

ORIGINAL ARTICLE

Antibiotic Prescription Patterns for Respiratory Infections in Urban Outpatient Settings in India: A Multicenter, Retrospective, EMR-Based Study Using WHO AWaRe Classification

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ABSTRACT

Introduction: The emergence of antimicrobial resistance represents an escalating worldwide challenge, with developing nations like India experiencing heightened vulnerability due to substantial prevalence of communicable diseases coupled with widespread inappropriate antimicrobial utilization. Despite the growing adoption of electronic medical record (EMR) systems, their potential for AMR surveillance remains underutilized. **Methods:** In this multicenter, retrospective observational study, we analyzed anonymized EMR data from 183,608 outpatient prescriptions for respiratory system infections in seven major metropolitan cities in India, collected between January 2021 and December 2023. **Results:** Antimicrobials agents were utilized in 59,779 (32%) cases, with a significant majority (85%) classified under the WHO AWaRe “Watch” category. Azithromycin (28.09%), cefpodoxime proxetil (19.07%), and cefixime (13.61%) represented the most prescribed agents, while acute upper respiratory infections comprised (40.6%) of diagnoses linked to antimicrobial prescribing. **Conclusion:** These observations emphasize the critical requirement for strengthened antimicrobial stewardship through strict compliance to WHO AWaRe recommendations to limit the broad-spectrum antimicrobial overutilization and mitigate AMR. Comprehensive antibiotic policies, regionally tailored strategies, and enhanced EMR-based surveillance are critical to fostering rational antibiotic use and reducing AMR rates in India.

KEYWORDS

Antibiotic Stewardship; Respiratory Tract Infections; WHO AWaRe Classification; Antimicrobial Resistance; India; EMR; Real World Data; Eka Care

INTRODUCTION

The phenomenon of antimicrobial resistance (AMR) represents an escalating worldwide challenge, with projections indicating that without intervention, it may account for approximately 10 million fatalities per year by the year 2050.(1) This challenge assumes heightened significance within resource-constrained nations, including India, where the substantial prevalence of communicable diseases coupled with widespread inappropriate antimicrobial utilization contributes to the accelerated development of drug-resistant microbial variants.(2) The excessive utilization of antimicrobial agents compromises the therapeutic management of routine infectious conditions, resulting in therapeutic inefficacy and elevating medical expenditures through prolonged hospitalization periods and the requirement for more aggressive and costly interventions. In addition, the misuse of antibiotics in agriculture and improper disposal practices contribute to environmental contamination, facilitating the spread of resistance across ecosystems.(3,4) This multisectoral influence emphasizes the necessity for implementing a comprehensive "One Health" framework that harmonizes human, veterinary, and ecological health initiatives, as advocated by the WHO.(5) Furthermore, antibiotic misuse can adversely affect the human microbiome, potentially leading to gut dysbiosis and related health issues such as inflammatory bowel disease and impaired immune function.(6)

To mitigate the AMR crisis, the World Health Organization introduced the AWaRe Classification, which groups antibiotics into Access, Watch, and Reserve categories based on their importance and risk of resistance development.(7) The aim is for at least 60% of antibiotic prescriptions to fall within the Access category to preserve the efficacy of critical antimicrobials. However, recent studies have highlighted an increased use of Watch and Reserve category antimicrobials within India, emphasizing the need for stronger

stewardship and policy interventions.(8,9) A recent study highlights excessive utilization of wide-spectrum antimicrobial agents and lack of Antimicrobial Sensitivity Tests (AST), underscoring the urgent need for increased awareness and evidence-based antibiotic stewardship guidelines to combat antimicrobial resistance.(10) To address the AMR crisis, India implemented the National Action Plan on Antimicrobial Resistance (NAP-AMR 2.0) during 2022, which harmonizes with the WHO Global Action Plan framework. This initiative aims to enhance surveillance, increase public awareness, optimize antimicrobial usage, and bolster investments in research and infrastructure.(11)

Understanding how antibiotics are prescribed is the first step in combating AMR. Previous studies on inappropriate antibiotic use in India have been limited by small, geographically restricted samples that fail to adequately represent private primary care settings.(12,13) Electronic medical record (EMR/EHR) systems, such as Eka Care, along with other PHR applications, play a critical role in this endeavour.(14) Despite the increasing adoption of electronic medical record (EMR) systems, these tools remain underutilized for AMR surveillance, highlighting an important gap in current healthcare practices.(15)

This study examines the demographic profiles and antimicrobial prescribing behaviours for respiratory system infections in private OPDs in urban India using real-world EMR data and the WHO AWaRe Classification. The findings are expected to inform targeted stewardship programs and promote rational antibiotic use, thereby contributing to efforts to curb the progression of AMR.

MATERIAL & METHODS

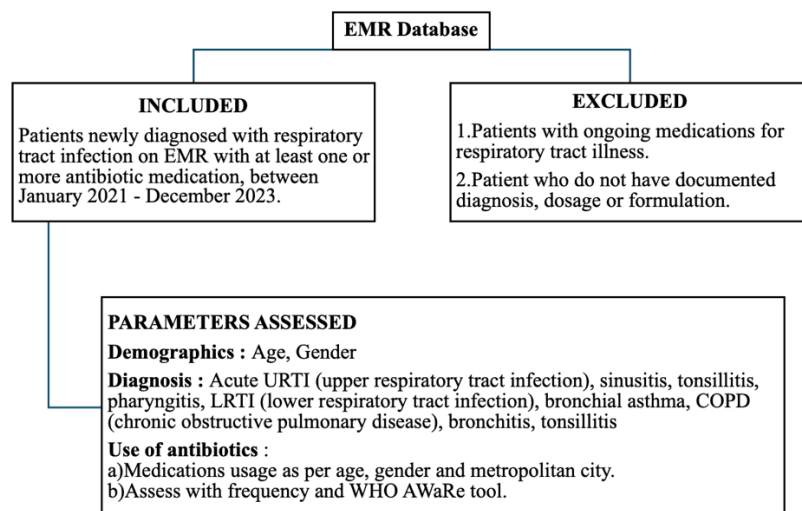
Data Sources: This multicenter retrospective study utilized de-identified prescription data from the Eka Care EMR/EHR platform, a leading electronic medical record provider in India.(16) The platform serves registered allopathic practitioners, including both general

physicians and specialists. Data were collected from outpatient clinics in seven major metropolitan cities between January 2021 and December 2023.

Study Design: Details of the inclusion and exclusion criteria, along with the assessed factors and parameters, are presented in Figure 1. Eligible records provided information on patient demographics (age and gender), the

generic nomenclature of the prescribed antimicrobial agent, and the corresponding disease condition. The antimicrobial compounds were systematically classified utilizing the Anatomical Therapeutic Chemical (ATC) classification system and subsequently analyzed according to the World Health Organization's AWaRe framework.

Figure 1. Study design with factors and parameters to be assessed



Consent and Privacy: The study utilized anonymized and aggregated prescription data to safeguard participant privacy and confidentiality. No personally identifiable information (PII) was accessed or used, as the anonymization process adhered to standard data protection protocols, ensuring both user privacy and research integrity.

Data Analysis: Statistical analysis was conducted utilizing Microsoft Excel Version 16.81 (Microsoft, 2024). The analytical approach included determination of the relative distribution of antimicrobial agents within each WHO AWaRe classification category, expressed as percentages of the total antibiotic prescription dataset. Findings are presented through charts and frequency tables, illustrating the distribution of antibiotic

classes across RTIs. A predefined, templated data collection method was employed to ensure consistency, accuracy, and reproducibility throughout the study.

RESULTS

In our study, 183,608 patients with respiratory system infection as the primary diagnosis were analyzed, of whom 59,779 (32%) received antibiotic prescriptions. The gender distribution was nearly equal, with 30,152 (50.4%) males. The 18-45 years age group accounted for the highest proportion of antibiotic recipients at 29,890 (50.4%), while patients aged over 60 years comprised only 9,412 (15.7%) (Table 1)

Table 1. Gender-wise, Age-wise distribution of antibiotic prescriptions.

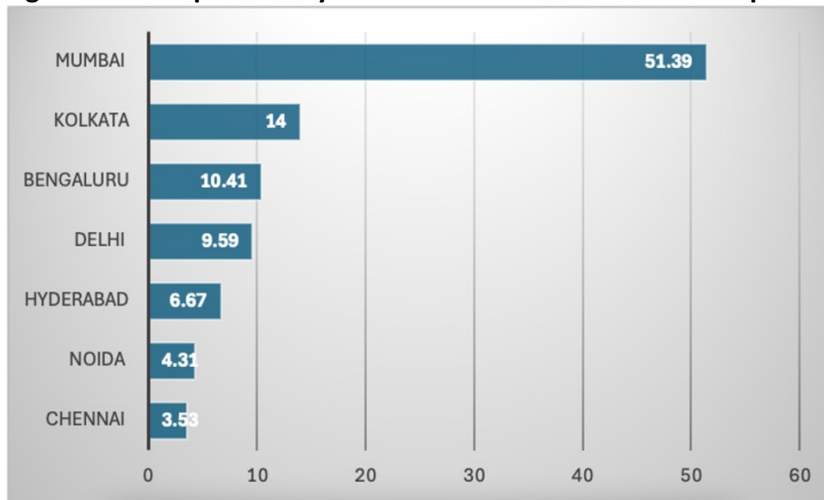
Patient Characteristics	Number (%)
Sex	
Male	30,152 (50.43)
Female	29,627 (49.56)
Age group (years)	

Patient Characteristics	Number (%)
<18	10,149 (16.97)
18-45	29,890 (50)
45-60	10,328 (17.27)
60+	9,412 (15.74)

Among the antibiotic prescriptions analyzed, acute infections of the upper respiratory system was the most frequent primary diagnosis 24,294 (40.6%), followed by rhinitis 7,885 (14.7%), bronchitis 6,943 (12.9%), chronic obstructive pulmonary disease 4,851 (9.0%), bronchial asthma 3,951 (7.3%), sinusitis

3,767 (7.0%), pharyngitis 2,021 (3.8%), and lower respiratory tract infection 2,018 (3.8%). Data from seven major metropolitan cities in India revealed that most prescriptions originated from Mumbai 31,290 (51.4%) (Figure 2).

Figure 2. Metropolitan city wise distribution of the antibiotic prescriptions in percentage.



Evaluation through the WHO AWARe framework indicated that majority of prescribed antimicrobial agents belonged to the Watch class 50,812 (85%) followed by the Access 7,174 (12%) and Reserve 1,793 (3%) categories. Among each class of the WHO AWARe Classification, the ATC classification codes alongside prescription frequencies for

the most utilized antibiotics are presented in (Table 2). In the Access class, doxycycline led with 4,132 prescriptions (6.16%), while azithromycin was most prevalent in the Watch class with 18,825 prescriptions (28.09%). Within the Reserve category, linezolid and minocycline accounted for 1,021 (1.52%) and 225 (0.33%) prescriptions, respectively.

Table 2. Commonly prescribed antibiotics of each class with ATC codes

Generic Name	Drug Classification	ATC Classification Code	Prescription Count (n)	Percentage (%)	WHO AWARe Class
Doxycycline	Tetracyclines	J01AA02	4,132	6.16	Access class
Metronidazole	Imidazoles	P01AB01	747	1.11	
Cefadroxil	Cephalosporins	J01DB05	642	0.95	
Amoxicillin	Penicillins	J01CA04	632	0.94	
Amikacin	Aminoglycosides	J01GB06	612	0.91	
Azithromycin	Macrolides	J01FA10	18,825	28.09	Watch class
Cefpodoxime proxetil	Third-generation-cephalosporins	J01DD13	12,784	19.07	
Cefixime	Third-generation-cephalosporins	J01DD08	9,124	13.61	

Generic Name	Drug Classification	ATC Classification Code	Prescription Count (n)	Percentage (%)	WHO AWaRe Class
Levofloxacin	Fluoroquinolones	J01MA12	2,925	4.36	Reserve class
Cefuroxime	Second-generation-cephalosporins	J01DC02	3,622	5.4	
Clarithromycin	Macrolides	J01FA09	1,894	2.82	
Moxifloxacin	Fluoroquinolones	J01MA14	1,622	2.42	
Ceftriaxone	Third-generation-cephalosporins	J01DD04	1,019	1.52	
Linezolid	Oxazolidinones	J01XX08	1,021	1.52	
Faropenem	Penems	J01DI03	225	0.33	
Colistin sulphate	Polymyxins	A07AA10	31	0.04	

DISCUSSION

This study represents the first large-scale, multicenter investigation of real-world electronic medical record (EMR) data on antimicrobial prescribing practices for respiratory system infections in India between 2021 and 2023. Analysis of 183,608 prescriptions from outpatient private clinics revealed that antibiotics were prescribed in 59,779 (32%) cases, with a notable 50,812 (85%) of these falling under the WHO AWaRe “Watch” category. This disproportionate use of Watch antibiotics is concerning, as it likely contributes to the accelerating challenge of antimicrobial resistance (AMR) in India.

Our findings are consistent with prior research documenting high proportions of Watch class antibiotic prescriptions. For instance, studies examining geographical variations in antibiotic consumption in India from 2011 to 2019 reported that (51.8%) of prescribed antibiotics were in the Watch category, despite WHO guidelines favoring the use of Access antibiotics for their lower resistance potential.(17) Similarly an AWaRe index evaluation in Indian hospitals between 2017 and 2018 demonstrated a reduction in Access category antibiotics was observed from (53.31%) to (41.21%), concurrent with an elevation in Watch category prescriptions from (40.09%) to (46.94%).(18) Although that hospital-based study focused on tertiary care facilities managing more complex cases, its findings are indicative of a broader trend toward increased reliance on broad-spectrum antibiotics.

Global studies further support this trend; a 69-country survey highlighted an increased use of Watch category antibiotics, particularly in middle-income countries like India, where economic factors, high infection rates, and the emergence of AMR contribute significantly to these patterns.(19) Notably, the World Health Organization's 13th General Programme of Work (2019–2023) delineates country-specific objectives mandating that Access group antibiotics constitute at least 60% of total antimicrobial consumption. This target underscores the importance of shifting prescription practices towards agents with lower resistance potential.(7) Furthermore, our data reveal a tendency to prescribe macrolides, 2nd and 3rd generation cephalosporins, quinolones, and tetracyclines over first-line Access antibiotics, a pattern that reinforces concerns regarding inappropriate antibiotic use and the potential acceleration of AMR. Our findings underscore the need for targeted interventions in private outpatient settings, where antibiotic misuse is particularly prevalent. The preference for extended-spectrum antimicrobials, such as 3rd generation cephalosporin derivatives and other Watch antibiotics, over Access antibiotics may be driven by several factors, including prescribing habits, availability, and affordability.(17,20)

Presently, India lacks national or regional policies for antibiotic use in private outpatient settings, which highlights the need to raise awareness among healthcare providers regarding the rational and appropriate utilization of antimicrobial therapy in routine respiratory infections and the clinical criteria

for broad-spectrum antibiotic use.(21) In outpatient settings, typically managing less severe cases, the substantial use of Watch antibiotics suggests that additional measures are urgently needed to enhance antibiotic stewardship. RTIs, which are often viral in nature, generally do not require antibiotic therapy. Nevertheless, our study identified common respiratory conditions, including upper respiratory tract infections (URTIs), rhinitis etc., as frequent diagnoses associated with antibiotic prescriptions. This observation is in line with previous reports showing high antibiotic prescription rates for RTIs, particularly in the private healthcare sector where rates can reach 57%, compared to 45% in the public sector.(22,23)

While this study benefits from a large, multicenter dataset derived from EMR data in urban India, it has several limitations. Our analysis was restricted to private, non-hospital-affiliated clinics in metropolitan areas, which may limit the generalizability of the results to public sector facilities or regions with lower EMR adoption rates. Moreover, the reliance on EMR data from Eka Care meant that some prescriptions were excluded if they lacked a primary diagnosis or if they focused on secondary diagnoses, such as diabetes or hypertension. This highlights ongoing challenges in achieving standardized EMR documentation across healthcare settings in India.(24) Future research should incorporate diverse healthcare settings and work toward greater standardization of EMR data to improve surveillance and the quality of data-driven insights.

CONCLUSION

This study provides a comprehensive overview of outpatient antimicrobial prescribing practices for respiratory system infections within India, highlighting an increasing reliance on WHO's Watch class antibiotics, a practice that may significantly drive antimicrobial resistance (AMR). Our findings emphasize the urgent need for rigorous adherence in accordance with the WHO AWaRe framework to optimize antimicrobial utilization and reduce AMR rates.

In recent periods, India's federal government, working alongside the Indian Council of Medical Research (ICMR) and the WHO, has taken critical steps to address AMR. The execution of the National Action Plan on Antimicrobial Resistance (NAP-AMR) seeks to advance judicious antibiotic utilization and establish robust surveillance networks. Recently, ICMR's guidelines for antibiotic stewardship programs and the Integrated Disease Surveillance Program (IDSP) under the National Health Mission have strengthened AMR efforts by monitoring over 33 epidemic-prone diseases for early detection and response. Despite these initiatives, targeted interventions in private outpatient settings remain essential.

To combat AMR effectively, comprehensive antibiotic policies must promote the judicious use of broad-spectrum antibiotics while incorporating robust education and awareness campaigns for healthcare providers. A collaborative approach involving healthcare professionals, policymakers, and the pharmaceutical industry is crucial for promoting prudent antimicrobial utilization and addressing AMR challenges within India.

RECOMMENDATION

Given the diverse patterns of antibiotic use across regions, shaped by factors such as availability, affordability, cultural variations, disease endemicity, and sociocultural influences, India should implement tailored regional antibiotic policies. Government initiatives like ABDM and ABHA ID can significantly aid in tracking patients' complete treatment histories, antibiotic usage, and resistance trends, thereby empowering clinicians to make informed decisions. Integrating these strategies is critical for optimizing antibiotic use, enhancing therapeutic outcomes, and consequently managing the growing concern of AMR across India.

RELEVANCE OF THE STUDY

This is the first large-scale, EMR-based assessment of outpatient antibiotic prescribing for respiratory infections in urban India. It

highlights the overuse of WHO "Watch" antibiotics and, importantly, demonstrates the utility of EMR data as a powerful tool for AMR surveillance and stewardship planning.

AUTHORS CONTRIBUTION

All authors have contributed equally.

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Nil

CONFLICT OF INTEREST

There are no conflicts of interest.

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DECLARATION OF GENERATIVE AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors haven't used any generative AI/AI assisted technologies in the writing process.

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