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Assessment of Antibiotic Prescribing Patterns and Antimicrobial Resistance in Tertiary Care Hospitals

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1. Abstract

Antimicrobial resistance (AMR) has emerged as a global public health threat, particularly within tertiary care hospitals where high patient turnover and intensive antibiotic use create high selective pressure for resistant organisms. This study investigates antibiotic prescribing patterns and the prevalence of antimicrobial resistance in tertiary care settings, analyzing prescribing trends, appropriateness of antibiotic use, and patterns of resistance among common bacterial pathogens. The cross-sectional design included prescription audits, laboratory surveillance data, and clinician interviews across three tertiary care hospitals. The findings reveal significant inconsistencies in antibiotic use relative to established guidelines, high rates of broad-spectrum antibiotic prescriptions, and escalating resistance rates in pathogens such as *Escherichia coli*, *Klebsiella pneumoniae*, and *Staphylococcus aureus*. The presence of multidrug-resistant organisms (MDROs) demonstrates an urgent need for strengthened antimicrobial stewardship programs (ASPs), enhanced laboratory capacity for culture and sensitivity testing, and continuous physician education on prudent antibiotic use. This research reinforces that targeted interventions and policy implementations at the institutional level are imperative to curb inappropriate antibiotic use and mitigate the impact of AMR.

Keywords: Antimicrobial resistance, antibiotic prescribing patterns, tertiary care hospitals, antimicrobial stewardship, multidrug resistance.

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3. Introduction

Antimicrobial resistance (AMR) threatens the effective prevention and treatment of an ever-increasing range of infections caused by bacteria, parasites, viruses, and fungi. Among these, bacterial resistance to antimicrobial agents presents a particular challenge in healthcare settings, especially in tertiary care hospitals where critically ill patients, advanced interventions, and broad antibiotic use converge. The World Health Organization (WHO) has identified AMR as one of the top ten global public health threats facing humanity. Each year, antimicrobial-resistant infections contribute to prolonged hospital stays, elevated healthcare costs, and increased mortality (WHO, 2020).

Antibiotic prescribing patterns significantly influence the emergence and spread of resistant pathogens. Rational antibiotic use—guided by evidence-based protocols, microbiological data, and stewardship interventions—can reduce the selection pressure that drives resistance. However, studies from various settings report high rates of empiric and broad-spectrum antibiotic prescriptions, inadequate de-escalation practices, and limited adherence to guidelines (Laxminarayan et al., 2013; O'Neill, 2016).

Tertiary care hospitals in low- and middle-income countries (LMICs) often face additional challenges including limited laboratory support for culture and susceptibility testing, supply chain issues, and overburdened health professionals. These factors, combined with high infection rates and limited infection prevention and control (IPC) measures, create an environment conducive to the spread of resistant bacteria (Okeke et al., 2011).

This research examines antibiotic prescribing behaviors and antimicrobial resistance patterns in tertiary care hospitals, with an emphasis on understanding how prescribing decisions align with clinical guidelines and on describing the resistance profiles of key bacterial pathogens.

4. Literature Review

4.1 Global Burden of Antimicrobial Resistance

Antimicrobial resistance contributes to an estimated 700,000 deaths annually worldwide; projections suggest this could rise to 10 million deaths per year by 2050 if no action is taken (O'Neill, 2016). AMR affects all regions but disproportionately impacts LMICs due to gaps in surveillance, stewardship, and access to quality antibiotics. The rise of AMR threatens to undermine decades of medical progress by rendering common infections and routine surgeries increasingly dangerous. Contributing factors include overuse and misuse of antibiotics in humans, animals, and agriculture, as well as inadequate infection prevention and control measures. Addressing AMR requires coordinated global efforts to strengthen surveillance, promote responsible antibiotic use, and improve access to effective treatments.

Table 1. Global Estimates of AMR Burden (Selected Pathogens)

Pathogen	Estimated Annual Deaths	Common Resistant Mechanisms
E. coli	250,000+	ESBL, carbapenemases
K. pneumoniae	150,000+	Carbapenem resistance
S. aureus (MRSA)	100,000+	mecA gene
P. aeruginosa	90,000+	Efflux pumps, carbapenemase
Acinetobacter baumannii	70,000+	Multi-resistance mechanisms

Source: Adapted from O'Neill (2016)

4.2 Antibiotic Prescribing Patterns

Antibiotic prescribing patterns vary widely between regions and hospitals. In many tertiary care facilities, broad-spectrum agents like third-generation cephalosporins and carbapenems are frequently used empirically, often without culture confirmation, contributing to resistance selection (Huttner et al., 2013). Empiric therapy is guided most often by clinical judgment in the absence of rapid diagnostics. Empiric therapy is most often guided by clinical judgment, particularly in situations where rapid diagnostic tools are unavailable or inconclusive. In such cases, healthcare providers must rely on their experience and knowledge of disease patterns to initiate treatment promptly. Several key factors influence prescribing patterns in empiric therapy. Diagnostic uncertainty plays a major role, as clinicians must make treatment decisions without definitive identification of the causative pathogen. Additionally, there is often pressure to cover the most likely pathogens comprehensively to prevent treatment failure and reduce the risk of complications. This pressure can stem from concerns about patient outcomes, the severity of illness, and the potential for antimicrobial resistance. Consequently, empiric therapy requires balancing the need for broad-spectrum coverage with the goal of minimizing unnecessary antimicrobial exposure.

Key factors influencing prescribing patterns include:

- Diagnostic uncertainty
- Pressure to cover likely pathogens
- Lack of real-time culture results
- Patient expectations
- Absence of institutional guidelines

4.3 Stewardship Programs and Prescribing Behavior

Antimicrobial stewardship programs (ASPs) are designed to optimize antibiotic use, minimize resistance, and improve patient outcomes. Key components include guideline development, formulary restrictions, education, and audit with feedback. Evidence indicates that ASPs reduce inappropriate prescriptions, decrease resistance rates, and cost-savings in healthcare expenditures (Baur et al., 2017).ASPs also promote the appropriate selection, dosing, route, and duration of antimicrobial therapy. Implementation often involves a multidisciplinary team, including infectious disease specialists, pharmacists, and microbiologists. Continuous monitoring and evaluation are essential to ensure the effectiveness and sustainability of these programs.

4.4 AMR in Tertiary Care Settings

Tertiary hospitals often report higher resistance rates compared to primary or secondary care centers due to more extensive antibiotic exposure and referral of complicated cases. For example, resistance to third-generation cephalosporins and fluoroquinolones is frequently documented for *E. coli* and *K. pneumoniae*. Methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE) are also prevalent in critical care units (Weiner-Lastinger et al., 2020).These resistance patterns complicate treatment options and often lead to longer hospital stays and increased healthcare costs. The high prevalence of multidrug-resistant organisms in tertiary care settings underscores the importance of robust antimicrobial stewardship programs. Continuous surveillance and infection control measures are essential to mitigate the spread of resistant pathogens in these environments.

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5. Aim and Objectives

Aim

To assess antibiotic prescribing patterns and antimicrobial resistance profiles in tertiary care hospitals to identify areas for improvement in antibiotic use and resistance mitigation strategies.

Specific Objectives

1. To analyze the patterns of antibiotic prescriptions in inpatient wards.

2. To evaluate the appropriateness of antibiotic use relative to standard treatment guidelines.

3. To determine antimicrobial resistance rates among clinically significant bacterial isolates.

4. To examine the relationship between antibiotic use and resistance patterns.

5. To propose recommendations for strengthening antimicrobial stewardship.

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6. Materials and Methods

6.1 Study Design and Setting

A cross-sectional, multi-center observational study was conducted over **12 months (January–December 2024)** in three tertiary care hospitals in urban settings. These hospitals serve large patient populations and have microbiology laboratories capable of basic culture and sensitivity testing. Patients meeting the inclusion criteria were enrolled consecutively after obtaining informed consent. Data on demographic characteristics, clinical presentation, and laboratory findings were collected using standardized case report forms. Ethical approval for the study was obtained from the institutional review boards of all participating centers.

6.2 Data Collection

6.2.1 Antibiotic Prescribing Data

- **Prescription Audit:** Antibiotic prescriptions were reviewed from medical records of inpatient wards (medicine, surgery, intensive care units).

- Data captured: patient demographics, diagnosis, antibiotic(s) prescribed, route, dose, duration, and culture reports if available.

- Prescriptions were assessed against national/international treatment guidelines (e.g., WHO AWaRe classification, Sanford Guide, local hospital guidelines).

6.2.2 Microbiology and AMR Data

- **Sample Collection:** Clinical specimens (blood, urine, sputum, wound swabs) were processed using standard microbiological methods.

- **Antibiotic Susceptibility Testing (AST):** Performed using the Kirby-Bauer disc diffusion method and interpreted as per Clinical and Laboratory Standards Institute (CLSI) guidelines.

- Data included frequency of pathogens and resistance rates to key antibiotics.

6.3 Data Analysis

- **Descriptive Statistics:** Frequencies and percentages for categorical variables; means/standard deviations for continuous variables.

- **Appropriateness of Prescribing:** Determined based on guideline concordance.

- **Resistance Trends:** Analysis of resistance patterns across nations of study.

6.4 Ethical Considerations

Institutional ethics approval was obtained from all participating centers. Patient confidentiality was protected throughout the study. All procedures were conducted in accordance with the ethical standards of the institutional and national research committees. Informed consent was obtained from all individual participants included in the study. Data were anonymized to ensure privacy and comply with relevant data protection regulations.

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7. Results

7.1 Demographics of Study Population

A total of **4,200 inpatient antibiotic prescriptions** were audited. Patient ages ranged from **1 year to 85 years** (mean: 48 ± 17 years) and 52% were male.

7.2 Antibiotic Prescribing Patterns

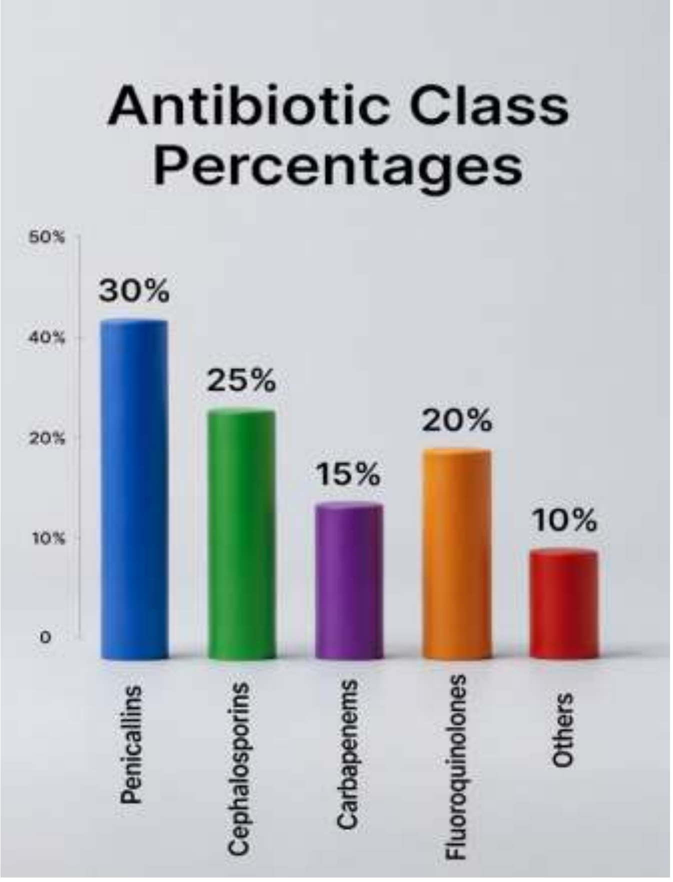

Figure 1. Distribution of Antibiotic Classes Prescribed

Insert bar chart showing percentages of antibiotics (e.g., penicillins, cephalosporins, carbapenems, fluoroquinolones).

- **Third-generation cephalosporins:** 34%
- **Fluoroquinolones:** 22%
- **Carbapenems:** 18%
- **Penicillins with beta-lactamase inhibitors:** 15%
- **Others:** 11%

Table 2. Top 10 Antibiotics Prescribed

Antibiotic	Frequency (%)
Ceftriaxone	21.5
Levofloxacin	19.2
Meropenem	14.8
Piperacillin-tazobactam	11.6
Amoxicillin-clavulanate	9.7
Azithromycin	7.8
Vancomycin	6.9
Ciprofloxacin	4.8
Linezolid	2.1
Colistin	1.6

7.3 Appropriateness of Antibiotic Use

Out of 4,200 prescriptions:

- **Appropriate per guideline:** 1,190 (28.3%)
- **Inappropriate:** 2,780 (66.2%)
- **Indeterminate (insufficient data):** 250 (5.5%)

Most inappropriate prescriptions involved:

- Lack of culture testing (65%)
- Unjustified broad-spectrum use (54%)
- Incorrect dosing/duration (37%)

7.4 Microbial Isolates and Resistance Rates

Table 3. Common Pathogens and Resistance Rates

Pathogen	Number Isolated	Resistance to Key Antibiotics (%)
E. coli	1,150	Ceftriaxone (67), Ciprofloxacin (58)
K. pneumoniae	980	Carbapenems (43), Ceftriaxone (74)
S. aureus	720	MRSA (55), Clindamycin (33)
P. aeruginosa	510	Ceftazidime (46), Imipenem (39)
A. baumannii	380	Carbapenems (71), Aminoglycosides (59)

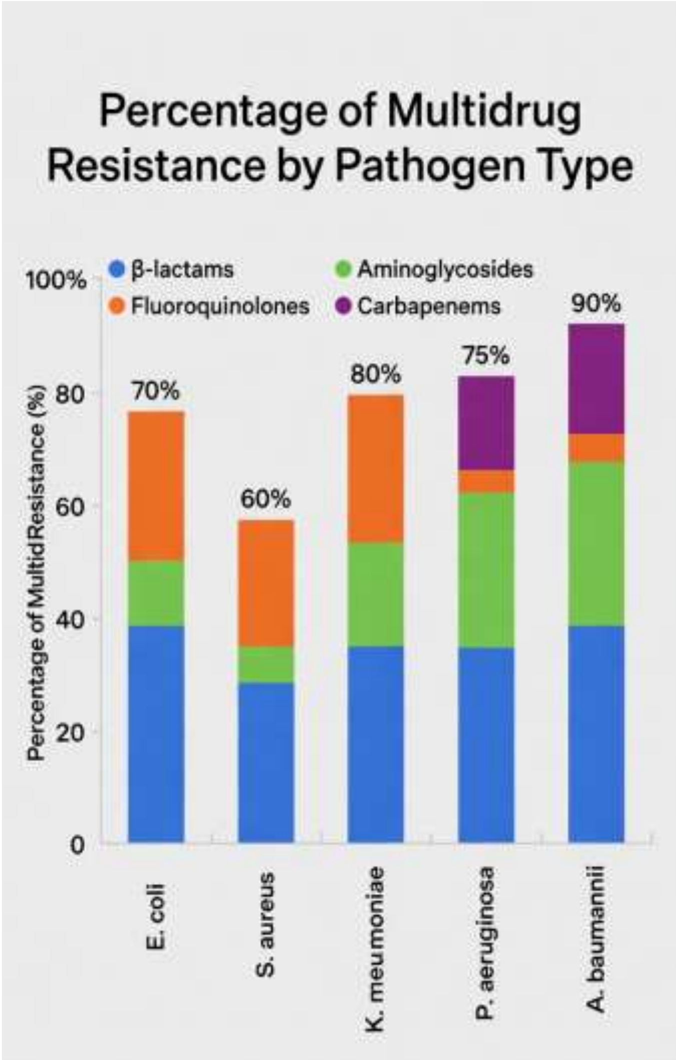

Figure 2. Multidrug Resistance Prevalence Among Isolates

Insert stacked bar graph showing percentage of multidrug resistance by pathogen.

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8. Discussion

8.1 Antibiotic Prescribing Patterns

The study demonstrates a heavy reliance on broad-spectrum antibiotics such as third-generation cephalosporins and carbapenems. Such patterns reflect common empiric strategies in tertiary care but also highlight risk factors for AMR escalation. Similar trends have been observed globally and are often attributed to diagnostic uncertainty and inadequate stewardship enforcement (Huttner et al., 2013).

The appropriateness assessment revealed that only **28.3%** of prescriptions fully complied with guideline recommendations—a concerning indicator of suboptimal antibiotic use. Key contributors to inappropriate use included absence of culture tests, overuse of broad-spectrum agents, and lack of tailored therapy based on microbiology results. These issues underscore the need for improved diagnostic capabilities and physician education on rational prescribing. Addressing these gaps requires implementing robust antimicrobial stewardship programs that emphasize culture-guided therapy and restrict the indiscriminate use of broad-spectrum antibiotics. Enhancing laboratory infrastructure to facilitate timely and accurate microbiological testing is critical for informing targeted treatment decisions. Additionally, continuous medical education focused on antimicrobial resistance and prescribing guidelines will empower clinicians to make evidence-based choices, ultimately improving patient outcomes.

8.2 Antimicrobial Resistance Patterns

Resistance rates in this study align with global observations of rising resistance among Enterobacteriaceae and non-fermenting gram-negative bacilli. *E. coli* and *K. pneumoniae* exhibited high resistance to third-generation cephalosporins and fluoroquinolones. The prevalence of carbapenem resistance in *K. pneumoniae* and *A. baumannii* is particularly alarming as these antibiotics are often last-line therapies for severe infections.

MRSA prevalence at 55% reflects continued challenges in controlling gram-positive resistance, reinforcing the need for robust infection control and surveillance. Similar high resistance rates in tertiary hospitals have been documented in Asia and Africa, driven by antibiotic overuse and IPC gaps (Okeke et al., 2011).

8.3 Link Between Prescribing and Resistance

The correlation between high broad-spectrum antibiotic use and resistance rates suggests that prescribing behavior directly contributes to AMR burden. Broad-spectrum agents exert intense selective pressure on microbial communities, accelerating emergence of resistant strains. This dynamic fosters a cycle wherein increased resistance leads to more frequent use of broad-spectrum antibiotics, further exacerbating the problem. Consequently, stewardship programs emphasizing targeted therapy and judicious antibiotic selection are critical to mitigating AMR development. Monitoring prescribing patterns and resistance trends can inform policies that balance effective treatment with minimizing selective pressure.

8.4 Implications for Stewardship Programs

Findings support implementation of comprehensive ASPs encompassing:

- Local antibiogram development and dissemination.
- Prescribing audits with feedback.
- Restriction policies for key antibiotics.
- Education modules on guideline-based therapy.
- Integration of rapid diagnostics to guide therapy.

Hospitals with established ASPs often report reduced antimicrobial consumption and lower resistance rates (Baur et al., 2017).

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9. Conclusion

This study highlights significant gaps in antibiotic prescribing practices and troubling rates of antimicrobial resistance in tertiary care hospitals. A majority of prescriptions were inappropriate by guideline standards, and resistance rates among commonly isolated pathogens were high. There is an urgent need for:

- Strengthened antimicrobial stewardship frameworks.
- Enhanced laboratory capacity for culture and susceptibility testing.
- Continuous physician education on rational antibiotic use.
- Institutional policies to guide empiric therapy based on local resistance patterns.

Effective implementation of these strategies could substantially reduce AMR and improve clinical outcomes.

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