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Evaluation of guideline compliance and prescription trends of beta-lactam antibiotics in adult infectious disease management at a tertiary hospital

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Abstract

Beta-lactam antibiotics play a crucial role in the treatment of infectious diseases. However, the increasing antimicrobial resistance necessitates a critical evaluation of prescription patterns and adherence to national guidelines. This retrospective observational study was conducted at PVS Hospital (P) Ltd, Calicut, Kerala, to assess the prescribing pattern and guideline adherence of beta-lactam antibiotics. Medical records from January 2016 to January 2022 were analyzed for 100 patients meeting the study criteria. The study found that pneumonia (52%) was the most commonly treated infectious disease, followed by urinary tract infections (25%). Among the prescriptions, 57% were monotherapy, with penicillins (47.36%) being the most frequently used class, followed by cephalosporins (43.85%). Combination therapy accounted for 43%, with amoxicillin-clavulanic acid being the most prescribed regimen.

Comorbidities were present in 71% of the patients, with hypertension (52.11%) being the most prevalent, followed by diabetes mellitus (33.8%). The study revealed that only 43% of prescriptions adhered to the National Treatment Guidelines, while 57% deviated due to incorrect drug selection (66.6%), dosage (14.05%), frequency (12.2%), or duration (7.01%). Comorbid conditions such as hypertension, diabetes mellitus, and dyslipidemia were significantly associated with poor adherence to guidelines.

The study underscores the need for improved guideline adherence through educational interventions, clinical pharmacist involvement, and stricter adherence monitoring. Enhancing antibiotic stewardship programs can minimize resistance development and improve treatment outcomes.

Keywords: Beta-lactam antibiotics, prescribing patterns, guideline adherence, antimicrobial resistance, infectious diseases, combination therapy, comorbidities

Introduction

Antibiotics have revolutionized modern medicine, playing a vital role in the treatment and management of bacterial infections. Among these, beta-lactam antibiotics, including penicillins, cephalosporins, carbapenems, and monobactams, remain the cornerstone of antimicrobial therapy due to their broad-spectrum activity and relative safety. However, the widespread and often inappropriate use of these antibiotics has contributed to the alarming rise of antimicrobial resistance (AMR), a major global health crisis. AMR not only reduces the efficacy of antibiotics but also increases morbidity, mortality, and healthcare costs worldwide (Laxminarayan *et al.*, 2013) [3]. In India, antibiotic consumption has doubled over the last two decades, with beta-lactams accounting for a significant share of prescriptions (Klein *et al.*, 2018) [4].

One of the key issues contributing to AMR is the irrational prescribing of antibiotics. Studies indicate that a substantial proportion of antibiotic prescriptions deviate from established guidelines, leading to the misuse of broad-spectrum agents when narrower-spectrum drugs could suffice (Mikkelsen *et al.*, 2013) [13]. Non-adherence to national and international treatment guidelines results in the overuse of certain antibiotics, which fosters the emergence of resistant bacterial strains. Research from both developed and developing countries has highlighted this trend, particularly in tertiary care hospitals where empirical antibiotic therapy often overrides guideline-based prescriptions (Fratoni *et al.*, 2021; Wathne *et al.*, 2019) [1, 5]. In India, the National Treatment Guidelines for Antimicrobial Use in Infectious

Diseases (Version 1.0, 2016) were developed to promote rational antibiotic use, yet studies suggest that adherence to these guidelines remains suboptimal (Kotwani *et al.*, 2007) [2].

The present study aims to assess the prescribing patterns and adherence of beta-lactam antibiotics to national treatment guidelines in a tertiary care hospital in Calicut, Kerala. By analyzing medical records over six years, this study seeks to identify the extent of irrational prescribing, common deviations from guidelines, and the impact of comorbidities such as hypertension, diabetes, and dyslipidemia on antibiotic selection. A retrospective observational method is employed to compare actual prescriptions with recommended guidelines, highlighting discrepancies and providing data-driven insights for improving antibiotic stewardship.

Addressing these issues is critical to curbing antibiotic resistance and enhancing patient outcomes. This study emphasizes the need for continuous medical education, strict adherence monitoring, and clinical pharmacist involvement in prescribing decisions. By identifying patterns of inappropriate antibiotic use, the findings will contribute to developing more effective strategies for ensuring rational antibiotic use in clinical practice.

Materials and Methods

This study was conducted as a retrospective observational analysis at PVS Hospital (P) Ltd, a 350-bedded multispecialty tertiary care hospital in Calicut, Kerala. The objective was to evaluate the prescribing patterns and guideline adherence of beta-lactam antibiotics in the treatment of infectious diseases. The study spanned 12 months (January 2022 – Dec 2022), during which medical records from January 2016 to January 2022 were reviewed.

The study included adult patients (>18 years) diagnosed with infectious diseases and prescribed beta-lactam antibiotics, either as monotherapy or in combination. Patients were included irrespective of the presence or absence of comorbidities such as hypertension, diabetes mellitus, and dyslipidemia. However, certain populations were excluded, including pregnant and lactating women, patients below 18 years, individuals with kidney or liver diseases, and those with mental instability.

Data were collected using a structured data collection form, which extracted relevant details from patient medical records. Information gathered included demographics (Age, gender, occupation), clinical history (Diagnosis, comorbidities, past medical records), laboratory investigations, and medication orders related to beta-lactam antibiotics. The prescribing pattern was then assessed, focusing on the proportion of monotherapy versus combination therapy, and adherence to the National Treatment Guidelines for Antimicrobial Use in Infectious Diseases (Version 1.0, 2016). Non-adherence was categorized based on deviations in drug selection, dosage, duration, frequency, or route of administration. Additionally, the study examined the impact of comorbid conditions on prescribing trends and guideline compliance.

Ethical approval was secured from the Institutional Review Board, Devaki Amma Memorial College of Pharmacy, Malappuram, Kerala, and the Institutional Ethics Committee, PVS Hospital (P) Ltd, Calicut, Kerala (Approval Ref. No. PVS/EC/02/17-18). Statistical analysis was performed using SPSS software (Windows Version 20),

with T-tests applied to determine statistical significance in deviations from guidelines and the association between comorbidities and prescribing patterns.

Study Procedure

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Results

Patient Demographics and Clinical Characteristics

The study population consisted of 53% female and 47% male patients, with a mean age of 39.74 ± 11 years. The most commonly treated infectious disease was pneumonia, accounting for 52% of cases, followed by urinary tract infections (25%), enteric fever (15%), cellulitis (5%), and biliary tract infections (3%). Pneumonia was found to be more prevalent in older patients, whereas urinary tract infections were reported across all age groups. Enteric fever was more commonly observed in younger individuals, and cellulitis and biliary tract infections were relatively less frequent.

Prescribing Pattern of Beta-Lactam Antibiotics

Among the 100 patients, 57% received monotherapy, while 43% were prescribed combination therapy. Within the

monotherapy group, penicillins (47.36%) were the most frequently prescribed drug class, followed by cephalosporins (43.85%), carbapenems (8.77%), and monobactams (0%). The high preference for penicillins in monotherapy could be attributed to their broad-spectrum activity and cost-effectiveness.

In the combination therapy group, the most frequently prescribed regimen was amoxicillin + clavulanic acid (53.4%), followed by cefoperazone + sulbactam (37.2%) and piperacillin + tazobactam (9.3%). The preference for amoxicillin + clavulanic acid was consistent with national guidelines, which recommend beta-lactamase inhibitors in cases where resistance is a concern. However, in some cases, broader-spectrum combinations such as cefoperazone + sulbactam and piperacillin + tazobactam were prescribed without clear indications, raising concerns about potential overuse of broad-spectrum antibiotics.

Comorbidities and Their Impact on Prescribing Patterns

The study found that 71% of the patients had comorbidities, while 29% had none. Among those with comorbid conditions, hypertension (52.11%) was the most prevalent, followed by diabetes mellitus (33.8%) and dyslipidemia (14.08%).

Patients with multiple comorbidities were more likely to receive combination therapy rather than monotherapy. This trend was particularly notable among patients with diabetes mellitus and hypertension, as they were often prescribed broader-spectrum antibiotics, possibly due to concerns about delayed recovery or complications. However, the preference for combination therapy in these patients was not always aligned with treatment guidelines, leading to a higher rate of non-adherence.

Guideline Adherence in Prescribing Beta-Lactam Antibiotics

One of the key findings of the study was the suboptimal adherence to the National Treatment Guidelines for Antimicrobial Use in Infectious Diseases (Version 1.0, 2016). Of the 100 cases reviewed, only 43% of prescriptions were found to be in accordance with the guidelines, while 57% deviated from the recommended treatment protocols. Among the 57% of non-adherent prescriptions, the most frequent deviation was incorrect drug selection (66.6%), followed by wrong dosage (14.05%), wrong frequency (12.2%), and wrong duration (7.01%). Incorrect drug selection was the most significant issue, often resulting from the overuse of broad-spectrum beta-lactam antibiotics, even in cases where narrower-spectrum agents would have sufficed.

Association between Comorbidities and Guideline Adherence

The presence of comorbidities significantly influenced guideline adherence. Patients with hypertension, diabetes mellitus, and dyslipidemia showed a higher likelihood of receiving empirical therapy rather than guideline-based treatment.

- Among hypertensive patients (n = 37), only 45.94% received treatment as per guidelines, while 54.05% were prescribed empirical therapy.
- In diabetic patients (n = 24), adherence was even lower, with only 25% following guidelines, whereas 75% received empirical treatment.
- Among patients with dyslipidemia (n = 10), 40% adhered to guidelines, while 60% did not.

Statistical analysis showed a negative correlation between the presence of comorbidities and guideline adherence, with:

- Hypertension (p = 0.032, $\phi = -0.0456$)
- Diabetes mellitus (p = 0.020, $\phi = -0.204$)
- Dyslipidemia (p = 0.04, $\phi = -0.0201$)

Table 1: Distribution of Infectious Diseases Treated with Beta-Lactam Antibiotics

Infectious Disease	Number of Cases (N=100)	Percentage (%)
Pneumonia	52	52%
Urinary Tract Infection (UTI)	25	25%
Enteric Fever	15	15%
Cellulitis	5	5%
Biliary Tract Infection	3	3%

Table 2: Prescribing Patterns of Beta-Lactam Antibiotics

Type of Therapy	Number of Cases (N=100)	Percentage (%)
Monotherapy	57	57%
Combination Therapy	43	43%

Table 3: Distribution of Monotherapy Drugs

Drug Class	Number of Cases	Percentage (%)
Penicillins	27	47.36%
Cephalosporins	25	43.85%
Carbapenems	5	8.77%
Monobactams	0	0%

Table 4: Distribution of Combination Therapy Drugs

Combination Therapy	Number of Cases	Percentage (%)
Amoxicillin + Clavulanic Acid	23	53.4%
Cefoperazone + Sulbactam	16	37.2%
Piperacillin + Tazobactam	4	9.3%

Table 5: Guideline Adherence in Antibiotic Prescriptions

Guideline Adherence	Number of Cases (N=100)	Percentage (%)
Adherent	43	43%
Non-Adherent	57	57%

Table 6: Types of Deviations in Non-Adherent Prescriptions

Type of Deviation	Number of Cases (N=57)	Percentage (%)
Incorrect Drug Selection	38	66.6%
Wrong Dosage	8	14.05%
Wrong Frequency	7	12.2%
Wrong Duration	4	7.01%

Table 7: Association between Comorbidities and Guideline Adherence

Comorbidity	Guideline Adherent (N=43)	Non-Adherent (N=57)	P-value (Significance)	Correlation (ϕ)
Hypertension	17 (45.94%)	20 (54.05%)	0.032 (Significant)	-0.0456
Diabetes Mellitus	6 (25%)	18 (75%)	0.020 (Significant)	-0.204
Dyslipidemia	4 (40%)	6 (60%)	0.04 (Significant)	-0.0201

Discussion

The study revealed significant deviations from national guidelines in the prescribing patterns of beta-lactam antibiotics, with only 43% adherence and 57% of prescriptions being non-compliant. The most common deviations included incorrect drug selection (66.6%), wrong dosage (14.05%), wrong frequency (12.2%), and improper duration (7.01%). Monotherapy (57%) was more frequently prescribed than combination therapy (43%), with penicillins being the most commonly used drug class. Combination therapy was mostly observed in patients with comorbidities, with amoxicillin + clavulanic acid being the preferred regimen.

Comorbid conditions such as hypertension, diabetes mellitus, and dyslipidemia were significantly associated with lower guideline adherence, as physicians often opted for broad-spectrum antibiotics due to concerns about complications. This trend, although aimed at reducing risk, contributes to antimicrobial resistance. Similar findings have been reported in previous studies, emphasizing the urgent need for improved prescribing practices.

To enhance adherence to guidelines, interventions such as regular prescription audits, physician training, integration of clinical pharmacists, and electronic decision-support tools are recommended. Strengthening antimicrobial stewardship programs can help optimize antibiotic use and reduce resistance risks. While this study provides valuable insights, further multi-center research is needed to validate these findings and assess the impact of adherence on patient outcomes.

Conclusion

The study highlighted significant deviations from national guidelines in the prescribing patterns of beta-lactam antibiotics, with only 43% adherence and 57% of prescriptions being non-compliant. Monotherapy was more commonly prescribed, with penicillins being the most frequently used drug class, while combination therapy was prevalent among patients with comorbidities. The presence of hypertension, diabetes mellitus, and dyslipidemia was significantly associated with lower adherence to guidelines, leading to the overuse of broad-spectrum antibiotics.

These findings emphasize the urgent need for improved antimicrobial stewardship programs, physician training, and regular prescription audits to promote rational antibiotic use. Implementing clinical pharmacist involvement and electronic decision-support tools can further enhance adherence to guidelines and prevent the rise of antimicrobial resistance. Future research should focus on multi-center studies to assess the broader implications of prescribing patterns and develop targeted interventions for optimizing antibiotic use.

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