



Antibiotic Prescribing Practices in Primary Care Settings Using 2019 WHO AWaRe Framework

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Authors' contributions

This work was carried out in collaboration among all authors. Authors HP, VA, AM and MB conceptualized the study, performed the study methodology. Authors VA, AM and MB did study investigation. Authors HP, VA and SSVP performed data analysis. Authors HP, VA, AM, MB and SSVP did data validation. Authors HP and VA wrote the original draft of the manuscript. Authors HP and SP wrote, reviewed and edited the manuscript. All authors take responsibility for appropriate content, critically revised the manuscript, and approved the version of the manuscript to be published.

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ABSTRACT

Background: Bacteria have ability to rapidly evolve, develop strategies to resist antibiotics, and reduce the effectiveness of antibiotics. The emergence and spread of antimicrobial resistance is an important global public health challenge to tackle. Studying antibiotic prescribing practices would allow rational use and preserve effectiveness of antibiotics.

Objective: To study prescribing practices of antibiotics in out-patients in primary care settings using the WHO AWaRe framework.

Methodology: A prospective cross-sectional study was conducted to evaluate prescribing practices of antibiotics in the primary care facility of three private hospitals using the WHO 'core prescribing indicators' and Access, Watch, and Reserve (AWaRe) classification. A systematic sampling technique was employed to collect the prescriptions at each hospital for three months. Descriptive statistics were applied to the collected data.

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Results: A total of 2685 prescriptions were systematically evaluated. 1280 encounters had at least one antibiotic (47.7%), of which 1041 consist of only one antibiotic (81.5%). Among 1280 antibiotic encounters, the average number of antibiotics per encounter was 1.2 and 14.6% were prescribed with a parenteral antibiotic. 26.6% and 78.6% antibiotics were prescribed using generic names and from the WHO Essential Medicines List, respectively. Amoxicillin/clavulanic acid, ceftriaxone, azithromycin, cefoperazone, and amoxicillin were the five most commonly prescribed antibiotics. According to the WHO AWaRe classification, a total of 27 specific antibiotics (Access 11, Watch 14, and Reserve 2) were prescribed. 38.4%, 53.7%, 0.3%, and 10.5% of antibiotics prescribed were from the 'Access', 'Watch', 'Reserve', and 'Not Recommended' categories, respectively. Third generation cephalosporins (24.0%) were prescribed in high rate among 'Watch' category. The most commonly prescribed 'Access' and 'Watch' antibiotics were amoxicillin/clavulanic acid (12.5%) and ceftriaxone (10.6%), respectively. Amoxicillin index was 19.5% and 'Access-to-Watch' index was 0.76, which were below the priority values.

Conclusion: Except few indicators, still better prescribing practices of antibiotics are needed to fully meet the WHO recommendations. Antibiotic prescribing guidelines as per the WHO AWaRe framework, changes in prescription patterns and preference of "Access" over 'Watch' antibiotics are crucial to preserve effectiveness and promote rational use of antibiotics.

Keywords: Antibiotics; antimicrobial resistance; core indicators; prescribing pattern; prescribing practice; primary care; AWaRe classification.

1. INTRODUCTION

Bacteria, which are resistant to at least one antibiotic, are now developing multidrug resistance (MDR) and such 'superbugs' make infections harder to treat with currently available antibiotics [1]. Indeed, the global burden of infectious diseases is on the rise parallel to the increased consumption of antibiotics in humans is increasing. A recent study revealed that almost 40% increase in the global antibiotic consumption rate wherein low- and middle-income countries (LMIC) like China and India contributed largely than high-income countries (HIC) [2]. Moreover, managing AMR is an economic burden as it increases healthcare costs. It is estimated that 10 million people will die every year and will cost the world about 100 trillion U.S. dollars if AMR continues to rise and right measures not taken by 2050 [3].

Antibiotic exposure, particularly, irrational use is the major risk factor for the development of AMR [2,4]. Accumulating data indicates that misuse and overuse prevalent in most of the clinical settings, typically hospital medicine and primary care. It is reported that for every 1,000 people, approximately 412 and 838 antibiotic prescriptions were dispensed for out-patients in India and the US, respectively [5,6]. Antibiotics are generally prescribed empirically in primary care; however, ear infections and seasonal cold and influenza do not require antibiotics. Despite having prescribing guidelines on the choice of antibiotics for common infections, there is a high

rate (60–95%) of antibiotic prescriptions in primary care [7-9]. It has been reported that 23%–46% of out-patient antibiotic prescriptions are inappropriate and often contributes to high expenditure in primary care [9,10]. Indeed, high antibiotic prescription rate is reported in private than in public health facilities [6,7]. In addition, various factors such as pharmaceutical marketing strategies and incentives influence the selection of newer and broad-spectrum antibiotics [4,11]. Moreover, inter-physician variability in the selection of antibiotics and the number of antibiotic per patient visit for a particular clinical condition might contribute to the potential risks of prescribing errors [12]. Besides, antibiotics are the only medicines used to prevent and treat bacterial infections and often used as a substitute for basic public health. When primary care is not favorable, patients would obtain any drug including antibiotics from pharmacies and quacks, encouraging their use without prescription, and leads to irrational use and deterioration of healthcare system [12,13]. Therefore, it is essential to monitor good prescribing practices to preserve antibiotic effectiveness and to maintain physician-patient integrity in primary care settings.

The World Health Organization (WHO) has developed 'core prescribing indicators' and that remains the only standardized tool for measuring the drug utilization as well as the evaluation to identify inappropriate use of drugs [14,15]. Recently, the WHO classified antibiotics into 'Access', 'Watch', and 'Reserve' (AWaRe)

categories largely sourced from the evidence based medicine studies. The 'Access' category antibiotics are those that are narrow-spectrum, readily accessible, less expensive, and should initially be used for the most common and severe infections. The 'Watch' category consist of antibiotics under surveillance and should be used in moderation due to the relatively high risk of resistant bacterial strains, while the 'Reserve' category consist of antibiotics of last resort and should be used for the treatment of MDR bacterial infections [16]. Essentially, the 'AWaRe' antibiotics framework seeks to improve the quality of antibiotic prescriptions to decrease the spread of resistant microorganisms and reduce adverse reactions, and overall cost of the treatment.

This study was intended to understand prescription pattern of antibiotics at primary care level. The first objective of this study was to describe general pattern of out-patient antibiotic prescriptions based on WHO prescribing indicators. The second objective of this study was to show trends in prescription practices of narrow- and broad-spectrum antibiotic in primary care settings based on WHO AWaRe framework.

2. METHODOLOGY

2.1 Study Design

A prospective, observational, cross-sectional study was conducted in the primary care facility of three private sector hospitals, which are located at a distance of 10 KM apart in Hyderabad, Telangana, India, for a period of three months from 1 October, 2019 to 31 December, 2019. The MD physicians were allopathic medical practitioners registered with the Indian Medical Association, Telangana State Branch. The physicians were explained in detail about the objective of the study, the methodology, and the analysis of the data. They were explained that their identities would not be revealed and that the data would be used for research purposes only.

2.2 Data Collection Procedure

A systematic sampling technique was employed to collect the prescriptions at each primary care facility. The legible and complete prescriptions collected from the patients, who visited the hospitals during the study period, were included. The prescription included the demographic and the presenting complaints of the patient, the

findings on examination and the provisional diagnosis. Prescriptions from patients with chronic illness, AIDS, and tuberculosis which necessitate antibiotic treatment and those who were referred to higher healthcare were not collected. Prescriptions that were incomplete and not written during the study period were excluded. After individual data extraction, information was compared, the responsible healthcare practitioner was asked for clarifications if any crucial data were unclear, and reached a consensus of inclusion or exclusion for each prescription.

2.3 Statistical Analysis

Descriptive statistics were applied to the collected data using Microsoft Excel and the results are expressed as frequencies, averages, and percentages. All the eligible prescriptions were analysed for socio-demographic, clinical presentation, and provisional diagnosis of patients, and general prescription pattern and distribution of antibiotics. The WHO prescribing indicators with their standard values were utilized to measure rational use of drugs with due focus on antibiotics prescribing pattern [14,15]. Antibiotics were reported by drug names according to the fifth level WHO ATC classification system and their inclusion in the 21st WHO Essential Medicines List (EML) [17,18]. The prescribing patterns of antibiotics were described according to the 2019 WHO AWaRe antibiotic classification [16]. The data were further analysed for three AWaRe index metrics: the percentage of amoxicillin (Amoxicillin index), the percentage of 'Access' antibiotics, and the ratio of 'Access to Watch' antibiotics prescribed (Access-to-Watch index) to examine prescription pattern as well as prioritizing rational use of antibiotics [19].

3. RESULTS

3.1 Patient Characteristics

Only one prescription from the eligible patients was collected and a total of 852, 1208, 625 prescriptions were collected from the three hospitals, altogether 2685 prescriptions that met the inclusion criteria were finally selected to analyse general prescription pattern of drugs. Out of 2685 encounters, 1280 (47.7%) received at least one antibiotic of which 754 were male (58.9%) and 526 were female (41.1%) with the highest rate of prescription was seen in the 6 - 15 years (27.8%), followed by 6 - 15 years (24.0%) age groups (Table 1).

Table 1. Socio-demographic characteristics of the study population

Patient characteristics	Total prescriptions (2685)	Antibiotic prescriptions (1280)
	n (%)	n (%)
a) Gender		
Male	1472 (54.8)	754 (58.9)
Female	1213 (45.2)	526 (41.1)
b) Age (years)		
0 - 5	562 (20.9)	307 (24.0)
6 - 15	412 (15.3)	356 (27.8)
16 - 30	181 (6.7)	121 (9.5)
31 - 45	318 (11.8)	161 (12.6)
46 - 60	712 (26.5)	191 (14.9)
> 60	500 (18.6)	144 (11.3)

3.2 General Prescription Pattern of Antibiotics

Out of 2685 encounters, 1405 (52.3%) didn't have any antibiotic and 1280 (47.7%) had received at least one antibiotic. Among these 1280 antibiotic encounters, 1041, 219, and 20 patients received one (81.3%), two (17.1%), and three (1.6%) antibiotics, respectively. None of the prescription had four antibiotics. Upper respiratory tract infections (URTI) were the most commonly diagnosed (31.3%), followed by gastrointestinal tract infections (GITI; 20.9%), lower respiratory tract infections (LRTI; 18.8%), and among others for which antibiotics were prescribed (Table 2).

3.3 Prescribing Pattern of Drugs and Antibiotics Based on WHO Prescribing Indicators

A total of 6554 drugs were prescribed in the 2685 prescriptions with an average number of drugs

per encounter found to be 2.4. The total number of encounters prescribed with at least one antibiotic and parenteral drug was 47.7% and 15.5%, respectively. About 34.8% of the drugs were prescribed by their generic name and 75.1% prescribed drugs were from the EML (Table 3). Among these 1280 antibiotic prescriptions that accounted for a total of 1539 antibiotics, the average number of antibiotics per encounter was 1.2. Percentage of antibiotics prescribed by generic name, percentage of encounters with parenteral antibiotics, and percentage of antibiotics prescribed from the EML were 26.6, 14.6, and 78.6, respectively (Table 3). Amoxicillin/clavulanic acid (192, 12.5%), ceftriaxone (186, 12.1%), azithromycin (176, 11.4%), cefoperazone (133, 8.6%), and amoxicillin (124, 8.1%) were the five most commonly prescribed antibiotics and all are broad-spectrum antibiotics which accounted for 52.7% of all the 1539 antibiotics prescribed (Table 4).

Table 2. General prescription pattern of antibiotics (2685)

Pattern descriptor	Number of encounters, n (%)
Without antibiotic	1405 (52.3)
With antibiotic	1280 (47.7)
Antibiotics per prescription (1280)	
One	1041 (81.3)
Two	219 (17.1)
Three	20 (1.6)
Provisional diagnosis/ presenting complaints	
URTI	401 (31.3)
LRTI	241 (18.8)
GITI	268 (20.9)
UTI	222 (17.3)
SSTI	63 (4.9)
Others	85 (6.6)

URTI: Upper respiratory tract infection; LRTI: Lower respiratory tract infection; GITI: Gastrointestinal tract infection; UTI: Urinary tract infection; SSTI: Skin and soft tissue infection

Table 3. Prescribing pattern of drugs and antibiotics based on WHO prescribing indicators

WHO prescribing indicator (N = 2685)	Number	WHO standard
Average number of drugs per encounter	2.4	1.6 – 1.8
Percentage of encounters with an antibiotic prescribed	47.7	20 – 26.8
Percentage of drugs prescribed by generic name	34.8	100
Percentage of encounters with parenteral drug prescribed	15.5	13.4 – 24.1
Percentage of drugs prescribed from EML	75.1	100
Antibiotic prescribing indicator (N = 1280)		
Average number of antibiotics per encounter	1.2	
Percentage of antibiotics prescribed by generic name	26.6	
Percentage of encounters with parenteral antibiotic prescribed	14.6	
Percentage of antibiotics prescribed from EML	78.6	

Table 4. Most commonly prescribed antibiotics

Rank	Name of the antibiotic	Frequency (%)
1	Amoxicillin/ clavulanic acid	192 (12.5)
2	Ceftriaxone	186 (12.1)
3	Azithromycin	176 (11.4)
4	Cefoperazone	133 (8.6)
5	Amoxicillin	124 (8.1)

3.4 Prescription Pattern and Distribution of Antibiotics Based on WHO AWaRe Classification

A total of 1539 antibiotic regimens from 1280 prescriptions were systematically evaluated to classify into 'Access', 'Watch', 'Reserve' (AWaRe), and 'Not Recommended' antibiotic categories. Among 1539, 38.4% antibiotics (591) were from the 'Access' category. Notably, 53.7% of the total antibiotics (782 out of 1539) were from the 'Watch' category demonstrating a higher prescription rate. Particularly, 369 third generation cephalosporins contribute to major proportion (24.0%) of all the antibiotics prescribed. On the other hand, 5 antibiotics (0.3%) were from the 'Reserve' category and 161 fixed dose combination (FDC) antibiotics (10.5%) were from the 'Not Recommended' category. A total of 27 specific antibiotics were frequently prescribed in 1280 encounters accounted to 1539 antibiotics that were examined for their listing in the 2019 WHO-EML. Of 27 specific antibiotics, 19 antibiotics were listed and the remaining 8 antibiotics were not listed. Out of 27, 11 antibiotics were from the 'Access' category and 9 are listed. The five most frequently prescribed 'Access' antibiotics were amoxicillin/clavulanic acid (192, 12.5%), followed by amoxicillin (107, 7.0%), metronidazole (72, 4.7%), amikacin (56, 3.6%), and cefadroxil (38, 2.5%). Among 27 frequently prescribed

antibiotics, 14 were from the 'Watch' category, of which only 9 antibiotics are listed in the EML. The five most frequently prescribed 'Watch' antibiotics were ceftriaxone (163, 10.6%), followed by azithromycin (155, 10.1%), cefoperazone (121, 7.9%), ciprofloxacin (52, 3.4%), and gatifloxacin (51, 3.3%). 'Reserve' antibiotics were relatively uncommon that include one listed colistin (3, 0.2%) and another non-listed aztreonam (2, 0.1%) in the EML. Amoxicillin/clavulanic acid (23, 1.5%) and azithromycin/levofloxacin (5, 1.0%), among others were the commonly prescribed FDC that are 'Non Recommended' antibiotics and are not listed in the EML (Table 5).

3.5 Prescription Pattern of Antibiotics Based on AWaRe Index Metrics

The percentage of amoxicillin/clavulanic acid (12.5%) and amoxicillin alone (7.0%) prescribed was (19.5%) vs. all the third generation cephalosporins (24.0%), the percentage of 'Access' antibiotics was also less (38.4%; Recommended value more than 60%), and the ratio of 'Access to Watch' antibiotics (Access-to-Watch index) was 0.76 which was less than the priority value of 1.5 indicating the prescription practices of antibiotics needs improvement as specified by the WHO recommendations (Table 6).

Table 5. Prescription pattern and distribution of antibiotics based on WHO AWaRe classification (N = 1539)

WHO AWaRe Category	ATC code	n (%)	Listed in EML
Access (591, 38.4%)			
Amoxicillin/clavulanic acid	J01CR02	192 (12.5)	Yes
Amoxicillin	J01CA04	107 (7.0)	Yes
Metronidazole	J01XD01	72 (4.7)	Yes
Amikacin	J01GB06	56 (3.6)	Yes
Cefadroxil	J01DB05	38 (2.5)	No
Watch (782, 53.7%)			
Ceftriaxone	J01DD04	163 (10.6)	Yes
Azithromycin	J01FA10	155 (10.1)	Yes
Cefoperazone	J01DD12	121 (7.9)	No
Ciprofloxacin	J01MA02	52 (3.4)	Yes
Gatifloxacin	J01MA16	51 (3.3)	No
Reserve (5, 0.3%)			
Aztreonam	J01DF01	2 (0.1)	No
Colistin	J01XB01	3 (0.2)	Yes
Not Recommended (161, 10.5%)			
Amoxicillin/cloxacillin		23 (1.5)	No
Azithromycin/levofloxacin		15 (1.0)	No
Ceftriaxone/sulbactam		14 (0.9)	No
Metronidazole/norfloxacin		12 (0.8)	No
Ceftriaxone/tazobactam		9 (0.6)	No

*No codes exist for such drug combinations in the ATC index

Table 6. Prescription pattern of antibiotics based on AWaRe Index metrics

AWaRe index metrics	Observed value (%)	Priority value
Amoxicillin index	19.5	> Any antibiotic (%)
Access antibiotics index	38.4	> 60%
Access-to-Watch index	0.76	1.5

*Majority of the prescribed third generation cephalosporins (24.0%) were 'Watch' antibiotics

4. DISCUSSION

The present study systematically evaluated antibiotic prescription practices in primary care settings. Our results indicated that more percent of male than female patients visited for primary care, pediatric patients below 15 years of age were predominant and prescribed with at least one antibiotic. Particularly, 47.7% encounters had at least antibiotic and among those the majority (81.3%) were prescribed with one antibiotic. The commonly diagnosed cases were URTI, followed by GITI, and LRTI, among others. The results are consistent with previous studies and vary with other studies conducted in developed countries and India [7,10,11,15,20]. There are many variations in antibiotic prescription rate across the geographies and within the country as well. Studies from LMICs like China (77.5%) and HICs like USA (59%) and UK (82%) reported high prescription rate of antibiotics for out-patients [9,21-23]. Relatively

lower rates of antibiotics prescription were also observed in LMICs like India, China, and developed nations [8,13,20,24]. In general, irrespective of speciality, hospitalized patients receive antibiotic treatment on need basis after through clinical diagnosis where as empirical use is predominant in primary care. Empirical use of antibiotics, particularly for URTI, is not required as per many national guidelines; however, there are disparities in antibiotic prescribing practices. This study is different from other studies, which focused on out-patient prescription of antibiotics for only one specific infectious disease such as acute bronchitis or diarrhoea. Antibiotic use specific to acute bronchitis, pharyngitis, acute otitis media, acute rhinosinusitis was also reported high in HIC [9,10,22,23,25]. Moreover, there is an increase trend of antibiotic use among children less than 5 years of age with fever, diarrhoea, or cough was also reported in LMICs [26]. It is reported that antibiotics for URTI have a modest beneficial effect considering the duration

of symptom free periods over risk of potential side effects, hospitalization, rise in treatment cost, and most likely development of AMR [27]. Indeed, excess antibiotic use in this age group could be due to URTIs are most commonly prevalent and the similarity of presenting symptoms in bacterial and viral diseases that allow clinicians to use antimicrobials. Thus, the percent prescription of antibiotics noticed in our study might be conveying a reasonable variability in antibiotic prescription that affects quality of care provided.

To rationalize drug and antibiotic use in primary care settings, we evaluated WHO prescribing indicators. It is noticed that an average number of drugs prescribed per encounter was found to be 2.4 where as that of antibiotic was 1.2 among the prescriptions with at least one antibiotic. Though the number of antibiotics prescribed per encounter might be cautiously acceptable as the figure is slightly more than 1; however, polypharmacy is noticed, which is higher than the recommended standard (1.6 – 1.8). The results are consistent to a previously reported study (2.45), higher values of average drugs per encounter (2.83, 3.4) and antibiotic prescriptions (61%) were also reported in India [14,28,29]. Of particular note, the percent parenteral drugs (15.5%) and that of antibiotics (14.6%) prescribed are within the recommended range (13.4 – 24.1). This is a positive from this study in that overuse of antibiotics increases the risk of dysbiosis, secondary infections, developing antibiotic-associated diarrhea, prolonged stay in hospital, and also increases medical expenditures [27,30]. There has been a geographical variation in these values across the globe with higher and lower values reported in both LMICs and HICs [15,21,28]. Nonetheless, more number of drugs and antibiotics were prescribed with their brand names rather than generic names and most of them about three-fourths were from the WHO EML. There is no consistency with regard to these values as variability exists among physicians, regional guidelines, healthcare policies as well as prevalence and severity of presented illness and infections that do not preclude prescription of antibiotics. It has been reported that total antibiotic use and volume were strongly correlated with unnecessary antibiotic prescribing [31]. Moreover, physician-medical representative interactions would influence prescribing brand-name drugs [11,32]. Essentially, injectable formulations with their brand names are preferred when generic versions are not

available readily. Even a higher value 61% was also reported in India [28]. It is observed that the commonly prescribed were broad-spectrum antibiotics, particularly from the third-generation cephalosporins and such trend was also reported in studies from LMICs and HICs [9,10,20,24,25]. One reason could be absence of penicillin allergy information and inconclusive clinical presentation, particularly in children and others could be time taking microbial testing and absence of quick diagnostic results that allow physicians to prescribe a broad-spectrum antibiotic in acute and severe infection cases. The results are consistent with previous findings in Indian out-patient studies [6,33]. Despite this, a narrow-spectrum antibiotic should be more appropriate over a broad-spectrum antibiotic to minimize the risk of AMR and MDR.

In order to assess the prescription pattern of antibiotics, specific to narrow- and broad-spectrum, the data were systematically evaluated using WHO AWaRe classification. The present results revealed that there are marked differences in relative prescription of 'Access, Watch, and Reserve' antibiotics with major proportion of antibiotics prescribed were from the 'Watch' category (53.7%), followed by the 'Access' category (38.4%). The 'Reserve' category antibiotics were prescribed minimum; however 10.5% antibiotics were from the 'Non-Recommended' category and are discouraged combination of antibiotics. Recent studies reported such differences in relative use of antibiotics based on WHO AWaRe classification [19,34-37]. Similar to previously reported studies based on national and global antibiotic consumption and sales data, the prescription of 'Watch' antibiotics was high and mostly contributed by second and third generation cephalosporins, fluoroquinolones, and macrolides. In addition, the 'Access-to-Watch' ratio in this study was below one that further indicates that less proportion of 'Access' antibiotics were prescribed. Previous studies reported prescription, use, consumption, and/or sale of antibiotics based on pharmacological and chemical classes and such information misleading to precisely understand prescription pattern of antibiotics. It has been reported that there was a tremendous increase in the consumption of antibiotics, 'Watch' over 'Access' antibiotics, particularly in LMICs like India and China [35,36,38]. Indeed, there are many drivers such as increased access to antibiotics, improved quality healthcare, and rising economical standards attributed to the high

prescription rate of 'Watch' antibiotics [4,6,36]. Accumulating data indicates that high levels of 'Watch' over 'Access' antibiotic use was also reported in HICs such as USA and UK [36,38]. Conversely, developing nation like South Africa and LMICs like Burkina Faso and Burundi had high proportion of high 'Access-to-Watch' ratios. Furthermore, 'Reserve' category that consists of antibiotics of last resort and recommended for MDR infections were prescribed minimum. However, high use of 'Reserve' antibiotics was reported in Latin American countries and one study in India whereas none was reported in Laos and Nigeria [36,39]. These disparities are partly due to existing healthcare and diagnostic facilities, affordability, and antibiotic availability in those countries.

It is also observed that antibiotic FDCs were prescribed for which there is no evidence to validate use of such combinations. Pharmaceutically, antibiotic FDC can have clinical advantages such as ease of administration, improving effectiveness, and medication adherence. It is well known fact that India is a global paradise of pharmaceuticals and has the highest numbers of FDC antibiotics [40,41]. Conversely, FDC use is potentially inappropriate and majority of the FDC antibiotics were not approved by either US FDA or WHO EML [18,40,41]. Importantly, antibiotic FDCs has been reported about the lack of proven efficacy, increasing toxicity, potential for developing AMR. Notwithstanding to this, three of the five most commonly prescribed antibiotics were from 'Watch' category, namely ceftriaxone, azithromycin, and cefoperazone that were indicated for URTI, GITI, and LRTI. Though amoxicillin/clavulanic acid was the most commonly prescribed, together with amoxicillin constitute representative portion of 'Access' antibiotics. Amoxicillin is the one antibiotic widely used and recommended by many national guidelines as first-line agent for treatment of common infections [19,42]. It is generally preferred that amoxicillin index should be more than any antibiotic that improves the use of 'Access' antibiotics in order to reduce AMR. Owing to high rate of prescription of 'Watch' antibiotics, especially broad-spectrum third generation cephalosporins (24.0%) over amoxicillin and amoxicillin/clavulanic acid (19.5%), the 'Amoxicillin', 'Access' antibiotic, and 'Access-to-Watch' indices are low. Apart from unnecessary antibiotic prescribing, inappropriate or suboptimal antibiotic prescribing including inappropriate choice, duration or dose of

antibiotic treatment contributes to treatment failure and AMR as well. It is well reported that bacteria are developing resistance against third generation cephalosporins, azithromycin, and fluoroquinolones, that are classified in the 'Watch' category, and their excess use would cause MDR [1,43]. Though minimal, 'Reserve' antibiotics, aztreonam and colistin, were prescribed for severe diarrhea and these agents should be prescribed only after diagnosis and when such clinical condition is not improved by 'Access' and 'Watch' antibiotics [42]. Indeed, the WHO recommends using 'Access' antibiotics at least 60% and prescription and consumption preferences must be given to antibiotics from 'Access' over 'Watch' category as first-line agents [44]. Indeed, antibiotics are the only agents used for prophylaxis as well as treatment of infectious diseases and contribute to improve in quality of life and increase in life expectancy of human globally. In recent years, there has been a 90% decrease in the approval of newer antibiotics due to high cost of research and further hampered by rapid evolution of AMR and MDR [45,46]. Essentially, changes in the prescription practices during primary care visits definitely allow prescription of 'Access' antibiotics and that will improve all the three indices, which is a measure of good practice.

5. CONCLUSION

It is observed that 47.7% of encounters had at least one antibiotic and most of the out-patients prescribed with antibiotics were children below 15 years. 'Watch' antibiotics were prescribed more frequently than 'Access' antibiotics. The 'Access', 'Amoxicillin', and 'Access-to-Watch' indices were below the priority values. Therefore, in wake of less antibiotic approvals and increased AMR, prescription of right antibiotics using the WHO AWaRe classification is important to minimize resistance and for effective treatment of MDR infections. Continuous surveillance and new prescribing guidelines are essential to monitor selection of antibiotic and good antibiotic prescription practices in primary care settings, especially to preserve their effectiveness for future in the post-antibiotic era.

6. LIMITATIONS

There are certain limitations for this study. First, prescriber's bias as clinicians was aware about the study. Second, determining the quality of diagnosis, revisits, and evaluating the appropriateness of choice of antibiotic was

beyond the scope of this study. Third, these data evaluated antibiotics prescribed rather than consumed. Fourth, the study was conducted in only three sites in one city and thus it would not be possible to generalize the findings.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

CONSENT AND ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee of the Department of Pharmacy Practice, Bharat Institute of Technology-Pharmacy, Hyderabad. The permission was obtained and individual patient consent was taken to collect the data.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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