Monaldi Archives for Chest Disease

eISSN 2532-5264 https://www.monaldi-archives.org/

Monaldi Arch Chest Dis 2026 [Online ahead of print]

To cite this Article:
Reddy MS, Gurav VJ, Hanamgond JA, et al. **Prescribing patterns of antimicrobial therapy in respiratory tract infections at a tertiary care teaching hospital: a prospective study**. *Monaldi Arch Chest Dis* doi: 10.4081/monaldi.2026.4118

Submitted: 15-05-2026
Accepted: 24-07-2026

Prescribing patterns of antimicrobial therapy in respiratory tract infections at a tertiary care teaching hospital: a prospective study

Mandati Santhosh Reddy, Vaishnavi Jotiba Gurav, Jyoti A Hanamgond, Anasuya Vannur, Alika V Martins, Pradnya Rajmane

Department of Pharmacy Practice, KLE College of Pharmacy, Belagavi, KLE Academy of Higher Education and Research, Karnataka, India

Correspondence: Mandati Santhosh Reddy, Department of Pharmacy Practice, KLE College of Pharmacy, Basavan Kudachi, Belagavi, KLE Academy of Higher Education and Research, Karnataka, India. Tel.: 7349022785. E-mail: mandatisanthoshreddy@gmail.com

Contributions: Mandati Santhosh Reddy, Vaishnavi Jotiba Gurav, Jyoti A Hanamgond, Anasuya Vannur, Alika V Martins: design of the work acquisition, analysis and interpretation of data and drafting of the paper. Pradnya Rajmane, Mandati Santhosh Reddy: review of the paper critically for important intellectual content. All authors finally approved the submitted version.

Conflict of interest: the authors declare that they have no competing interest, and all authors confirm accuracy.

Ethics approval and consent to participate: the study protocol was approved by the KLECOP BGM Ethics Committee Belagavi (KLECOPBGMEC/D021-2026).

Informed consent: written informed consent was obtained from each participant before enrollment.

Patient consent for publication: written informed consent was obtained from a legally authorized representative(s) for anonymized patient information to be published in this article. The manuscript does not contain any individual person's data in any form.

Availability of data and materials: raw data were generated at KLEs Dr Prabhakar Kore Hospital and MRC Belagavi, Karnataka. Derived data supporting the findings of this study are available from the corresponding author on request. Data was collected anonymously.

Acknowledgments: the authors express gratitude to Principal, KLE College of Pharmacy, Belagavi and all the faculty members of Department of Pharmacy Practice, KLE College of Pharmacy, Belagavi, Medical Director and Medical Superintendent of KLEs Dr. Prabhakar Kore charitable hospital and MRC, Belagavi, Head of Department of General medicine & Respiratory Medicine.

Declaration of generative artificial intelligence and artificial intelligence-assisted technologies in the writing process: the authors declare that no generative artificial intelligence (AI) or AI-assisted technologies were used in the writing process of this manuscript.

Abstract

Respiratory tract infections (RTIs) are among the most common causes of hospital admissions and antibiotic use worldwide, and inappropriate antimicrobial prescribing in such cases significantly contributes to the growing problem of antimicrobial resistance, particularly in tertiary care settings. This prospective observational study was conducted in the Departments of General Medicine and Respiratory Medicine at a tertiary care teaching hospital from March to May 2026 and included 113 adult inpatients (≥18 years) diagnosed with upper or lower RTIs and receiving at least one antimicrobial agent. Data were collected from case records and analyzed using WHO prescribing indicators along with descriptive statistics. The average number of antibiotics prescribed per patient was 1.7. Injectable formulations were predominantly used, accounting for 88% of prescriptions, while oral therapy constituted only 12%. Generic prescribing was observed in 72% of cases, and the mean duration of antimicrobial therapy was 6.2 days. Upper RTIs were the most common diagnosis (42.48%), followed by community-acquired pneumonia (26.55%). Ceftriaxone emerged as the most frequently prescribed antibiotic, used as monotherapy in 26.5% of patients and in combination with azithromycin in 19.5% of cases. A high proportion of prescriptions involved broad-spectrum "Watch" category antibiotics, including piperacillin-tazobactam and meropenem, whereas the use of "Access" antibiotics was relatively limited. Intravenous-to-oral switch therapy was also found to be underutilized. Overall, the study highlights a strong reliance on broad-spectrum and injectable antibiotics in the management of RTIs, with suboptimal utilization of Access-category agents. Although prescribing practices were broadly consistent with guideline recommendations for more severe infections, the excessive use of Watch and Reserve antibiotics indicates a need for stronger antimicrobial stewardship interventions. Enhancing culture-guided therapy, promoting intravenous-to-oral switch strategies, encouraging generic prescribing, and strengthening institutional antimicrobial stewardship programs are essential measures to optimize antibiotic use and help curb antimicrobial resistance in tertiary care settings.

Key words: antimicrobial resistance, antibiotic stewardship, pneumonia, respiratory tract infections, therapeutic drug monitoring.

Introduction

Respiratory tract infections (RTIs) are among the most common infectious diseases worldwide and continue to be a major cause of morbidity, mortality, and healthcare utilization, especially in developing countries such as India. RTIs are broadly classified into upper respiratory tract infections (URTIs), involving the nasal cavity, pharynx, larynx, and trachea, and lower respiratory tract infections (LRTIs), which affect the bronchi, bronchioles, and lung parenchyma. Conditions such as pneumonia, bronchitis, bronchiolitis, and chronic obstructive pulmonary disease exacerbations significantly contribute to hospital admissions and healthcare burden in tertiary care hospitals. Infections of the respiratory tract are particularly important in tertiary care teaching hospitals because these institutions manage critically ill patients, complicated infections, and individuals with multiple comorbidities requiring intensive antimicrobial therapy [1].

Antimicrobial therapy remains the cornerstone in the management of bacterial RTIs. However, irrational prescribing practices, including overuse of broad-spectrum antibiotics, polypharmacy, inappropriate dosing, and prolonged duration of therapy, have become major concerns globally. Excessive and inappropriate antibiotic use accelerates the emergence of antimicrobial resistance (AMR), which has become a significant public health threat. The increasing prevalence of multidrug-resistant organisms (MDROs) in healthcare settings complicates treatment outcomes, prolongs hospital stay, increases healthcare costs, and contributes to higher mortality rates [2].

Studies conducted in tertiary care hospitals have reported alarming trends in antimicrobial prescribing for respiratory infections. Drug utilization studies have shown that antibiotics constitute the majority of medications prescribed for RTIs, with cephalosporins, penicillins, macrolides, and fluoroquinolones being the most commonly used agents. Polypharmacy and empirical use of broad-spectrum antibiotics are frequently observed, particularly in inpatient settings. Antibiotics account for more than half of all prescribed drugs in RTI patients in a tertiary care teaching hospital, indicating substantial antibiotic exposure among hospitalized patients [1]. Irrational prescribing patterns were observed, highlighting the need for regular prescription audits and antimicrobial stewardship programs to promote rational drug use [3].

The inappropriate use of antibiotics in RTIs is especially concerning because a substantial proportion of upper respiratory tract infections are viral in origin and do not require antimicrobial therapy. Despite this, antibiotics are frequently prescribed empirically without microbiological confirmation. Antimicrobials were prescribed in nearly 90% of cases, although only a limited number of patients had confirmed bacterial infections [4]. Such prescribing practices contribute significantly to the development of resistant bacterial strains and reduce the effectiveness of currently available antimicrobial agents.

Antimicrobial resistance has emerged as one of the greatest challenges in modern medicine. Resistant pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA), extended-spectrum beta-lactamase (ESBL)-producing organisms, and multidrug-resistant gram-negative bacilli are increasingly reported in hospitalized patients with respiratory infections. Antibiogram-based prescribing and antimicrobial stewardship interventions are therefore essential in tertiary care settings. Recent evidence emphasizes the importance of institutional antibiotic policies and local antibiograms to guide empirical therapy and minimize unnecessary exposure to broad-spectrum antibiotics [5].

Drug utilization and prescription pattern studies play a vital role in evaluating prescribing behavior and promoting rational use of medicines. The World Health Organization (WHO) recommends periodic prescription audits using prescribing indicators to assess the quality of healthcare delivery and identify irrational drug use. Such studies help in understanding trends in antimicrobial prescribing, adherence to treatment guidelines, use of generic medicines, and compliance with essential medicine lists [6]. In teaching hospitals, prescribing practices are often influenced by multiple healthcare professionals including consultants, postgraduate residents, interns, and medical students, which may result in variability in therapeutic approaches and antibiotic selection.

Recent studies from Indian tertiary care hospitals have highlighted the urgent need for antimicrobial stewardship programs (ASPs). These programs aim to optimize antibiotic therapy, improve patient outcomes, reduce adverse drug reactions, and limit the development of antimicrobial resistance. Rational antimicrobial prescribing requires careful selection of appropriate drugs, dosage, route of administration, and duration of treatment based on clinical and microbiological evidence. Monitoring prescribing patterns can

therefore provide valuable insights into current practices and help formulate strategies for evidence-based therapy [7].

Lower respiratory tract infections caused by resistant gram-negative organisms are increasingly associated with poor clinical outcomes and prolonged hospitalization. Carbapenem-resistant *Acinetobacter baumannii* (CRAB) has emerged as a serious nosocomial pathogen, particularly in intensive care units and tertiary hospitals. These infections are difficult to treat because of limited therapeutic options and high resistance rates to conventional antimicrobial agents. The growing burden of resistant respiratory pathogens highlights the necessity for antimicrobial stewardship programs and strict infection control measures in healthcare settings [8].

Considering the growing burden of RTIs and the increasing threat of antimicrobial resistance, it is essential to evaluate the prescribing patterns of antimicrobial agents in tertiary care teaching hospitals. Such studies are important for identifying irrational prescribing trends, assessing adherence to standard treatment guidelines, and promoting rational antimicrobial use.

Materials and Methods

This prospective observational drug utilization study was conducted at KLES Dr. Prabhakar Kore Hospital and Medical Research Centre in the Departments of General Medicine and Respiratory Medicine of a tertiary care teaching hospital. The study was carried out over a period of three months from March 2026 to May 2026. Consecutive eligible patients were enrolled prospectively and followed throughout their hospitalization. WHO prescribing indicators were applied as standardized prescribing quality indicators to evaluate antimicrobial prescribing practices and were not used to classify the study as a cross-sectional or point prevalence survey. The objective of the study was to evaluate the prescribing pattern and rational use of antimicrobial agents in patients diagnosed with respiratory tract infections admitted to the inpatient department (IPD).

The study included both male and female patients aged 18 years and above who were diagnosed with upper or lower respiratory tract infections and were receiving at least one antimicrobial agent during their hospital stay. Patients admitted to the inpatient department

were screened for eligibility based on the predefined inclusion and exclusion criteria. Patients with incomplete medical records, those discharged within 24 hours of admission, and pregnant or lactating women were excluded from the study.

As receipt of at least one antimicrobial agent was an eligibility criterion, the present study was designed to evaluate antimicrobial prescribing practices among hospitalized patients with respiratory tract infections rather than to estimate the prevalence of antibiotic use. Accordingly, the analysis focused on prescribing patterns, including antibiotic selection, route of administration, number of antibiotics prescribed, duration of therapy, and WHO prescribing indicators.

Data were collected prospectively from patient case records, medication charts, laboratory reports, and treatment sheets after obtaining necessary institutional permission. The collected data included patient demographics such as age and gender, clinical diagnosis, details of antimicrobial therapy including drug name, dose, frequency, and duration, as well as the total number of drugs prescribed per prescription. The prescribing pattern was evaluated using predefined parameters including appropriateness of antimicrobial selection, correctness of dose, adequacy of treatment duration, rationality of antimicrobial combinations, prescribing by generic name, and utilization of drugs from the Essential Medicines List (EML). The collected data were entered into Microsoft Excel and analyzed. Descriptive statistical methods were used to summarize and present the study findings in tables.

Results

A total of 156 patients were screened during the study period, of whom 113 fulfilled the inclusion criteria and were enrolled in the study. The study population predominantly consisted of young adults, with the highest proportion belonging to the 18-30 years age group. Female participants outnumbered males, and the majority of patients were from urban areas. Occupational analysis revealed that farming was the most common occupation among the participants, followed by unemployed individuals and security guards. Detailed socio-demographic characteristics are presented in Table 1.

Evaluation of WHO prescribing indicators showed that the mean number of antibiotics prescribed per patient was 1.7. Antibiotics were prescribed by their generic names in 72% of prescriptions. Injectable formulations accounted for 88% of antimicrobial prescriptions, whereas oral formulations constituted 12%. The mean duration of antimicrobial therapy during hospitalization was 6.2 days (Table 2).

Among the hospitalized patients, Tuberculosis represented a substantial proportion of the diagnosed respiratory infections, followed by community-acquired pneumonia, indicating the predominance of these conditions among hospitalized patients requiring antimicrobial therapy. Other frequently observed conditions included bronchitis, acute exacerbation of chronic obstructive pulmonary disease (COPD), and upper as well as hospital-acquired respiratory infections (Table 3).

A total of 113 hospitalized patients received antimicrobial therapy, with 176 antimicrobial regimens documented during the study period (Table 4). Intravenous administration was more frequently utilized compared with oral therapy, reflecting the need for parenteral treatment among hospitalized patients with acute infections. Both monotherapy and combination therapy regimens were prescribed according to the clinical condition, infection severity, and therapeutic requirements of individual patients.

During hospitalization, intravenous-to-oral antibiotic conversion was implemented in a subset of patients, indicating the adoption of step-down antimicrobial therapy following clinical improvement (Table 5). The conversion strategy was primarily considered after stabilization of the patient's condition, improvement in clinical parameters, and the ability to tolerate oral medications.

Details of the intravenous-to-oral antibiotic transitions demonstrated that step-down therapy mainly involved conversion from intravenous broad-spectrum agents to oral antibiotics, with amoxicillin-clavulanic acid being the commonly selected oral continuation therapy (Table 6).

Discussion

The present study enrolled 113 patients, of whom the majority belonged to the 18-30 years age group, followed by 30-40 years. This predominance of younger adults is consistent with

the broader epidemiological pattern of respiratory tract infections, which affect all age groups but are frequently seen in economically active populations who are more likely to seek tertiary care. A study conducted by Gupta et al. similarly noted a wide adult age distribution among RTI inpatients without a single age extreme dominating the clinical profile [9].

Females constituted the majority of participants compared to males. This contrasts with study conducted by Kumar RN & Selva P who reported a male predominance (64%) among RTI patients at a tertiary care hospital [10]. Gupta et al. reported a closer distribution of 53% males to 47% females in a pulmonology inpatient population [9]. The higher female proportion in the present study may reflect differences in care-seeking behavior, the local burden of respiratory disease in women engaged in indoor biomass-fuel-related occupations, or broader referral patterns specific to the study institution.

Urban residents comprised 67.3% of the study population, consistent with the referral pattern of an urban tertiary care hospital. Occupationally, farmers (18.6%) and the unemployed (15.0%) were the most represented groups. Outdoor occupational exposure among farmers may increase susceptibility to airborne respiratory pathogens, while the unemployed group likely represents patients with limited access to earlier levels of care, resulting in presentation at a tertiary facility with established infection.

Tuberculosis was the most frequently diagnosed condition followed by Community-Acquired Pneumonia, Bronchitis, URTI, Acute Exacerbation of COPD (AECOPD) and Hospital-Acquired Pneumonia (HAP). A systematic review and meta-analysis on antimicrobial prescribing patterns in outpatient RTI populations reported that pharyngitis, sinusitis, and acute bronchitis were the most common diagnoses triggering antibiotic therapy, with a pooled inappropriate antibiotic prescription rate of 45% [11]. The admission of patients with URTI, conditions predominantly viral in aetiology, to inpatient care with antibiotic therapy raises important questions about prescribing appropriateness and diagnostic stewardship in this setting.

The proportions of CAP (26.5%) and HAP (8.8%) are clinically expected in a tertiary respiratory ward and represent clear indications for antimicrobial therapy. The IDSA released updated CAP clinical pathway tools in October 2023 to facilitate guideline-

concordant implementation in hospitalized patients, emphasizing antibiogram guidance and severity-stratified treatment decisions [12].

As receipt of at least one antimicrobial agent was an eligibility criterion, all enrolled patients had antimicrobial exposure by study design. Therefore, the present study focused on evaluating prescribing patterns, including the number of antibiotics prescribed, route of administration, duration of therapy, and selection of antimicrobial agents. The observed prescribing trends provide useful insights into antimicrobial utilization practices among hospitalized patients with respiratory tract infections. A multicentric point prevalence survey across eight Indian tertiary care hospitals, found antibiotic use rates of 88.6% overall, rising to 100% in ICU settings [13]. A point prevalence study by Garg et.al, similarly found 88.6% of admitted patients received at least one antimicrobial [14]. A prospective observational study conducted by Ravi G et. al, found that the most common indication for empirical antibiotic therapy was respiratory infections (42% of all indications) [15]. These data collectively contextualize the 100% rate observed in the present study within the broader national pattern of high inpatient antibiotic use in India.

The mean number of antibiotics per patient was 1.7, exceeding the WHO-recommended value of 1.0 and indicating a tendency towards combination antibiotic therapy. This mirrors findings from studies conducted by Gupta et al. reported a mean of approximately 1.5 antibiotics per patient in a pulmonology inpatient ward [9]. A Himalayan tertiary care study reported a closely aligned average of 1.71 antimicrobials per prescription [15]. Combination antibiotic therapy is clinically appropriate for specific indications including severe CAP (beta-lactam plus macrolide), HAP with risk of MDR pathogens, and AECOPD with secondary bacterial infection. However, the overall average of 1.7 across all diagnoses, including URTI, suggests that combination therapy may be applied beyond strictly guideline-indicated scenarios.

In the present study, 72% of antibiotics were prescribed by their generic (International Non-proprietary) names. A prospective cross-sectional study conducted in a teaching hospital in South India that assessed antibiotic prescribing using WHO prescribing indicators reported a higher generic prescribing rate of 87.5% [16]. In contrast, a cross-sectional hospital discharge prescribing study reported a markedly lower generic prescribing rate of only 1.6%

[17]. The World Health Organization recommends prescribing medicines by their generic names as a standard practice to promote transparency, minimize medication errors, and encourage cost-effective therapy. Additionally, the ICMR Antimicrobial Stewardship Programme guidelines advocate institutional policies promoting generic prescribing along with regular sensitization and training of prescribers to strengthen rational antimicrobial use [18].

Injectable antibiotics constituted 88% of prescriptions, with oral antibiotics comprising only 12%. This high parenteral rate is consistent with inpatient tertiary care practice, where clinical severity often necessitates parenteral therapy for rapid achievement of therapeutic drug concentrations. A prospective study reported a similarly high injectable rate of 71% [15]. The substantially lower injectable proportions seen in outpatient studies further illustrate that the setting of care is the primary determinant of route of administration [10].

However, an 88% injectable rate raises the question of whether systemic intravenous-to-oral (IVOS) switching is implemented once patients are clinically stable. A systematic review conducted by Harvey EJ et al. identified IVOS as a key and feasible antimicrobial stewardship intervention that reduces catheter-related infections, treatment costs, and hospital length of stay without adverse clinical outcomes [19]. Current Indian critical care antibiotic guidelines similarly advocate early IV-to-oral transition as a stewardship priority [20].

The mean duration of antibiotic therapy was 6.2 days. Contemporary evidence-based guidelines recommend 5-7 days for non-severe CAP, 5-7 days for AECOPD exacerbations, and approximately 7 days for uncomplicated HAP. A study conducted by Dharan R et al. reported a mean empirical therapy duration of 5.8 days [21], which is closely comparable to the present study's 6.2 days.

Ceftriaxone was the most frequently prescribed antibiotic, used as monotherapy in 26.5% patients and in combination with azithromycin in 19.5% patients.This is strongly corroborated by national evidence. The multicentric study by Shrivastava et al. identified ceftriaxone as the most prescribed antibiotic across eight Indian tertiary care hospitals, comprising 14.9% of 4,248 antibiotic prescriptions [13]. A prospective study using WHO AWaRe criteria found that ceftriaxone was the single most common antibiotic (28.1% of

prescriptions), followed by cefuroxime (24.8%) and piperacillin-tazobactam (22.4%) [22]. Another study found that ceftriaxone dominated 61.5% of cephalosporin prescriptions in a tertiary care hospital [21].

The ceftriaxone + azithromycin combination aligns well with the IDSA/ATS 2019 CAP guidelines, which recommend a beta-lactam plus macrolide as first-line empirical therapy for hospitalized, non-ICU CAP patients [20]. However, ceftriaxone is classified under the WHO AWaRe 'Watch' category agents with higher resistance potential that should be reserved for specific, clearly indicated clinical scenarios. Its use as monotherapy in a sizeable proportion of URTI patients warrants review within a structured antibiotic stewardship framework. The WHO's 2023 benchmark that at least 60% of hospital antibiotic prescriptions should belong to the 'Access' group [23], is clearly unmet in the present study setting, as it is in most Indian tertiary care hospitals.

The frequent use of broad-spectrum regimens, particularly piperacillin-tazobactam and meropenem combined with vancomycin, reflects adherence to current IDSA/ATS recommendations for managing severe HAP/VAP and suspected MDR pathogens. Their predominant use in the study indicates a preference for empiric coverage against MRSA and resistant Gram-negative organisms in hospitalized patients [24].

The observed use of vancomycin- and piperacillin-tazobactam–based regimens is comparable to findings from the EPIC study [25]. However, the relatively higher use of meropenem, a WHO AWaRe ‘Reserve’ antibiotic, may reflect the severity of HAP and complicated CAP cases in this tertiary care setting, highlighting the need for culture-guided de-escalation to minimize unnecessary use of last-resort agents. [22]

The multicentric Indian PPS highlights predominant empirical prescribing in tertiary hospitals, with high use of WHO “Watch” antibiotics like ceftriaxone, piperacillin-tazobactam, and meropenem, raising concerns about overuse and resistance [13]. This supports the need for culture-guided therapy and de-escalation practices.

Oral antibiotic use was limited (12%), which is expected in a hospitalized respiratory cohort where most patients present with moderate to severe illness. However, the low proportion also suggests limited use of IV-to-oral switch therapy, despite evidence supporting its role in reducing hospital stay and antimicrobial exposure. As previously noted, early IVOS

remains underutilized in Indian tertiary care settings and should be strengthened within stewardship programmes [19,20].

Intravenous therapy was continued for the full duration of hospitalization in 91.2% of patients, and a formal switch to oral therapy occurred in only 8.8% (10 of 113). This proportion is broadly in line with, and in some respects more conservative than, comparable South Asian data. A WHO point prevalence survey conducted at a tertiary public hospital in Karachi reported an almost identical parenteral prescribing rate (89.2%) alongside a markedly low intravenous-to-oral switch rate of 2.9% [26]. Similarly, a prospective study from a tertiary hospital in Nepal found that although 83.9% of patients receiving intravenous antibiotics met standard clinical eligibility criteria for conversion, only 18.7% were actually switched to oral therapy, indicating that low observed switch rates in this region typically reflect under-recognition of eligible patients rather than a genuine absence of candidates for step-down therapy [27]. Because the present study did not prospectively screen patients against standardized switch-eligibility criteria such as afebrile status, hemodynamic stability, and ability to tolerate oral intake, it is plausible that a larger proportion of the cohort could have been switched earlier had a structured IVOS protocol been in place.

Table 6 shows that among the ten patients who were switched, the transition most often involved converting ceftriaxone (40%) or piperacillin-tazobactam (40%) to oral amoxicillin-clavulanic acid, with a smaller proportion of cefotaxime switched to cefixime (20%). These choices represent pharmacologically sound step-down options, as amoxicillin-clavulanic acid and cefixime retain activity against many of the Gram-positive and Gram-negative organisms targeted by the corresponding parenteral agents, while achieving oral bioavailability adequate for continued equivalent coverage. This spectrum-matched substitution mirrors internationally recommended IVOS practice, in which the oral agent is selected to correspond to the original intravenous drug rather than being escalated or de-escalated arbitrarily [19]. Notably, none of the switches in this cohort involved the broad-spectrum Watch-category combinations most heavily used in the intravenous regimens described in Table 4, such as meropenem or vancomycin-based therapy, suggesting that step-down therapy was largely confined to patients on comparatively narrower-spectrum

monotherapy and had not yet been extended to those who received broader-spectrum empirical regimens.

The AWaRe classification demonstrates a predominance of "Watch" antibiotics, with limited use of "Access" agents and notable use of "Reserve" antibiotics such as meropenem, indicating a tendency toward broad-spectrum prescribing. This pattern is consistent with the study by Nazir T et al., which reported higher use of Watch-category antibiotics as a potential driver of resistance [17], and is further supported by the multicentric study by Shrivastava S et al., which also observed widespread use of Watch agents with limited de-escalation to Access antibiotics [13].

These findings underscore the need for a formal Antimicrobial Stewardship Program (AMSP) in the study setting. Indian evidence shows that structured AMSP interventions significantly reduce antibiotic consumption, improve appropriateness, and increase de-escalation rates, with additional benefits such as shorter hospital stay [28,29].

Strengths and limitations

It employed a prospective observational design, enabling real-time and accurate data collection from patient case records, medication charts, and laboratory reports. The use of standardized WHO prescribing indicators provides a globally comparable framework.

The limitations include the single-centre design, which may limit generalizability to other healthcare settings. The three-month study duration may not capture seasonal variation in RTI epidemiology and prescribing. Culture results, antimicrobial resistance patterns, and clinical outcomes were beyond the scope of the present prescribing pattern study and were not systematically evaluated.

Conclusions

The present study demonstrated a high utilization of antimicrobial agents among hospitalized patients with respiratory tract infections in a tertiary care teaching hospital. Broad-spectrum antibiotics, particularly ceftriaxone, piperacillin-tazobactam, and azithromycin, were the most frequently prescribed agents, with a predominance of injectable therapy and Watch-category antibiotics. Although the average duration of therapy

was largely consistent with current treatment recommendations, the frequent use of combination therapy and broad-spectrum agents highlights the need for improved antimicrobial stewardship practices.

The findings emphasize the importance of regular prescription audits, adherence to standard treatment guidelines, culture-guided therapy, and implementation of institutional antibiotic stewardship programs to promote rational antimicrobial use and reduce the emergence of antimicrobial resistance. Strengthening generic prescribing practices and encouraging timely intravenous-to-oral switch therapy may further optimize antibiotic utilization and improve patient outcomes in tertiary care settings.

Abbreviation	**Full Form**
RTI	Respiratory Tract Infection
URTI	Upper Respiratory Tract Infection
LRTI	Lower Respiratory Tract Infection
CAP	Community-Acquired Pneumonia
HAP	Hospital-Acquired Pneumonia
COPD	Chronic Obstructive Pulmonary Disease
AECOPD	Acute Exacerbation of Chronic Obstructive Pulmonary Disease
AMR	Antimicrobial Resistance
MDRO	Multidrug-Resistant Organism
MRSA	Methicillin-Resistant *Staphylococcus aureus*
ESBL	Extended-Spectrum Beta-Lactamase
WHO	World Health Organization
IDSA	Infectious Diseases Society of America
ATS	American Thoracic Society
AWaRe	Access, Watch, Reserve (WHO antibiotic classification)
EML	Essential Medicines List
ASP	Antimicrobial Stewardship Program
AMSP	Antimicrobial Stewardship Program
IVOS	Intravenous-to-Oral Switch
PPS	Point Prevalence Survey
DOT	Days of Therapy
ICU	Intensive Care Unit
MDR	Multidrug-Resistant
INN	International Nonproprietary Name
ICMR	Indian Council of Medical Research

References

1. Beg MA, Dutta SB, Bawa S, et al. Prescribing trends in respiratory tract infections in a tertiary care teaching hospital. Int J Res Med Sci 2017;5:2588-91.
2. Gupta CN, Chatterjee K. Prescription pattern of antibiotics in respiratory disorders in a tertiary care teaching hospital in Eastern part of India. Int J Res Med Sci 2017;5:1430-3.
3. Naveen A, Sravani MR. Study of drug utilization trends in respiratory tract infections in a tertiary care teaching hospital: a retrospective study. Int J Basic Clin Pharmacol 2017;6:2583-6.
4. Srikanth S, Mohapatra S, Tharunya P, Rani RJ. Prescribing pattern of antibiotics and susceptibility of pathogens in upper respiratory tract infections: a study from a tertiary care hospital. Int J Res Med Sci 2020;8:1221-5.
5. Prasad A, Mukherjee S, Era N, Mukherjee M. Antibiotic susceptibility pattern of bacteria isolated from patients of respiratory tract infection in a tertiary care hospital of Eastern India. Int J Basic Clin Pharmacol 2019;8:757-61.
6. Kokani VR, Pandit PR, Bhave KA. Antimicrobial prescribing pattern in the treatment of acute respiratory tract infections in children in a tertiary care hospital. Int J Basic Clin Pharmacol 2016;5:1770-4.
7. Raju RN. Across-sectional observational study on drug utilization and prescribing patterns of antibiotics in lower respiratory tract infections in tertiary care teaching hospital. AJP 2024;18910-3.
8. Merli M, D'Amico F, Travi G, Puoti M. Current state of antimicrobial treatment of lower respiratory tract infections due to Carbapenem-resistant Acinetobacter baumannii. Future Pharmacol 2023;3:473-87.
9. Gupta N, Singarapu S, Ahmed MI, et al. An ambispective observational study on antibiotics in pulmonology department in a tertiary care hospital. Int J Community Med Public Health 2024;11:1608-11.
10. Kumar RN, Selva P. Analysis of prescription pattern of antibiotics among patients with respiratory tract infections at a tertiary care hospital. Biomed Pharmacol J 2019;12:1595-602.

11. Kebede GE, Cosh SM, Humphries J, Islam MS. Antimicrobial prescription pattern and appropriateness for respiratory tract infection in outpatients: a systematic review and meta-analysis. Syst Rev 2024;13:229.

12. Rearigh L. Infectious Diseases Society of America Community-Acquired Pneumonia Clinical Pathway Overview. 2023. Available from: https://asap.nebraskamed.com/2023/11/23/infectious-diseases-society-of-america-community-acquired-pneumonia-clinical-pathway-overview/.

13. Shrivastava S, Mothsara C, Shafiq N, et al. Antimicrobial prescription patterns in tertiary care centres in India: a multicentric point prevalence survey. EClinicalMedicine 2025;82:103175.

14. Garg R, Wankhade AB, Banerjee T. Point prevalence study of antibiotic appropriateness and economical cost in a tertiary care trauma hospital of Northern India. Open Forum Infect Dis 2025;12:ofae631.1927.

15. Ravi G, Chikara G, Bandyopadhyay A, Handu S. A prospective study to evaluate antimicrobial prescribing pattern among admitted patients in hilly Himalayan region of northern India. J Family Med Prim Care 2021;10:1607-13.

16. Priyadharsini RP, Ramasamy K, Amarendar S. Antibiotic-prescribing pattern in the outpatient departments using the WHO prescribing indicators and AWaRe assessment tool in a tertiary-care hospital in South India. J Family Med Prim Care 2022;11:74-8.

17. Nazir T, Ashai Z, Tabassum R, Ayoub I. Prescription pattern of antibiotics in hospital discharge summaries of a tertiary care hospital in India: a cross-sectional study. Int J Basic Clin Pharmacol 2026;15:112-8.

18. Indian Council of Medical Research. Antimicrobial Stewardship Programme (AMSP) in Hospitals. Available from: https://www.icmr.gov.in/icmrobject/custom_data/pdf/resource-guidelines/AMSP_0.pdf

19. Harvey EJ, McLeod M, De Brún C, Ashiru-Oredope D. Criteria to achieve safe antimicrobial intravenous-to-oral switch in hospitalised adult populations: a systematic rapid review. BMJ Open 2023;13:e068299.

20. Khilnani GC, Tiwari P, Mittal S, et al. Guidelines for antibiotics prescription in critically ill patients. Indian J Crit Care Med 2024;28:S104-216.

21. Dharan R, Dorairajan SK, Hassan S, Roshni M. P-1716. Assessing appropriateness of cephalosporins prescription in a tertiary care hospital in south India. Open Forum Infect Dis 2025;12:ofae631.1881.
22. Dorairajan SK, Roshni M, Hassan S, et al. Understanding antibiotic prescribing practices by utilizing WHO AWaRe criteria in a tertiary care hospital in South India: a prospective observational study. Open Forum Infect Dis 2025;12:ofae631.1930.
23. Mudenda S, Daka V, Matafwali SK. World Health Organization AWaRe framework for antibiotic stewardship: where are we now? Antimicrob Stewardship Healthc Epidemiol 2023;3:e84.
24. Kalil AC, Metersky ML, Klompas M, et al. Management of adults with hospital-acquired and ventilator-associated pneumonia: 2016 clinical practice guidelines by IDSA and ATS. Clin Infect Dis 2016;63:e61-111.
25. Tomczyk S, Jain S, Bramley AM, et al. Antibiotic prescribing for adults hospitalized in the etiology of pneumonia in the community study. Open Forum Infect Dis 2017;4:ofx088.
26. Zehra A, Ansari T, Muttaqi Shah SSA, et al. Antibiotic stewardship benchmarking-Using the WHO point prevalence survey of antimicrobial prescribing in a Tertiary Care Public Hospital, Karachi. PLoS One 2026;21:e0342985.
27. Acharya U, Shrestha S, Rawal A, et al. Analysis of the practice of switch of antibiotics from intravenous to oral therapy at a tertiary care hospital in Nepal: a prospective observational study. Antimicrob Stewardship Healthc Epidemiol 2025;5:e19.
28. Zacchaeus NGP, Palanikumar P, Alexander H, et al. establishing an effective antimicrobial stewardship program at four secondary-care hospitals in India using a hub-and-spoke model. Antimicrob Stewardship Healthc Epidemiol 2023;3:e99.
29. Swamy A, Sood R, Kapil A, et al. Antibiotic stewardship initiative in a Medicine unit of a tertiary care teaching hospital in India: A pilot study. Indian J Med Res 2019;150:175-85.

Table 1. Sociodemographic characteristics of the study participants (n=113).

Characteristics	Category	Number (n)	Percentage (%)
Age Group (in years)	18-30	35	30.97
	30-40	28	24.78
	40-50	18	15.93
	50-60	12	10.62
	60-70	19	16.81
	>70	6	5.31
Gender	Male	42	37.17
	Female	71	62.83
Residence	Urban	76	67.26
	Rural	37	32.74
Occupation	Farmer	21	18.58
	Driver	12	10.62
	Labor	14	12.39
	Student	12	10.62
	Guard	16	14.16
	Carpenter	12	10.62
	Unemployed	17	15.04
	Others	9	7.96

Table 2. WHO prescribing indicators of antibiotic utilization among hospitalized patients.

WHO prescribing Indicators	Percentage
Average number of antibiotics prescribed per patient	1.7
Percentage of antibiotics prescribed by generic name	72
Percentage of antibiotics prescribed in injection form	88
Percentage of antibiotics prescribed in oral form	12
Average duration of day's antibiotics prescribed during the hospital stay	6.2

Table 3. Distribution of respiratory tract infection diagnoses among study participants.

Diagnosis	Number (n)	Percentage (%)
Tuberculosis	38	33.63
Community-Acquired Pneumonia	30	26.55
Bronchitis	15	13.27
Upper Respiratory Tract Infections	10	8.85
Acute Exacerbation of COPD	10	8.85
Hospital-Acquired Pneumonia	10	8.85
Total	**113**	100.00

Table 4. Antimicrobial regimens prescribed during hospitalization among study participants (n=113).

Route of administration	Regimen	Frequency (n=176)	%
Oral Monotherapy	Amoxicillin	2	1.1
	Doxycycline	3	1.7
	Azithromycin	3	1.7
	Cefixime	2	1.1
Subtotal		**10**	**5.7**
Oral Combination Therapy	Amoxicillin + Clavulanic acid	4	2.3
	Amoxicillin + Azithromycin	1	0.6
	AKURIT-3	10	5.7
	AKURIT-4	28	15.9
	Co-trimoxazole	6	3.4
	Others	1	0.6
Subtotal		**50**	**28.4**
Intravenous Monotherapy	Ceftriaxone	30	17.0
	Piperacillin/Tazobactam	20	11.4
	Levofloxacin	5	2.8
	Moxifloxacin	6	3.4
	Linezolid	3	1.7
	Cefotaxime	3	1.7
Subtotal		**67**	**38.1**
Intravenous Combination Therapy	Ceftriaxone + Azithromycin	20	11.4
	Piperacillin/Tazobactam + Vancomycin	15	8.5
	Meropenem + Vancomycin	12	6.8
	Cefoperazone + Sulbactam	2	1.1
Subtotal		**49**	**27.8**
Total		**176**	**100.0**

Table 5. Intravenous-to-oral antibiotic therapy switch during hospitalization.

Antibiotic therapy modification	Frequency (n)	Percentage (%)
Continued intravenous antibiotic therapy throughout hospitalization	103	91.2
Switched from intravenous to oral antibiotic therapy	10	8.8
Total patients receiving antibiotic therapy	113	100.0

Table 6. Details of intravenous-to-oral antibiotic switching during hospitalization (n=10).

Initial Intravenous Antibiotic	Oral Antibiotic after Switching	Frequency (n)	Percentage (%)
Ceftriaxone	Amoxicillin + Clavulanic acid	4	40.0
Piperacillin/Tazobactam	Amoxicillin + Clavulanic acid	4	40.0
Cefotaxime	Cefixime	2	20.0
Total		**10**	**100.0**