did not fully comply with the guidelines, Shahrti et al.'s findings align with our study, emphasizing the need for better adherence to guidelines in surgical prophylaxis (28).

Our study reminds us antibiotic prophylaxis patterns is crucial for antimicrobial stewardship efforts. The observed prevalence of cephalosporins aligns with their established role in preventing SSIs. However, continuous monitoring and adaptation of prophylactic practices are essential, given the evolving landscape of antimicrobial resistance. The study underscores the importance of regional considerations, local epidemiology, and institutional preferences in shaping antibiotic prophylaxis guidelines. recent study conducted by Rahmanian et al. investigate the trend of

rational prescription of antibiotic prophylaxis in the ENT and neurosurgery departments of a teaching hospital, it was found that 71.60% of patients received a combination of two drugs, cefazolin and vancomycin. The use of this drug combination was contrary to the CDC guidelines in more than 70% of cases, which differs from the results of the current study. In Rahmanian's study, the rate of incorrect antibiotic prescription was high (29). In another study by Shohrati and colleagues in 2010, aimed at evaluating the rational use of ceftriaxone in the internal medicine and surgery departments of a teaching hospital, it was revealed that out of 300 studied patients, 266 received ceftriaxone as prophylactic antibiotic for surgery. However, drug prescription was in accordance with guidelines in only 32% of cases, and 68% of cases were contrary to accepted guidelines . The results of the Shohrati study also indicate that in Iran, in some cases, the selection of the type of drug is correct, while in other cases, the prescription of prophylactic antibiotics is mistakenly done. In the current study, it was determined that the appropriate time to start the antibiotic prophylaxis regimen was correct in 53.82% of patients and incorrect in 46.17% of cases. This indicates the overall correctness of the timing of prescription in most cases. The accuracy of drug prescription timing in other studies shows that the accuracy of antibiotic (30)prescription timing in this study is better than some studies(29), such as Paradiso et al. in 2002, Lallemand et al. in 2002, and Disseldorp's study, with accuracy rates of 66%, 61.40%, and 22%, respectively. However, it is weaker compared to Al-Momany et al.'s study in 2009, where the accuracy of prescription timing was reported to be over 99%(31-34)). The comparison of the results of the present study with domestic and foreign studies indicates that the prescription of the type, timing, and dose of antibiotic prophylaxis drugs is correct in some cases, but in most cases (more than 50% of cases), it is incorrect and requires direct distribution of educational programs to improve the knowledge of physicians for better prescription of antibiotics. In past studies, the reasons for incorrect prescriptions of the type, dose, or timing of drug prescriptions were reported as insufficient scientific knowledge of prescribing physicians, the absence of a pharmacist to regulate drug doses, and nurses not following the physician's instruction(٣٤)

our study is not without limitations. The single-center focus may limit the generalizability of findings to other healthcare settings. Additionally, a more in-depth exploration of the reasons behind non-compliance with guidelines could provide valuable insights. Future research may benefit from a multi-center approach, incorporating qualitative methods to elucidate healthcare provider perspectives on antibiotic prophylaxis decision-making.

Conclusion

In conclusion, this study sheds light on antibiotic prophylaxis patterns among surgical patients, emphasizing the predominant use of cephalosporins. The identified differences in the duration of prophylaxis between orthopedic and ENT surgery groups warrant further investigation. The high compliance rate with ASHP 2013 guidelines indicates a commitment to evidence-based practices but also highlights opportunities for improvement. These findings contribute to the ongoing discourse on antimicrobial stewardship, providing valuable insights for refining prophylactic strategies and optimizing patient outcomes in surgical settings.

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Conflicts of interest

No potential conflict of interest relevant to this article was reported

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Author contributions

All authors participated in the design of the study and approved the final version of the manuscript.

Ethics approval

This study was approved by Mazandaran university medical science The study was performed in accordance with the principles of the Declaration of Helsinki

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