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Comparative Analysis Of Antibiotic Prescribing Patterns And Their Association With Antimicrobial Resistance In Clinical Practice

Dr. Nitin Kumar Jumnani
Associate Professor & Head Department of Pharmacology, Alwar Pharmacy College, Alwar
Email: nitinjumnani6443@gmail.com
Shafeequllah
Ph.D. Scholar Lords International College of Pharmacy Alwar Rajasthan
Email - shafeeqrjr@gmail.com

Abstract
Antimicrobial resistance (AMR) is one of the serious clinical problems arising from improper and excessive use of antibiotics. In this context, this study comparatively evaluated the prescription practices of antibiotics and the relationship of such practices with AMR in clinical settings. This study employed a retrospective, observational and comparative study design, with data collected from 120 patient medical records, containing all necessary clinical, prescription and microbiological details. Descriptive statistics, Chi square test and logistic regression analyses were performed on the data obtained. Cephalosporins were the most prescribed antibiotic group (28.3%), with empirical prescriptions and broad-spectrum antibiotics being used in 60.0% and 63.3% of the cases, respectively. Antibiotic resistance was found among 54.2% of bacteria isolated, with Pseudomonas aeruginosa (66.7%) showing the highest percentage of resistance, followed by Klebsiella spp. (61.5%) and E. coli (54.3%). The significant relationships between antimicrobial resistance and empirical therapy ($p = 0.009$) and broad-spectrum prescription of antibiotics ($p = 0.009$) were also found. Logistic regression showed that broad spectrum prescription of antibiotics, empirical therapy and prior history of antibiotic exposure were the significant variables predicting resistance.

Keywords: Antibiotic Prescribing, Antimicrobial Resistance, Antimicrobial Stewardship, Broad-Spectrum Antibiotics, Clinical Practice

1.INTRODUCTION

Antibiotic treatment continues to be an essential part of medical practice especially when it comes to treating bacterial infections in both inpatient and outpatient settings. Yet, shifts in the way antibiotics are used together with rising levels of resistant bacteria have sparked doubts about the ongoing efficiency of widely-used antibiotics [1]. Thus, it is vital to comprehend the way antibiotics are prescribed and link it with the patterns of resistance to be able to make better treatment decisions [2].

1.1 Background of the Study

Antibiotics are very useful drugs which are used to prevent and treat various bacterial infections and which have greatly helped reduce infections morbidity and mortality rates [3]. The efficiency of these drugs greatly relies on proper prescription, including choice of drug, dosage, administration, frequency, and course of therapy [4]. Improper and excessive prescription of antibiotics may lead to clinical failures and increase AMR.

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The process of antibiotic prescription depends on the type of infection, patients characteristics, clinical situation, possibility to conduct microbiological studies, and local AMR pattern [5]. Usually, antibiotics are prescribed empirically, before conducting laboratory tests. Therefore, culture and antimicrobial susceptibility tests are important for treatment optimization.

1.2 Antibiotic Prescribing and Antimicrobial Resistance

Antimicrobial resistance involves the phenomenon whereby micro-organisms become less sensitive to antimicrobial drugs, which used to have the capability of fighting them [6]. Inappropriate use of antibiotics may lead to increased pressure for development of resistant strains of bacteria [7]. This is achieved through the use of unnecessary antibiotics that are broad spectrum, continued use without clear justification and in improper combinations [8]. Various factors determine the relationship between prescription of antibiotics and resistance to them. These include the type of bacteria, the type of antimicrobial drug, the previous use of antibiotics and infection control practices among other epidemiological factors [9].

1.3 Rationale and Significance of the Study

Antimicrobial resistance becoming a common phenomenon has made a need to evaluate the antibiotic prescribing habits systematically [10]. Comparison of the habits can give us an idea about the differences that exist regarding choice of antibiotics, choice of broad spectrum antibiotics, empirical versus culture directed therapy, and other habits of prescribing. Correlation of these habits with results of antimicrobial susceptibility tests may provide clues about the habits associated with antimicrobial resistance. This study thus is aimed at comparing the habits of antibiotic prescribing and correlating them with antimicrobial resistance.

1.4 Objectives of the Study

This study is designed to achieve the following aims:

1. To understand the pattern of prescription of antibiotics among the patients undergoing treatment in clinical settings.
2. To compare the prescription pattern of antibiotics among selected groups of patients in clinical settings.
3. To measure and understand the level and pattern of resistance of the identified bacteria to the use of antibiotics.
4. To find out the association between the use of antibiotics and resistance developed by the bacteria.
5. To determine the factors responsible for such resistance and suggest ways for improved antibiotic prescription.

2. REVIEW OF LITERATURE

Previous research studies explored antibiotic prescribing patterns in various healthcare settings and revealed considerable differences in antibiotic prescribing, use and resistance. The existing literature emphasized the importance of proper prescribing and antimicrobial stewardship.

Pauwels et al. (2021) [11] investigated hospital antibiotic prescribing among adult patients from 69 countries using the WHO Access, Watch and Reserve (AWaRe) classification. It was found that there was considerable variability in antibiotic utilization and high utilization of Watch group antibiotics. The results showed the usefulness of the AWaRe framework for monitoring prescribing and improving antimicrobial stewardship.

Ramachandran (2023) [12] compared patterns of antibiotic use and resistance in hospital patients. Differences in the use of various antibiotic groups and antimicrobial susceptibility of bacteria were found. The results underlined the importance of monitoring prescribing patterns and local resistance for proper antibiotic prescription.

Song et al. (2025) [13] performed a systematic review and meta-analysis of antibiotic prescribing practices in primary care around the world. Significant variation in prescribing was noted between countries and patient populations. Patient-, clinical condition-, prescriber- and healthcare-system characteristics were found to be the important factors influencing antibiotic use.

Trikha et al. (2020) [14] evaluated antibiotic prescribing patterns and knowledge about antimicrobial resistance in doctors who work in public health facilities in northern India. Variability in prescribing and lack of rational antibiotic use principles application were noted. The results pointed out at the necessity of improvement in prescriber education, following treatment guidelines and antimicrobial stewardship.

Waterlow et al. (2025) [15] explored the prescribing of antibiotics according to age and sex in primary care in England. Systematic difference in antibiotic use was found among different demographic groups. The importance of taking into account age and sex in studying prescribing patterns, interventions and antimicrobial resistance was demonstrated.

Antibiotic prescribing, patterns of resistance, differences among demographic groups and stewardship measures were studied in previous research in various healthcare settings. However, comparison of prescribing patterns with antimicrobial resistance in the same clinical setting was needed. Thus, the current study explored antibiotic prescribing patterns associated with antimicrobial resistance.

3. RESEARCH METHODOLOGY

The research methodology was aimed at creating a structure for studying the issue of antibiotic prescription practices in relation to antimicrobial resistance. It included such issues as the research design, population of the study, sampling method, inclusion criteria, data collection methods, variables used in the research, as well as statistical methods applied to analyze the sample of 120 patient charts chosen.

3.1 Research Design

A retrospective and observational study was undertaken to analyze and compare the patterns of antibiotic usage and their possible relationship with antimicrobial resistance. Antibiotic use and microbiology data from patients' prescriptions were analyzed for antibiotic utilization and antibacterial isolation and resistance.

3.2 Study Setting and Study Population

This study was carried out using data collected from patient records from chosen departments in a healthcare facility. The study sample comprised patients that were administered one or more systemic antibiotics during the study period. Data on clinical, prescribing, and microbiological parameters were analyzed to assess the usage and resistance patterns.

3.3 Sample Size and Sampling Technique

Total 120 patients' files were considered in this study. The sampling was done using purposive sampling, taking into account the set of defined criteria for sampling. Complete data of clinical, prescription, and microbiological reports were considered for each of these patients.

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3.4 Inclusion and Exclusion Criteria

Subjects who had taken at least one systemic antibiotic and had adequate clinical as well as prescription information were selected for inclusion. Relevant information regarding cultures and antimicrobial susceptibility from subjects was used to perform the analysis on resistance. Cases that had incomplete data or duplicates were excluded.

3.5 Data Collection

The information was collected using structured data extraction forms. The data included patient demographic features, patient clinical diagnosis, prescribed antibiotics, class of antibiotics, numbers of antibiotics, mode of delivery, treatment period, and empiric or culture-based therapy. The microbiological data included specimen type, isolated bacteria, and antibiotic sensitivity/resistance.

3.6 Study Variables

The important prescription factors were the type of the antibiotics, the number of the prescribed antibiotics, the use of broad-spectrum or narrow-spectrum antibiotics, monotherapy or combination therapy, empirical therapy or culture-guided therapy. The antimicrobial resistance was regarded as the primary outcome factor.

3.7 Statistical Analysis

Analysis of the data was done through the use of descriptive and inferential statistics. In descriptive statistics, frequencies and percentages were used to summarize data, while means and standard deviations were calculated for data that is quantitative in nature. The Chi-square test was used to test associations between categories of prescribing practices and antimicrobial resistance. Logistic regression was used where possible. Statistical significance was taken at $p<0.05$.

3.8 Ethical Considerations

Confidentiality of patients was adhered to during this research, and no personally identifiable data were included in the results. The clinical data was only used for research purposes, and permission was obtained where necessary.

4. RESULTS AND DISCUSSION

Data collected from 120 patient files were analyzed to evaluate the practices of antibiotic prescription and their relation with resistance to antibiotics. The results were evaluated in accordance with patient demographics, antibiotic usage, prescription strategy, bacterial isolates, resistance, and resistance related factors.

4.1 Demographic and Clinical Profile of Patients

These were the demographic and clinical features of the patients used in this study.

Table 1. Demographic and Clinical Profile of Patients (N = 120)

Characteristics	Category	Frequency	Percentage (%)
Gender	Male	66	55.0
	Female	54	45.0
Age	18–30 years	24	20.0
	31–45 years	32	26.7
	46–60 years	38	31.7
	>60 years	26	21.7
Clinical condition	Respiratory infection	31	25.8

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	Urinary tract infection	28	23.3
	Gastrointestinal infection	18	15.0
	Skin/soft-tissue infection	16	13.3
	Other infections	27	22.5

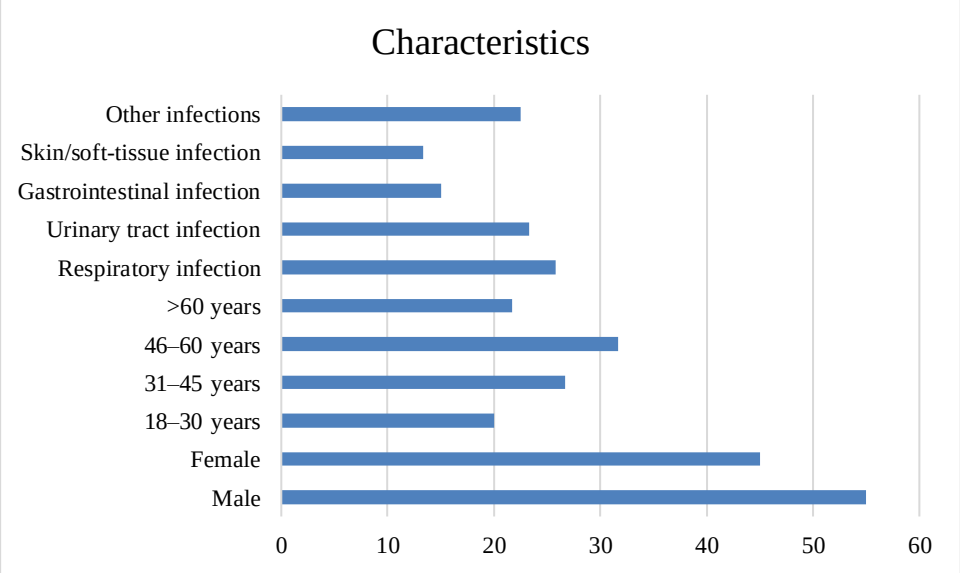

Figure 1: Graphical Representation of Demographic and Clinical Profile of Patients (N = 120)

Out of the total 120 patients, 55.0% were males while 45.0% were females. The biggest age group was that of patients aged between 46 to 60 years, 31.7% whereas that of 31 to 45 years was the second biggest, 26.7%. The most common type of disease was respiratory infection, 25.8%, whereas the second common was the UTIs, 23.3%.

4.2 Pattern of Antibiotic Prescribing

The use of antibiotics was analysed based on different groups of antimicrobials that were prescribed. In the case where a combination of different antibiotics was used, the primary antibiotic was selected for comparison purposes.

Table 2. Distribution of Major Antibiotic Classes Prescribed (N = 120)

Antibiotic Class	**Frequency**	**Percentage (%)**
Cephalosporins	34	28.3
Penicillins/β-lactam combinations	25	20.8
Fluoroquinolones	20	16.7
Macrolides	15	12.5
Carbapenems	11	9.2
Aminoglycosides	8	6.7
Others	7	5.8
Total	**120**	**100.0**

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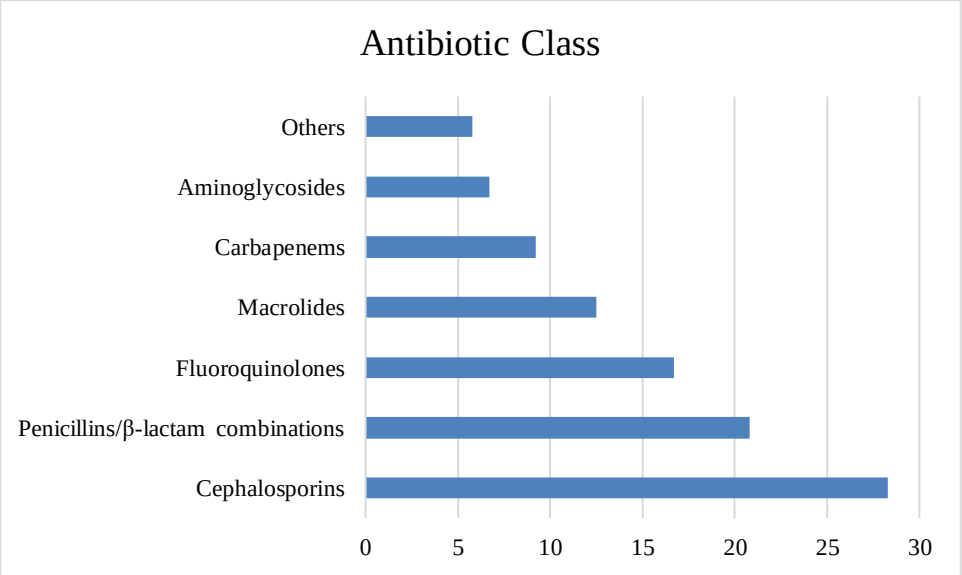

Figure 2: Graphical Representation of Distribution of Major Antibiotic Classes Prescribed (N = 120)

cases. Penicillins and β-Lactams comprised 20.8% of prescriptions, whereas fluoroquinolones comprised 16.7%. Antibiotics from carbapenem class were used in 9.2% of the cases. Preponderance of cephalosporins and other broad-spectrum antibiotics implied that there was a heavy dependence on broad-spectrum antibiotics. It could be seen that there was variability in the use of antibiotics depending on different clinical situations. The periodic assessment of the most commonly used classes of antibiotics is necessary for ensuring rational use of antibiotics.

4.3 Characteristics of Antibiotic Therapy

Prescribing methodology was assessed based on empiric or culture-guided therapy, spectrum of antimicrobial action, and monotherapy vs. combination therapy.

Table 3. Characteristics of Antibiotic Prescribing (N = 120)

Prescribing Characteristic	Category	Frequency	Percentage (%)
Treatment approach	Empirical therapy	72	60.0
	Culture-guided therapy	48	40.0
Spectrum	Broad-spectrum	76	63.3
	Narrow-spectrum	44	36.7
Treatment type	Monotherapy	79	65.8
	Combination therapy	41	34.2

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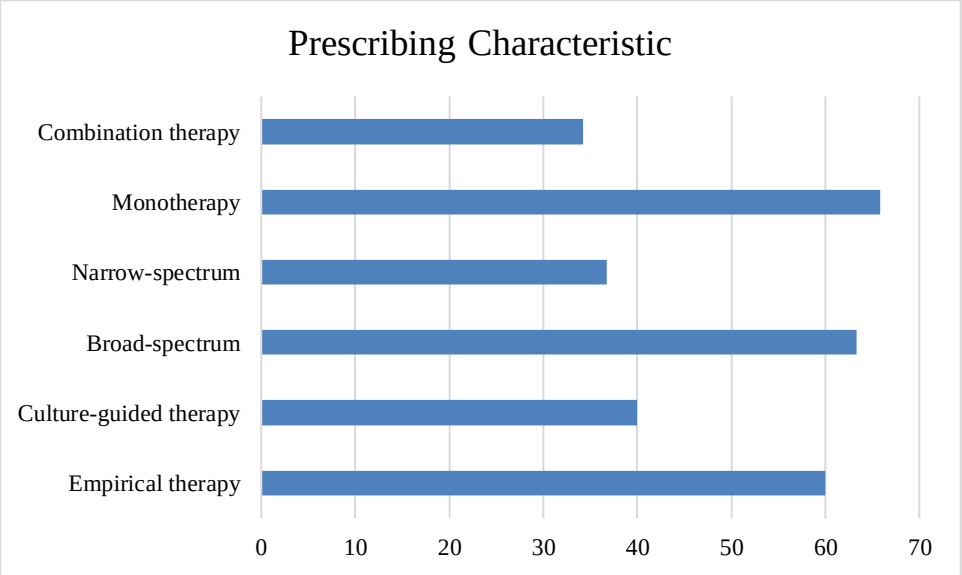

Figure 3: Graphical Representation of Characteristics of Antibiotic Prescribing (N = 120)

Empiric treatment was noted in 60.0% of cases, while 40.0% had culture-directed treatment. Broad spectrum antibiotics were prescribed in 63.3% of patients, while 36.7% got narrow spectrum treatment. Monotherapy was more common (65.8%), as compared to combination therapy (34.2%). The higher prevalence of empiric and broad-spectrum treatment could show that initial judgment was very influential in the choice of antibiotics. Empiric treatment could be justified by the need for prompt treatment, but the microbiological findings would guide further adjustments of treatment regimen. This information emphasized the need for proper antibiotic choice, evaluation of treatment efficacy and modification based on microbiological information.

4.4 Bacterial Isolates and Antimicrobial Resistance

Culture and susceptibility results were analyzed to determine the prevalence of significant bacterial organisms and their antibiotic resistance.

Table 4. Distribution of Bacterial Isolates and Resistance (N = 120)

Bacterial Isolate	Total Isolates	Resistant Isolates	Resistance (%)
Escherichia coli	35	19	54.3
Klebsiella spp.	26	16	61.5
Staphylococcus aureus	22	10	45.5
Pseudomonas aeruginosa	18	12	66.7
Enterococcus spp.	11	5	45.5
Other organisms	8	3	37.5
Total	**120**	**65**	**54.2**

Out of the 120 bacteria isolated, a total of 65 of them (54.2%) were resistant to one of the antibiotics under investigation. Among them, Pseudomonas aeruginosa had the greatest number of resistant strains (66.7%), followed by Klebsiella spp. (61.5%) and E.coli (54.3%). The results clearly revealed that resistance was evident among Gram negative and Gram positive bacteria.

This variation among bacteria implied that there was no uniform distribution of antimicrobial resistance in the various bacteria species. This research revealed the significance of using bacterial

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susceptibility profile when selecting an appropriate antibiotic. Surveillance of resistance among various bacteria can thus guide the use of antibiotics for better management of infections.

4.5 Association Between Prescribing Patterns and Antimicrobial Resistance

Chi-square Test was employed in order to establish the relationship between specific prescription features and antimicrobial resistance.

Table 5. Association of Antibiotic Prescribing Characteristics with Antimicrobial Resistance

Prescribing Factor	Resistant n (%)	Susceptible n (%)	χ^2	p-value
Empirical therapy (n=72)	46 (63.9)	26 (36.1)	6.90	**0.009**
Culture-guided therapy (n=48)	19 (39.6)	29 (60.4)		
Broad-spectrum (n=76)	48 (63.2)	28 (36.8)	6.79	**0.009**
Narrow-spectrum (n=44)	17 (38.6)	27 (61.4)		
Combination therapy (n=41)	27 (65.9)	14 (34.1)	3.54	0.060
Monotherapy (n=79)	38 (48.1)	41 (51.9)		

Statistically significant correlation was found between the treatment regimen and antibiotic resistance (p = 0.009), whereby antibiotic resistance was found in 63.9% patients who were under empirical treatment compared with 39.6% in culture-based treatment. The use of broad-spectrum antibiotics was also statistically correlated with resistance (p = 0.009). Even though the percentage of resistance among patients on combination treatment regimen was relatively high, the correlation was statistically insignificant (p = 0.060).

This was indicative of a correlation rather than causation. Patients with complex infection may be more likely to receive a combination treatment or broad-spectrum antibiotics. They could also be more likely to have resistant infections independent of the treatment used. However, the findings were supportive of the importance of microbiology investigations, review of empirical treatment regimen, and proper choice of antibiotics' spectrum.

4.6 Factors Associated with Antimicrobial Resistance

Further analysis for the prescription-related factors contributing to antimicrobial resistance was done using logistic regression analysis.

Table 6. Logistic Regression Analysis of Factors Associated with Antimicrobial Resistance

Predictor	Odds Ratio (OR)	95% CI	p-value
Broad-spectrum antibiotic use	2.47	1.14–5.36	**0.022**
Empirical therapy	2.31	1.08–4.95	**0.031**
Combination therapy	1.62	0.72–3.65	0.245
Previous antibiotic exposure	2.18	1.02–4.67	**0.044**
Age >60 years	1.39	0.59–3.28	0.451

The use of broad-spectrum antibiotics was found to be correlated with increased odds of resistance (OR = 2.47, p = 0.022) along with empirical therapy (OR = 2.31, p = 0.031). Prior exposure to antibiotics was found to be significantly correlated with resistance (OR = 2.18, p = 0.044). On the other hand, combination therapy and age of greater than 60 years did not have any statistical significance in the regression model.

In summary, the findings revealed that the prescribing features of antibiotics were significantly related to antimicrobial resistance among the study participants. The results emphasized the relevance of such factors as broad-spectrum use, empirical therapy, and prior exposure to antibiotics. However, the observational design of the study meant that the results had to be interpreted cautiously as associations might actually reveal clinical factors, such as infection severity and comorbidities.

5.CONCLUSION AND RECOMMENDATIONS

The analysis of prescribing patterns and the relationship between resistance and antimicrobials has been carried out among 120 patients. Broad spectrum antibiotics have been prescribed with frequency, and cephalosporins were the most frequent category of antibiotics. Empirical therapy has been employed in greater frequency than culture-directed therapy. Resistance to antimicrobials has been found in 54.2% of bacteria isolates. Resistance has been shown to be high among Pseudomonas aeruginosa, Klebsiella spp., and E.coli. There have been significant associations between antimicrobial resistance and empirical therapy, broad spectrum antibiotic usage, and past antibiotic use.

1. Culture-directed antibiotic therapy needs to be recommended when appropriate.
2. Broad spectrum antibiotics need to be prescribed wisely according to clinical indications and susceptibility results.
3. Antimicrobial stewardship programs need to be enhanced through prescription audits and resistance surveillance.

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