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Evaluation of Antibiotic Prescribing Patterns in Patients with Respiratory Tract Infections

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Abstract

Introduction: Respiratory tract infections (RTIs) are among the leading causes of healthcare visits and antibiotic prescribing worldwide. Although many RTIs are viral and self-limiting, inappropriate antibiotic use remains common and contributes to antimicrobial resistance, increased healthcare costs, adverse drug events, and poorer clinical outcomes. This study aimed to evaluate antibiotic prescribing patterns, assess the appropriateness of antibiotic prescriptions, and identify factors associated with inappropriate prescribing among patients with respiratory tract infections.

Methodology: A retrospective cross-sectional study was conducted among 422 patients diagnosed with respiratory tract infections at two tertiary care teaching hospitals over a six-month period (January–June 2025). Patient demographics, clinical diagnoses, prescribed antibiotics, dose, route of administration, frequency, duration of therapy, treatment setting, and hospital were extracted from medical records and prescription charts. Prescription appropriateness was evaluated using World Health Organization (WHO) prescribing indicators and evidence-based clinical treatment guidelines based on antibiotic selection, dose, frequency, route, and duration of therapy. Data were analyzed using SPSS version 26.0. Descriptive statistics, Chi-square test, independent-samples t-test, one-way ANOVA, and binary logistic regression were performed. Variables with $p < 0.20$ in bivariate analysis were entered into the multivariable logistic regression model, and both crude and adjusted odds ratios with 95% confidence intervals were reported. Statistical significance was set at $p < 0.05$.

Results: Of the 422 patients included, 216 (51.2%) were recruited from Jinnah International Hospital and 206 (48.8%) from Saidu Teaching Hospital. The mean age was 38.6 ± 17.4 years, and 55.2% were male. Upper respiratory tract infections accounted for 58.5% of cases, while lower respiratory tract infections accounted for 41.5%. A total of 587 antibiotics were prescribed, with cephalosporins (34.6%), penicillins (26.7%), and macrolides (18.4%) being the most frequently prescribed classes. Overall, 71.6% of prescriptions were appropriate, whereas 28.4% were inappropriate. The most common reasons for inappropriate prescribing were antibiotic use for likely viral infections (42.5%), inappropriate antibiotic selection (27.5%), incorrect dose (18.3%), and inappropriate treatment duration (11.7%). Multivariable logistic regression identified lower respiratory tract infection (AOR = 2.12, 95% CI: 1.34–3.36; p = 0.001), inpatient status (AOR = 1.89, 95% CI: 1.18–3.02; p = 0.008), and age >60 years (AOR = 1.67, 95% CI: 1.04–2.69; p = 0.034) as independent predictors of inappropriate antibiotic prescribing.

Conclusion: Although most antibiotic prescriptions adhered to evidence-based treatment guidelines, inappropriate prescribing remained common, particularly due to unnecessary antibiotic use for presumed viral respiratory tract infections and inappropriate empirical use of broad-spectrum agents. Strengthening antimicrobial stewardship, promoting adherence to clinical practice guidelines, and implementing regular prescription audits are essential to optimize antibiotic use and reduce the growing burden of antimicrobial resistance.

Keywords: respiratory tract infections; anti-bacterial agents; drug; drug prescriptions; drug utilization; antimicrobial stewardship; antimicrobial resistance; audit

Introduction

Respiratory tract infections (RTIs) are one of the most prevalent causes of morbidity globally, and are a significant cause of outpatient and hospital-based health care utilization [1]. These infections include viral and bacterial upper and lower respiratory tract illnesses such as the common cold, pharyngitis, sinusitis, otitis media, bronchitis, pneumonia or influenza-like diseases [2]. RTIs impact people of all ages and can have a significant impact on healthcare utilization, productivity loss, and economic cost to the health system. Many cases of infection of the respiratory tract are self-limiting, primarily caused by viruses, but antibiotics are still routinely prescribed for treatment [3,4].

Antibiotics have revolutionized the treatment of bacterial infections and have played a crucial role in reducing mortality and complications associated with infectious diseases. However, the occurrence of antimicrobial resistance (AMR) is undermining the effectiveness of these interventions and is now one of the most critical public health problems of the 21st century [5]. Unnecessary antibiotic prescriptions, choosing the wrong antibiotic, dosage and duration are all factors that add to the emergence and transmission of resistant microorganisms. Consequently, infections that used to be readily treatable are becoming difficult to treat and expensive [6].

Antibiotic use in the respiratory tract infections is a significant part of the global prescribing. Many studies have been published to show that antibiotics are often used when clinical signs indicate a viral cause, and therefore have no therapeutic effect [7]. The reasons for irrational prescribing are diagnostic uncertainty, patient expectation, not following clinical guidelines, time pressure in consultations, and lack of diagnostic aids. Antibiotics are often prescribed for the "precaution" of preventing complications, even when there is no clear evidence that the infection is indeed bacterial in origin, in many healthcare settings [8].

The irrational use of antibiotics in respiratory tract infections (RTIs) has significant clinical, economic and public health implications. Non-evidence based antibiotic prescription puts a financial strain on the patient and the healthcare system, puts the patient at risk of harm caused by the antibiotic and contributes to the development of antibiotic resistance [9]. Also, antimicrobial resistance makes existing treatments less effective, and makes diseases more time consuming and hospital stays longer, leading to increased hospitalisations and mortality. In response, the World Health Organization (WHO) and other international organizations have emphasised the importance of antimicrobial stewardship programmes to promote the rational use of antimicrobials and ensure their effectiveness [10].
Respiratory infections are prevalent, even in developing countries like Pakistan, with over the counter supply of antibiotics, absence of antimicrobial stewardship programmes and inadequate monitoring mechanisms leads to misuse of antibiotics. There are inconsistencies in the way different health professionals and institutions prescribe these medicines, indicating local evidence is needed for guiding policy development and clinical decisions [11]. To develop interventions to encourage rational antibiotic use and combat the increasing danger of antimicrobial resistance, it is important to understand the current trends of antibiotic prescribing.

As awareness has grown around the issues of antimicrobial resistance, there is still significant variation and inconsistency found in antibiotic prescribing practices for respiratory tract infections in research published. Furthermore, there are limited local data assessing the suitability of antibiotic use and adherence to best practice guidelines in many health care settings. This information deficit makes it challenging to detect prescribing gaps and put measures in place to address them. The current study was therefore designed to analyse antibiotic prescribing practices, gauge the rational use of antibiotics among patients with infection of the respiratory tract and to identify the scope of improvement in antibiotic use to ensure optimal treatment of patients and reduce the development of antimicrobial resistance.

Methodology

Study Design: Cross sectional observational study in a hospital setting to assess the pattern of antibiotic prescribing in people diagnosed with respiratory tract infections (RTIs). It concentrated on measuring the rates of antibiotic prescribing, type and appropriateness of the antibiotics prescribed, and their adherence to standard antibiotic treatment guidelines.

Study Setting and Duration: The study was conducted in the out-patient and in-patient departments of two tertiary care teaching hospitals: Jinnah International Hospital and Saidu Teaching Hospital, over a six-month period (January 2025–June 2025). Both hospitals participated in patient recruitment using identical eligibility criteria and standardized data collection procedures. Of the total 422 patients included in the study, 216 (51.2%) were enrolled from Jinnah International Hospital and 206 (48.8%) were enrolled from Saidu Teaching Hospital. These hospitals serve large urban and rural populations and were selected because of their high patient volume and diverse spectrum of respiratory tract infections.

Study Population: The patients included in the study were those with RDI who had been prescribed with at least one antibiotic during the visit or hospitalization. Upper respiratory tract infection (URTI) and lower respiratory tract infection (LRTI) including pharyngitis, tonsillitis, sinusitis, otitis media, acute bronchitis, community-acquired pneumonia and other clinically diagnosed respiratory infections.

Sample Size Determination: A sample size was determined from the formula for the single population

proportion "$n = \frac{Z^2 P\,(1-P)}{d^2}$". Here n = required sample size, Z = standard normal deviate at 95% confidence level (1.96), P = anticipated prevalence of antibiotic prescribing (50%) and d = margin of error (5%). Since no recent local estimate was available regarding the prevalence of appropriate antibiotic prescribing among RTI patients, a prevalence of 50% was assumed to obtain the maximum sample size.

$$n = \frac{(1.96)^2\ x\ 0.50\ (1 - 0.50)}{(0.05)^2}$$

The minimum required sample size was therefore 384 patients. To compensate for incomplete records and missing data, an additional 10% was added.

$$n = 384 + 38 = 422$$

A final number of 422 patients was finally analyzed.

Sampling Technique: A systematic random sampling technique was used to identify patients' records. Eligible prescriptions and medical records were retrieved from the hospital database and every kth patient record which fulfilled the inclusion criteria was included until the desired sample size was reached.

Inclusion Criteria: All patients, irrespective of gender and age, who were diagnosed with respiratory tract infections and prescribed at least one antibiotic in the study period were included. The eligible cases were outpatient and inpatient cases.

Exclusion Criteria: Patients with incomplete medical records, unknown prescription information, confirmed tuberculosis, fungal respiratory infection, COVID-19 needing special treatment protocols and severe immunocompromising disorders were excluded from the study. Also, patients with multiple visits to the same facility within the study period were not duplicated.

Data Collection Procedure: Patient medical records and prescription data were collected using a structured data collection form specifically designed for this study. Data included patient demographics, diagnosis, type of respiratory tract infection, antibiotic(s) prescribed, dose, frequency, route of administration, duration of therapy, number of antibiotics prescribed, concomitant medications, hospital of treatment, inpatient or outpatient status, and whether microbiological investigations (culture and sensitivity testing) were requested before antibiotic initiation. Collected prescriptions were analyzed for compliance with national and international evidence-based treatment guidelines [12,13].

Study Variables: The main outcome was the antibiotic prescribing pattern in patients with respiratory tract infections.

Patient age, gender, type of respiratory tract infection, clinical diagnosis, treatment setting (inpatient or outpatient), and hospital department were considered as independent variables. Indicators prescribed included the number of courses of antibiotics prescribed per encounter, class of antibiotic prescribed, route of administration, length of therapy, prescribing generic names, and following standard treatment guidelines.

Assessment of Rational Antibiotic Use: Antibiotic prescription rationality was evaluated using the World Health Organization (WHO) prescribing indicators together with established national and international evidence-based clinical guidelines for the management of respiratory tract infections. Prescriptions were assessed for the appropriateness of antibiotic selection, dose, route of administration, dosing frequency, and duration of therapy. A prescription was considered appropriate only when the prescribed antibiotic was recommended for the documented clinical diagnosis and all prescribing parameters—including dose, frequency, route, and duration—were consistent with guideline recommendations based on the patient's age, clinical condition, and type of infection. In addition, antibiotics were categorized according to their pharmacological class, including penicillins, cephalosporins, macrolides, fluoroquinolones, tetracyclines, and other commonly prescribed agents, to evaluate overall prescribing patterns.

Prescriptions were classified as inappropriate when one or more deviations from evidence-based recommendations were identified. These included antibiotic prescribing for likely viral respiratory infections without clinical evidence of bacterial infection, selection of an antibiotic not recommended for the documented diagnosis, incorrect dosage, inappropriate dosing frequency, inappropriate duration of treatment, or the unnecessary use of broad-spectrum antibiotics when narrower-spectrum agents were recommended. This standardized assessment enabled a comprehensive evaluation of prescribing quality and adherence to antimicrobial stewardship principles while identifying the most common types of inappropriate antibiotic use.

Microbiological culture and sensitivity testing was not routinely performed before initiation of therapy because most patients presented with uncomplicated community-acquired respiratory tract infections requiring empirical treatment. Culture reports were available only for selected hospitalized patients with severe lower respiratory tract infections or poor clinical response. Therefore, assessment of prescription appropriateness was primarily based on established clinical practice guidelines rather than microbiological confirmation.

Data Management and Statistical Analysis: Data were entered into Microsoft Excel and analyzed using the Statistical Package for the Social Sciences (SPSS) version 26.0. Descriptive statistics were used to summarize demographic characteristics and antibiotic prescribing patterns. Continuous variables were

presented as mean ± standard deviation (SD), whereas categorical variables were expressed as frequencies and percentages. Associations between categorical variables, including RTI type and prescription appropriateness, were assessed using the Chi-square test, while Fisher's Exact Test was applied when expected cell counts were less than five. The independent-samples t-test was used to compare continuous variables between two groups, and one-way Analysis of Variance (ANOVA) was performed to compare means across more than two groups. A two-tailed p-value of <0.05 was considered statistically significant.

To identify factors associated with inappropriate antibiotic prescribing, both bivariate and multivariable binary logistic regression analyses were performed. Independent variables entered into the regression model included age group, gender, type of respiratory tract infection (URTI/LRTI), treatment setting (inpatient/outpatient), hospital, number of antibiotics prescribed, route of antibiotic administration, and hospital department. Variables with a p-value <0.20 in the bivariate analysis were entered into the multivariable logistic regression model using the enter method to identify independent predictors. Both crude odds ratios (CORs) from the bivariate analysis and adjusted odds ratios (AORs) from the multivariable analysis were reported with their corresponding 95% confidence intervals (CIs). Model adequacy was assessed using the Hosmer–Lemeshow goodness-of-fit test, and multicollinearity among independent variables was evaluated using variance inflation factors (VIFs).

Ethical Considerations: The Institutional Review Board (IRB) of the respective institution granted ethical approval before the study was begun. The hospital administration has given the researcher permission to access the patient records. Patients' confidentiality and anonymity were ensured by the absence of any personal identifiers from the data set. The data collected were only used for research and not accessed by others without permission.

Results

The total number of patients diagnosed with RTIs included in this study was 422. The age of the subjects ranged from 2 to 84 years with a mean age of 38.6 ± 17.4 years. The total number of the study population was 233 males (55.2%) and 189 females (44.8%). The largest proportion of patients belonged to the age group of 18–40 years (36.5%), followed by 41–60 years (28.9%), less than 18 years (20.4%), and more than 60 years (14.2%, Table 1).

Table 1: Demographic Characteristics of Patients (n=422)

Variable	Frequency (n)	Percentage (%)
Gender		
Male	233	55.2
Female	189	44.8
Age Group		
<18 years	86	20.4
18–40 years	154	36.5
41–60 years	122	28.9
>60 years	60	14.2

Of the 422 patients, 247 (58.5%) had upper respiratory tract infections (URTIs) and 175 (41.5%) had lower respiratory tract infections (LRTIs). The most prevalent diagnosis was acute pharyngitis with 24.6% followed by community-acquired pneumonia (21.3%), acute bronchitis (18.5%), sinusitis (14.5%), tonsillitis (12.1%) and otitis media (9.0%, Figure 1). Fifty-eight-seven antibiotics were prescribed for a total of 422 patients, giving an average of 1.39 ± 0.63 antibiotics per prescription. In 301 (71.3%) patients, a single antibiotic was prescribed and 121 (28.7%) patients received two or more antibiotics. The most common classes of antibiotics were cephalosporins (34.6%), penicillins (26.7%), macrolides (18.4%), fluoroquinolones (11.2%), and other antibiotics (9.1%, Table 2).

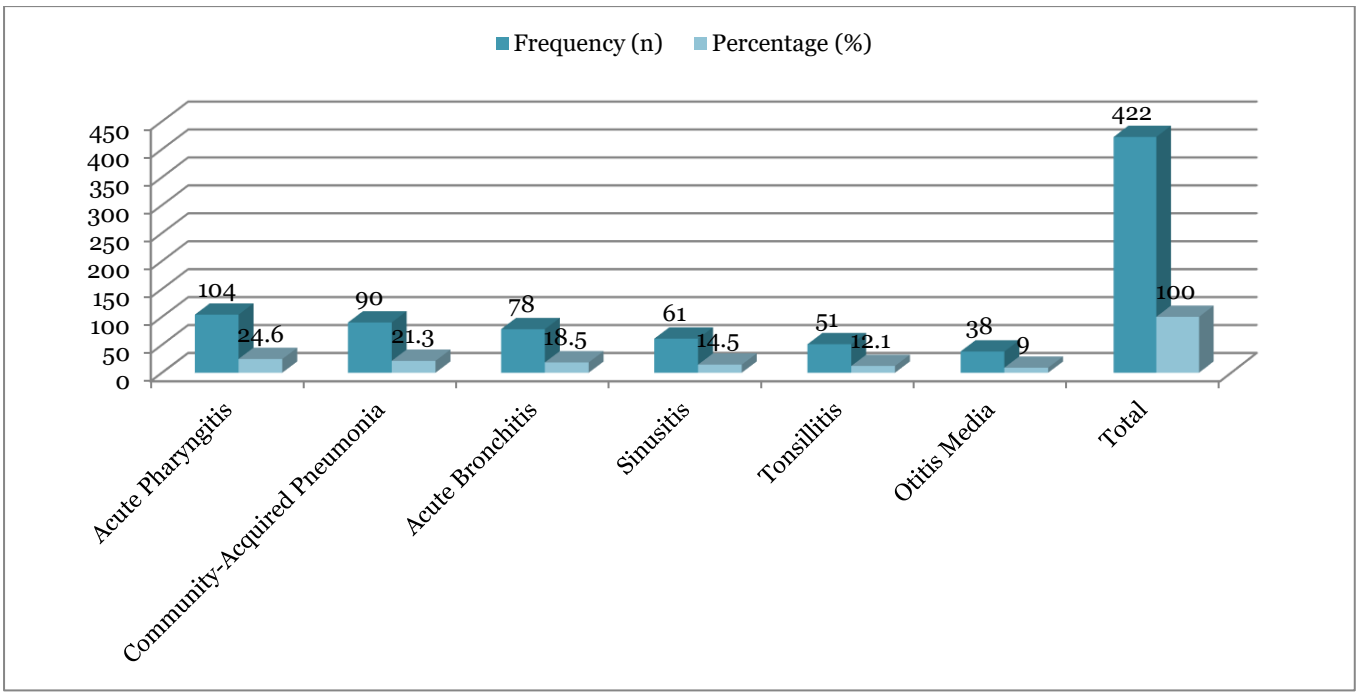

Figure 1: Clinical Diagnosis of Respiratory Tract Infections

Table 2: Distribution of Prescribed Antibiotic Classes

Antibiotic Class	Frequency (n)	Percentage (%)	χ^2	df	p-value
Cephalosporins	203	34.6	110.9	4	< 0.001
Penicillins	157	26.7			
Macrolides	108	18.4			
Fluoroquinolones	66	11.2			
Others	53	9.1			
Total	587	100			

Cephalosporins represented the most frequently prescribed antibiotic class (34.6%). Their predominant use reflected empirical treatment of hospitalized patients with moderate-to-severe lower respiratory tract infections, particularly community-acquired pneumonia, where third-generation cephalosporins are recommended by treatment guidelines. However, cephalosporins were also prescribed in a proportion of uncomplicated upper respiratory tract infections where narrower-spectrum antibiotics or supportive treatment would have been more appropriate. This finding suggests opportunities for strengthening antimicrobial stewardship and improving adherence to prescribing guidelines. Ceftriaxone (22.1%), amoxicillin-clavulanic acid (19.4%), azithromycin (17.2%), cefixime (12.8%), levofloxacin (8.5%) and other antibiotics (20.0%) were the most frequently prescribed individual antibiotics, with others being prescribed less frequently. 261 (61.8%) patients were prescribed oral antibiotics, and 161 (38.2%) were prescribed intravenous antibiotics. Lower respiratory tract infections were more likely to be treated intravenously among those who were hospitalized, especially with community-acquired pneumonia (Figure 2).

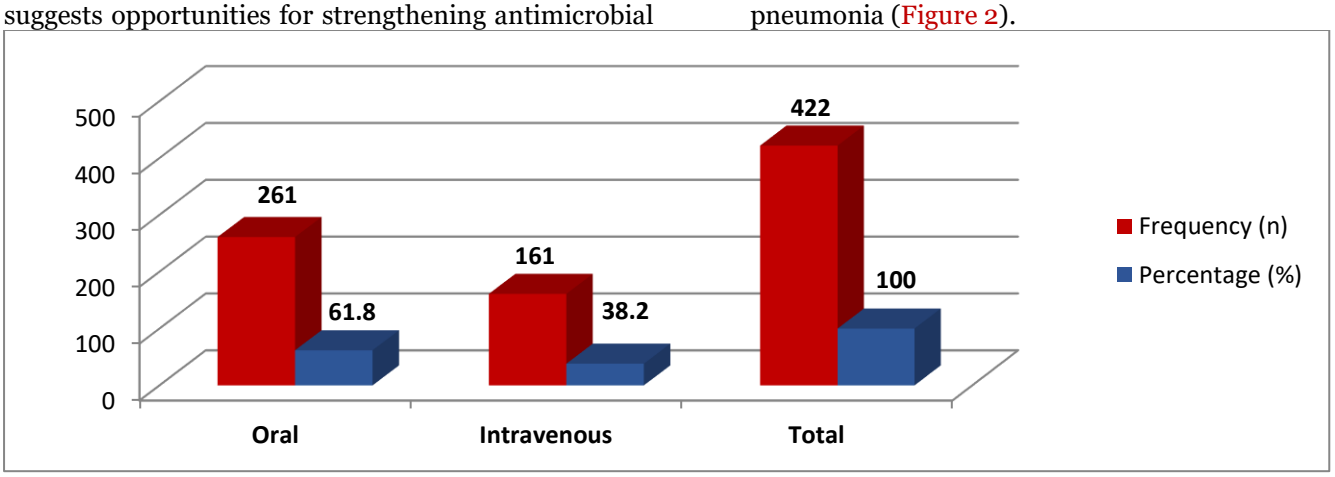

Figure 2: Route of Antibiotic Administration

When prescriptions were compared with standard treatment guidelines, 302 (71.6%) were classified as appropriate, whereas 120 (28.4%) were inappropriate. The most common reasons for inappropriate prescribing were antibiotic use for presumed viral respiratory infections (42.5%), inappropriate antibiotic selection (27.5%), incorrect dosage (18.3%), and inappropriate duration of therapy (11.7%, Table 3).

Table 3: Assessment of Prescription Appropriateness and Categories of Inappropriate Antibiotic Prescribing (n = 422)

Prescription Appropriateness	Frequency (n)	Percentage (%)
Appropriate prescriptions	302	71.6
Inappropriate prescriptions	120	28.4
• Antibiotics prescribed for viral infections	51	42.5*
• Incorrect antibiotic selection	33	27.5*
• Incorrect dose	22	18.3*
• Inappropriate duration of therapy	14	11.7*
Total prescriptions evaluated	422	100

**Percentages are calculated using the 120 inappropriate prescriptions as the denominator.*

A Chi square test was conducted to test for association between the type of respiratory tract infection and the appropriateness of prescription. The proportion of patients with appropriate prescriptions was lower for patients with lower respiratory tract infections (LRTIs) (108, 61.7%) than it was for those with upper respiratory tract infections (URTIs) (194, 78.5%). This association was statistically significant ($\chi^2 = 14.27$, $p = 0.0002$) suggesting that inappropriate prescribing was higher among patients with LRTIs (Table 4).

Table 4: Association between RTI Type and Prescription Appropriateness

RTI Type	Appropriate n (%)	Inappropriate n (%)
URTI (n=247)	194 (78.5)	53 (21.5)
LRTI (n=175)	108 (61.7)	67 (38.3)

Chi-square = 14.27, p = 0.0002

An independent sample t test was used to compare the mean number of antibiotics prescribed per patient for inpatient vs outpatient prescribers. The average number of antibiotics dispensed to inpatients were statistically significantly greater (1.72 ± 0.68) than those prescribed to outpatients (1.21 ± 0.44). The difference was statistically significant ($t = 8.91$, $p < 0.001$, Table 5).

Table 5: Comparison of Mean Number of Antibiotics Prescribed

Patient Category	Mean ± SD
Inpatients	1.72 ± 0.68
Outpatients	1.21 ± 0.44

Independent t-test = 8.91, p < 0.001

One-way ANOVA was performed to determine whether prescription appropriateness differed among age groups (Figure 3). The proportion of inappropriate prescriptions increased with advancing age. Patients older than 60 years demonstrated the highest rate of inappropriate prescribing (36.7%). ANOVA revealed a statistically significant difference among age groups ($F = 4.63$, $p = 0.003$).

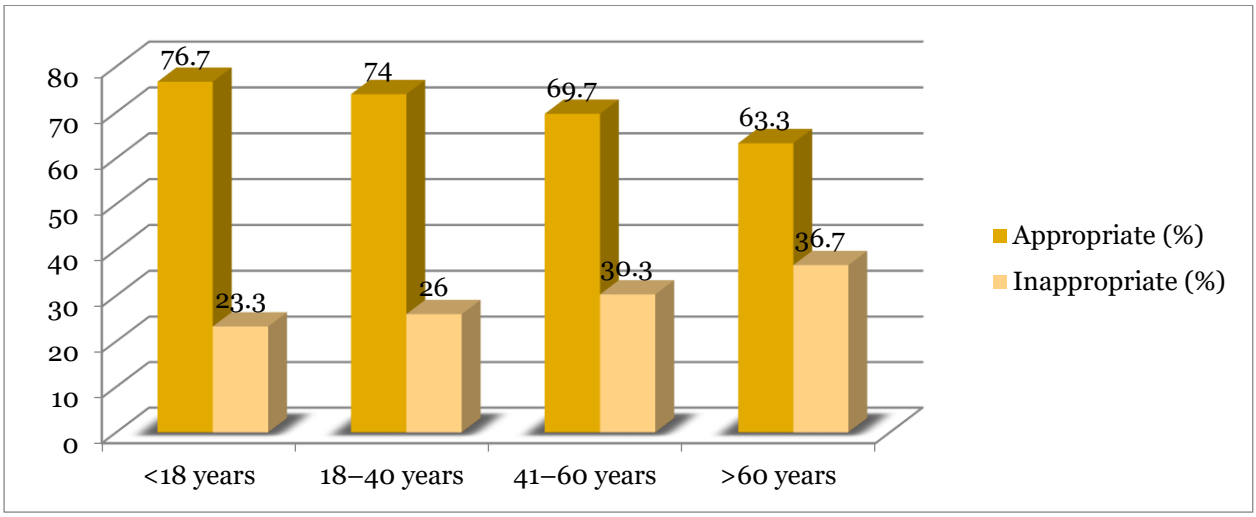

Figure 3: Prescription Appropriateness According to Age Group

A binary logistic regression analysis was performed to identify factors independently associated with inappropriate antibiotic prescribing (Table 6). Variables entered into the multivariable model included age group, gender, type of respiratory tract infection, treatment setting, hospital, route of antibiotic administration, and number of antibiotics prescribed. Variables demonstrating p<0.20 in bivariate analysis were included in the final multivariable model. The Hosmer-Lemeshow goodness-of-fit test indicated satisfactory model fit (p>0.05).

Table 6: Binary logistic regression analysis showing crude and adjusted odds ratios for factors associated with inappropriate antibiotic prescribing

Variable	Crude OR (95% CI)	Adjusted OR (95% CI)	p-value
LRTI vs URTI	2.38 (1.58–3.60)	2.12 (1.34–3.36)	0.001
Inpatient vs Outpatient	2.11 (1.42–3.14)	1.89 (1.18–3.02)	0.008
Age >60 years	1.81 (1.16–2.84)	1.67 (1.04–2.69)	0.034
Male Gender	1.12 (0.77–1.64)	1.08 (0.72–1.61)	0.701

OR = Odds Ratio; CI = Confidence Interval; LRTI = Lower Respiratory Tract Infection; URTI = Upper Respiratory Tract Infection.

The study showed that among the antibiotics prescribed for respiratory tract infections, cephalosporins were the most common ones. Some 33% of prescriptions showed irrational antibiotic use in some way. The associations of inappropriate prescribing were significant with lower respiratory tract infections, hospitalization status and older age. All of these were found to be independent predictors of inappropriate antibiotic use in logistic regression analysis. This discovery points to the importance of robust antimicrobial stewardship interventions and more effective implementation of evidence-based antimicrobial prescribing guidelines.

Discussion

The present study aimed to analyse antibiotic prescription practices in patients with RTIs and to evaluate the appropriateness of antibiotic use based on treatment guidelines. The results showed that respiratory tract infection was a significant indication for antibiotic prescribing with the URTIs dominating the LRTIs. The study also showed that cephalosporins were the most commonly used class of antibiotics, followed by penicillins and macrolides. While most medications were found to be in line with guidelines, there were significant numbers of prescriptions found to be inappropriate, suggesting irrational antibiotic prescribing continues.

The high proportion of URTIs recorded in this study is in line with the worldwide epidemicological pattern, which lists URTIs as one of the most frequent causes of visits to healthcare centres [7]. Various studies have been carried out in both developed and developing countries that have seen the prevalence of upper respiratory tract infections higher than lower respiratory tract infections. This may be due to the high prevalence of upper respiratory tract infections caused by viruses, especially in children and young adults [8].

This study shows that cephalosporins were the most commonly used antibiotics, which is consistent with a few prescription pattern studies carried out in tertiary care hospitals. Broad-spectrum activity, low toxicity and availability in both oral and parenteral formulations make cephalosporins a popular choice. Clearly, overuse of general antibiotics has been mentioned in the literature as one of the reasons for antimicrobial resistance. International treatment guidelines suggest the use of narrow-spectrum agents, if clinically appropriate, especially when treating uncomplicated respiratory infections [14,15].

The mean number of courses of antibiotics prescribed per episode in the current study was similar to those from other studies that evaluated antibiotic use among RTI patients [15]. The high proportion of monotherapy seen in this study suggests relatively rational prescribing, and is in line with guidelines recommending the use of a single effective antibiotic where possible. However, this is evidence that a significant number of patients are receiving multiple antibiotics, with possible scope for further optimization of antibiotic prescribing [16].

About one third of the prescriptions were deemed as inappropriate. This is similar to what has been observed in many healthcare facilities where the use of inappropriate antibiotics is a continued problem [17]. Unnecessary antibiotic use for viral respiratory infections, sub-optimal antibiotics selection, dosage, and/or duration of treatment have also been reported in previous studies. These activities can drive up overall healthcare expenditure and are also a major driver of antimicrobial resistance.

Previous studies have found a significant link between inappropriate antibiotic prescribing and LRTIs, and this finding was confirmed in this study [14,16]. Patients with lower respiratory tract infections usually have more severe clinical symptoms and are treated empirically with broad-spectrum antibiotics prior to identification of microorganisms. In these patients, diagnostic uncertainty and/or fears of complications could also lead to inappropriate and over-appropriate antibiotic usage.

The study also identified that the hospitalized patients were given significantly more antibiotics than the outpatients were given. These results are corroborated in the literature, where inpatients are more likely to be sicker, to receive empirical treatment, and to be treated with combination antibiotics [17]. It can be expected

that there will be an increase in antibiotic usage in hospitalized patients, but careful stewardship is needed to ensure their appropriate use.

Older age was found to be an independent risk factor for inappropriate antibiotic use. Similar observations have been seen in other research, in which elderly patients were often prescribed more "full-spectrum" antibiotics because they may have multiple comorbidities and may present with atypical symptoms, and be more likely to develop complications [18]. This is an important finding because it demonstrates that there is a need to increase awareness of evidence-based prescribing in older people. Altogether, the results of the present study are comparable to the current evidence indicating that respiratory tract infections are still one of the most frequent reasons for antibiotic use and that inappropriate antibiotic prescribing continues to be a big problem, although the awareness about antibiotic stewardship is growing.

Limitations

This study has several limitations that should be considered when interpreting the findings. The retrospective nature of data collection may have introduced documentation bias due to incomplete or inconsistently recorded clinical information. Third, microbiological culture and sensitivity testing was not routinely performed before antibiotic initiation and was available only for selected hospitalized patients with severe infections or poor clinical response. Consequently, the appropriateness of antibiotic selection was primarily evaluated using established evidence-based treatment guidelines rather than microbiological confirmation. Fourth, patient outcomes following antibiotic therapy, including clinical response, treatment failure, readmission, and adverse drug reactions, were not assessed, limiting evaluation of the clinical impact of prescribing practices. Finally, prescribing behaviors may have been influenced by institutional treatment protocols and local antimicrobial resistance patterns, which may differ across healthcare facilities.

Future Recommendations

Future research should include large, prospective multicenter studies involving diverse healthcare settings to improve the generalizability of findings on antibiotic prescribing practices. Incorporating routine microbiological culture and sensitivity testing, where clinically indicated, together with patient follow-up and outcome assessment would provide a more comprehensive evaluation of prescription appropriateness and treatment effectiveness. Healthcare institutions should strengthen antimicrobial stewardship programs through regular prescription audits, continuous physician education, implementation of evidence-based clinical pathways, and decision-support systems to improve adherence to treatment guidelines. Particular attention should be directed toward reducing unnecessary empirical use of broad-spectrum antibiotics, especially cephalosporins, for uncomplicated upper respiratory tract infections, thereby helping to optimize antibiotic use and combat the growing threat of antimicrobial resistance.

Conclusion

This multicenter study demonstrated that respiratory tract infections remain one of the leading indications for antibiotic prescribing, with cephalosporins representing the most frequently prescribed antibiotic class. Although the majority of prescriptions were consistent with evidence-based treatment guidelines, 28.4% of prescriptions were classified as inappropriate, most commonly due to antibiotic use for likely viral infections, inappropriate antibiotic selection, incorrect dosing, or inappropriate treatment duration. Logistic regression analysis identified lower respiratory tract infections, hospitalization, and age greater than 60 years as independent predictors of inappropriate antibiotic prescribing. These findings underscore the need to strengthen antimicrobial stewardship programs, promote guideline-directed prescribing, encourage appropriate use of microbiological investigations where clinically indicated, and implement regular prescription monitoring and clinician education to improve antibiotic use and help mitigate the growing challenge of antimicrobial resistance.

Author Contributions

All authors contributed equally to the conception and design of the study, data collection, analysis and interpretation of data, drafting and critical revision of the manuscript, and approved the final version for publication. All authors meet the authorship criteria of the ICMJE and agree to be accountable for all aspects of the work.

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Declarations

Ethical statement: This study was conducted in accordance with the ethical standards of the institutional research committee and the Declaration of Helsinki.

Competing interests: The authors declare that they have no known competing interests.

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