ORIGINAL RESEARCH

Antibiotic Utilization in Orthopaedic Inpatient Care: A 10-Year Retrospective Study

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ABSTRACT

Background:Frequent antibiotic prescription in high-risk departments, such as orthopedics, significantly contributes to the global surge in antibiotic resistance. Nevertheless, scant studies delineate antibiotic prescribing patterns and trends among orthopedic inpatients.

Aim:This study aims to meticulously compare and elucidate the patterns and trends of antibiotic prescriptions over a decade for orthopedic inpatients in a teaching care hospital in Western India.

Methods: Data from more than 6000 orthopedic inpatients were meticulously collected using a prospective cross-sectional study design. Patterns were meticulously compared based on indications, corresponding antibiotic treatments, mean Defined Daily Doses (DDD)/1000 patient-days, adherence to the National List of Essential Medicines India (NLEMI), and the World Health Organization Model List of Essential Medicines (WHOMLEM). Antibiotic prescriptions were meticulously analyzed separately for operated and non-operated inpatients. Linear regression was meticulously employed to analyze the time trends of antibiotic prescribing; overall through DDD/1000 patient-days and by antibiotic groups.

Results: In the teaching hospital, 65% of inpatients were male, with 53% receiving antibiotic prescriptions. Adherence to the WHO Model List of Essential Medicines (WHOMLEM) was 65%, surpassing the National List of Essential Medicines of India (NLEMI) at 31%. Fixed-dose combinations (FDCs) constituted 35% of prescriptions. Third-generation cephalosporins emerged as the most prescribed antibiotic class (TH-39%), with fractures being the most common indication (TH-48%). A significant majority of operated inpatients (TH-99%) received pre-operative prophylactic antibiotics. Non-operated inpatients also received antibiotics (TH-40%), despite a limited number having infectious diagnoses (TH-8%). Adherence to NLEMI was lower (TH-31%) than WHOMLEM (TH-65%) in both hospitals. Mean DDD/1000 patient-days was 16 times higher in TH (2658) compared to NTH (162).

Conclusion: A substantial number of inpatients received antibiotics without clear infectious indications. Adherence to NLEMI and WHOMLEM was low in both hospitals. Antibiotic use increased over 10 years in both hospitals, with higher rates in TH. This underscores the imperative need for developing and implementing local antibiotic prescribing guidelines.

Keywords- Adherence, Antibiotic resistance , Antibiotic prescribing, Essential medicines, Orthopedic inpatients

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INTRODUCTION

The rational use of antibiotics is imperative for mitigating morbidity and mortality arising from bacterial infections. Despite this, irrational antibiotic prescriptions yield adverse consequences such as drug events, compromised health outcomes, resource wastage, economic burdens, environmental contamination, and the emergence of antibiotic resistance [1–4]. Antibiotic resistance poses a significant global threat to public health, particularly impacting the health and economies of low- and middle-income countries (LMICs), including India [5,6]. Projections indicate that by 2050, antibiotic resistance may result in 10 million deaths annually worldwide, with 2 million deaths anticipated in India [7]. India, a major consumer of antibiotics globally, has witnessed a surge in antibiotic use despite a decline in infectious diseases worldwide [8]. Between 2000 and 2015, antibiotic consumption in India skyrocketed by 103%, surpassing increases observed in other countries, primarily attributed to the

persisting burden of infectious diseases, enhanced access to antibiotics, and misuse [8
While focused interventions could curb antibiotic misuse, identifying specific target areas remains a challenge in many countries. The World Health Organization (WHO) advocates for monitoring, registering, and analyzing local antibiotic prescribing practices concerning diagnoses, comparing them with other health facilities to pinpoint intervention areas [3].
Orthopedic surgery wounds, known for their depth and complexity, elevate the risk of healthcare-associated infections, especially with methicillin-resistant Staphylococcus aureus (MRSA), posing long-term recurrence risks [9]. Prophylactic antibiotic doses are pivotal in preventing infections related to surgical cuts and implants, reducing morbidity, disability, and mortality in orthopedic patients [10,11]. While prescribing guidelines recommend pre-operative prophylaxis, the relative infection risk is estimated to decrease by 81% in total knee and hip replacement surgery with antibiotic prophylaxis [12]. However, controversies surround the choice, dose, timing, and duration of prophylactic antibiotics, as their use, while reducing complications, heightens the risk of antibiotic resistance [10,13], presenting challenges in routine orthopedic surgeries and potentially resulting in physical disabilities and life-threatening infections [14]. Despite approximately 80% of healthcare facilities in India being private, research studies predominantly focus on public sector facilities [15–17]. Lack of basic data impedes estimating the actual antibiotic prescriptions, and private facilities, despite national guidelines, often deviate from recommended practices [15–17] Therefore, it is imperative to discern antibiotic prescribing patterns in high infection risk departments at private sector facilities. Currently, few studies analyze antibiotic prescribing patterns [18,19], and none explore antibiotic prescribing trends over an extended period in orthopedic departments in LMICs. This study aims to comprehensively analyze, compare, and present antibiotic prescription patterns and trends over a 10-year period in orthopedic departments at two private sector hospitals, identifying areas for sustaining or achieving rational antibiotic use.

OBJECTIVES

Study Setting: Data collection focused on orthopedic inpatients at a teaching Western India [15–17]. The TH, affiliated with Medical College, is located in the western indian, boasting an 1200-bed capacity, providing medical services and drugs to all patients. Doctors at TH receive fixed salaries, and interactions with pharmaceutical sales representatives are restricted. Our hospital maintain microbiology laboratory for antibiotic susceptibility testing, with diagnostic services at affordable charges[15–17,20].

Data Collection and Management: Prospective data collection spanned a decade from 2015 to 2024. Trained nurses utilized specifically designed forms to gather information, including patient details, admission/discharge dates, department number, consultant-determined diagnosis, surgery details, culture and susceptibility test dates, prescribed antibiotic details, and treatment outcomes. Recorded for each orthopedic ward inpatient, the analysis included those above 10 years who stayed for at least one night. Inpatients were categorized as operated or non-operated for detailed analysis, comparing demographic variables, hospital stay duration, type of surgery, indications, prescribed antibiotics, culture/susceptibility tests, antibiotic treatment duration, and treatment outcomes. Common indications, orthopedic infectious diagnoses, multiple fractures, and adherence to antibiotic prescribing guidelines were analyzed. Prescribed antibiotics were classified using WHO Anatomical Therapeutic Chemical (ATC) classification and generic names, with Defined Daily Doses (DDDs) standardized to 1000 patient-days for comparison between hospitals [23–26].

Statistical Analysis: Continuous variables were assessed using mean, median, and standard deviations, comparing through Student's t-test. Categorical variables were analyzed with Pearson's chi-squared test. Time series analysis utilized linear regression to examine trends in antibiotic use over time, with a coefficient (β) representing the monthly linear trend. P-values <0.05 indicated statistical significance. Excel and SPSS Version 26.0 were employed for data analysis.

Ethical Approval: Ethics committee approval from Institutional Review Board has been taken for this observational study without patient contact, the institutional ethics committee waived the need for individual informed consent. Data were anonymized at the group level, ensuring patient privacy and confidentiality.

RESULTS

Table 1. Characteristics of the inpatients at orthopedic departments in the teaching hospital

Characteristics of the inpatients	Teaching hospital(n=6446)
Sex	
Male	4214(65)
Female	2232(35)
Age	

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15-30	1857(29)
31-45	1926(30)
46-60	1527(24)
>60	1124(17)
Missing age information	12
Treatment procedure	
Operated	1479(23)
Prescribed antibiotics	3419(53)
Performed culture and susceptibility test	164(3)
Outcome	
Discharged	4484(69)
Shifted to other wards	53(1)
Absconded from the ward	1155(18)
Discharged on request	749(12)
Referred to other hospital for further	1(0)

Table 2: Antibiotic prescription details and adherence to the essential medicines lists at orthopedic departments in the teaching

variables	Teaching hospital (n = 90,626)
Antibiotic prescriptions adherent to the NLEMI, n (%)	27,798 (31)
Antibiotic prescriptions adherent to the WHOMLEM, n (%)	58,798 (65)
Prescribed FDCs listed by WHOCC[3], n (%)	31,730 (35)
Prescribed FDCs not listed by WHOCC, n (%)	54 (0)
Antibiotic prescriptions by generic name, n (%)	33,962 (38)
Prescribed DDD, mean (SD)	0.9 (0.7)

A total of 90626 antibiotic prescriptions were recorded for 6446 inpatients. Adherence to WHOMLEM surpassed NLEMI. Fixed-dose combinations (FDCs) constituted 35% (TH) of prescriptions, with notable FDCs including ceftriaxone and β-lactamase inhibitor (TH-18%) and cefoperazone and β-lactamase inhibitor (TH-8%). Few FDCs were prescribed without WHOCC-ATC codes. Generic name prescriptions were 38% in the TH. Mean prescribed DDDs were below the recommended value. Primary antibiotic classes were other β-lactams (TH-39%) and aminoglycosides (TH-35%). Third-generation cephalosporins (J01DD) led other β-lactams (TH-39%).

Table 3: Comparison of numbers of operated/non-operated inpatients who were prescribed antibiotics with respect to the most common diagnoses at orthopedic departments in the teaching in Western India.

Total inpatients, N, %	Operated. n=1479		Non-operated, N=4967	
	Frequency of diagnosis	Inpatients prescribed antibiotic, %	Frequency of diagnosis	Inpatients prescribed antibiotic, %
ICD-10 Codes and Diagnoses	1458(99)		1961(40)	
M 51 Other intervertebral disc disorders	63	53(84)	618	82(13)
M 54 Dorsalgia	7	5(71)	693	72(10)
S 32-S 82 Fractures of spine and limbs				
S 32 lumbar spine and pelvis	16	16(100)	108	33(31)
S 42 shoulder and upper arm	98	98(100)	280	138(49)
S 52 forearm	154	154(100)	344	183(53)
S 62 wrist and hand level	42	41(98)	67	27(40)
S 72 femur	381	380(100)	835	456(55)
S 82 lower leg, including ankle	269	269(100)	500	304(61)
T 14 Injury of unspecified body region	59	59(100)	111	44(40)
Multiple fractures	98	98(100)	122	71(58)
All bacterial infectious	68	67(99)	395	192(49)

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diagnoses				
Other non-infectious diagnoses	218	218(100)	857	359(42)

N = Total number of inpatients, n = frequency of diagnoses, n* = number of inpatients who were prescribed antibiotics. The percentage n* (%) is calculated for the number of inpatients who were prescribed antibiotic with specific diagnosis out of the total number of inpatients with that diagnosis.
Includes illegible or missing diagnoses (TH-43; NTH-25).
[#] P-Value (χ^2 test) is statistically significant.

Orthopedic Indications: The most prevalent orthopedic indications were fractures of spine and limbs (TH-48%) and dorsalgia (TH-11%). In the TH, 13% of inpatients had multiple diagnoses. Infectious indications constituted 7% (TH)of diagnoses. Operated inpatients were predominantly prescribed antibiotic prophylaxis (TH-99%). Non-operated inpatients in the TH had 8% infectious diagnoses. Antibiotics were prescribed to 40% of non-operated inpatients in the TH.

DISCUSSION

This study represents the initial cross-sectional examination of a 10-year trend in antibiotic prescribing within orthopedic departments in a low- and middle-income country (LMIC). Despite the teaching hospital (TH) having more inpatients and longer hospital staysexhibited significantly higher proportions of operated inpatients and those prescribed antibiotics. Adherence to the National List of Essential Medicines India (NLEMI) was higher in the TH, while adherence to the World Health Organization Model List of Essential Medicines (WHOMLEM) was higher in the TH. The most frequently prescribed antibiotic subclass in both hospitals was 3rd generation cephalosporins. Comparisons with previous studies within the same hospitals revealed varying prescribing practices in different departments. The TH, where communication with pharmaceutical sales representatives is unrestricted, showed higher fixed-dose combination (FDC) prescriptions, contrasting with the TH's greater adherence to generic names. Empirical prescribing was prevalent in both hospitals, reflecting a need for antibiotic prescription guidelines in orthopedic departments. Limited research on antibiotic prescribing trends in orthopedic departments in LMICs underscores the significance of this study. While other studies focused on shorter durations and smaller sample sizes, our research not only presented prescribing patterns but also trends over a decade. The high proportion of prescribed 3rd generation cephalosporins aligns with global studies. However, discrepancies in adherence to essential medicine lists between the two hospitals merit further investigation.

CONCLUSION

This study emphasizes the need for improved antibiotic prescribing practices within the orthopedic departments of both hospitals. Key areas for intervention include the development and implementation of antibiotic prescribing guidelines, increased frequency of culture and susceptibility testing, and the creation of orthopedic indication-specific guidelines tailored to local resistance patterns. Additionally, regular updates to the National List of Essential Medicines India (NLEMI) are recommended. Overall, the findings underscore the importance of enhancing rational antibiotic use and mitigating empirical prescribing practices in orthopedic care.

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