ASIAN JOURNAL OF PHARMACEUTICAL AND CLINICAL RESEARCH

INNOVARE ACADEMIC SCIENCES
Knowledge to Innovation

Vol 19, Issue 1, 2026

Online - 2455-3891
Print - 0974-2441

Research Article

TRENDS IN ANTIMICROBIAL PRESCRIBING: A RETROSPECTIVE ANALYSIS IN A TERTIARY CARE TEACHING HOSPITAL

BHAGYASHRI RAJOPADHYE[1]*, SONALI PALKAR[2], VASUNDHARA LONDHE[1]

[1]Department of Pharmacology, Bharati Vidyapeeth (Deemed University) Medical College, Pune, Maharashtra, India. [2]Department of Community Medicine, Bharati Vidyapeeth (Deemed University) Medical College, Pune, Pune, Maharashtra, India.
***Corresponding author: Bhagyashri Rajopadhye; Email: bhagyashree.rajopadhye@bharatividyapeeth.edu**

Received: 05 October 2025, Revised and Accepted: 22 November 2025

ABSTRACT

Objectives: The objective of this study was to assess trends in antimicrobial prescribing pattern in a tertiary care teaching hospital as a foundational step toward establishing an effective antimicrobial stewardship program.

Methods: A retrospective observational study was conducted at a tertiary care hospital involving patients admitted to the medicine ward and intensive care unit (ICU) from October to December 2019. Inclusion criteria comprised patients who received at least one antimicrobial agent (AMA). Data were collected from hospital records using a validated data collection tool that had been previously piloted for accuracy.

Results: We screened 1066 patients, including 324 (30.4%) patients for whom the rationality of the selection of AMAs was assessed. Only 53.3% of prescriptions were rational, per the hospital antimicrobial policy. Of the total prescriptions, 61.2% of AMAs were prescribed empirically, 31.5% definitively, and 7.3% prophylactically. The range of antibiotics prescribed per patient was 1–4. Although crucial, culture sensitivity testing was performed for 43.3% of ICU patients and 37.9% of medicine ward patients, resulting in an overall testing rate of 38.9% among patients.

Conclusion: The implementation of ASP is crucial in combating drug resistance; however, before its implementation, an audit, as conducted here, is essential to identify areas for improvement in antimicrobial prescribing practices. Our findings highlight the need to prioritize culture and sensitivity testing and to ensure adherence to the hospital's antimicrobial policy through continued education and training for prescribers.

Keywords: Anti-microbial agent, Antimicrobial stewardship program, Anti-microbial resistance.

 DOI: http://dx.doi.org/10.22159/ajpcr.2026v19i1.57181. Journal homepage: https://innovareacademics.in/journals/index.php/ajpcr

INTRODUCTION

The introduction of antibiotics marked a breakthrough in modern medicine, offering strong protection against bacterial diseases and significantly reducing morbidity and mortality in many populations [1]. Between 2000 and 2010, antibiotic consumption in 71 countries increased by 36%, with Brazil, Russia, India, China, and South Africa accounting for three-quarters of this increase [2]. In India, the prevalence of antibiotic use is 24–67% of the total antibiotics produced [3]. Antibiotics are the mostcommonly used and misused medications by patients and prescribers [4]. Excessive, inappropriate, andunnecessary use of antibiotics is the main reason for antibiotic resistance [5].

Antibiotics have indeed proven to be lifesaving, but their usefulness is surely under threat due to the universal increase in antibiotic resistance, which is a serious global health challenge [6]. Alexander fleming had this problem in mind when he cautioned against the overuse of these agents and anticipated the problem of resistance more than 70 years ago. According to the center for disease control and prevention, more than 2 million people are infected with antibiotic-resistant organisms, resulting in approximately 23,000 deaths annually. Excessive, inappropriate, and unnecessary use of antibiotics is the main reason for antibiotic resistance [7].

Realizing the threat of antimicrobial agent (AMA) resistance, from 2017 to 2021, India is implementing the National Action Plan on Antimicrobial Resistance to control it and to improve antibiotic use by doctors, consumers, and healthcare institutions [8]. The regulatory bodies in India recently introduced Schedule H1 under the existing drugs and cosmetics act of 1945 to restrict the irrational prescribing of antibiotics [9].

The antimicrobial stewardship program (AMSP), which ensures careful and responsible management of antibiotics, is one of the most powerful tools for ensuring rational AMA usage and preventing antimicrobial resistance [10]. The necessity for such a program is, fortunately, becoming more universally acknowledged, particularly at tertiary care facilities, with several of them already implementing it [11,12]. Knowledge about antibiotic utilization patterns is necessary for a constructive approach to the problems that arise from multiple usages of antibiotics [13]. Hence, the present study was planned to understand the prescribing pattern at a tertiary care teaching hospital as a prelude to the initiation of the antibiotic stewardship program.

METHODS

This retrospective observational study was conducted at a tertiary care teaching hospital in Pune, following approval from the Institutional Ethics Committee (BVDUMC/IEC/30 dated May 14, 2019).

The pilot study conducted in the same institute observed 42% of irrational antimicrobial prescriptions [14]. With 13% of error and a 95% confidence interval, the estimated sample size was 309. Considering some loss of information, 324 antimicrobial prescriptions were included in the study.

Inclusion criteria

All patients admitted to medicine ward or intensive care unit (ICU) who received at least one AMA during October 2019–December 2019.

Exclusion criteria
Patients with incomplete medical records were excluded.

Hospital records of 1066 patients were screened to include 324 patients being prescribed antibiotics. Patient data were collected from the hospital records obtained from the medical record department.

An "AMA record form" with the following components was prepared for data collection. A pilot study was conducted to see the feasibility and validation of the data collection form. The data collection form was modified according to the observations and conclusions from the pilot study [14].

The data collection form included patient demographics and diagnostic details. Details about AMA administered with dose, method, and duration; cause for starting AMA (empirically/definitively) were captured. Information about the investigations necessary for confirming the diagnosis and assessing the rationality of AMA use, such as X-ray of the chest, total leucocyte count (TLC), procalcitonin, C-reactive protein (CRP), and culture sensitivity report details, if sent, was noted. The presence of an implant, central line, or catheter, comorbidities, hemodynamic instability, or mechanical ventilationwas considered as an additional factor for justifying the need for AMAs.

Institutional standards for using AMAs had already been developed as a prelude to the start of the ASP, and the hospital antibiotic policy (HAP) had already been formulated. These parameters were used to assess the appropriateness of prescribed AMAs. Antibiotic selection was considered appropriate (rational) if it was in accordance with HAP. Adherence to HAP was also used to evaluate the rationality of AMA dosage, method, duration, and frequency of administration. The change in AMA after the culture and sensitivity report, if any, was also evaluated.

The HAP was developed in consultation with the department of microbiology and the hospital infection control committee. It recommends the use of narrow-spectrum agents as first-line therapy whenever appropriate, based on local antibiogram data. The policy specifies preferred first-choice drugs for common syndromes (e.g., ceftriaxone or amoxicillin-clavulanic acid for community-acquired respiratory infections; piperacillin-tazobactam for severe hospital-acquired infections) and restricts the use of high-end agents such as carbapenems and linezolid to culture-confirmed, resistant infections or on infectious disease consultation. The policy also emphasizes de-escalation based on culture resultsand limits empirical therapy duration to 72 h unless justified clinically [15].

Analysis of data
The data were analyzed using the Statistical Package for Social Sciences software ver. 25.0.

Descriptive statistics were expressed as mean±standard deviation for continuous variables and frequencies/percentages for categorical data. Chi-square tests were applied to compare proportions (e.g., culture sensitivity testing rates and rationality between ICU and ward patients). "$p<0.05$ was considered statistically significant."

RESULTS

Demographic details
A total of 1066 patients were screened for the study, of which 324 (30.4%) received at least one antibiotic, 60 from the ICU, and 264 from the medicine ward. The rate of antimicrobial prescription was higher (89.6%) for ICU patients compared to the ward (26.4%). Among the 324 patients, the male-to-female ratio was 1.45:1 (Table 1).

In the present study, the rate of performing culture sensitivity testing before antimicrobial prescription was 43.3% among ICU patients and 37.9% among patients in the medicine ward. A statistical comparison using the Chi-square test of independence revealed that this difference was not statistically significant (p=0.525). This indicates that the likelihood of conducting culture sensitivity testing was comparable between the two hospital settings (Table 2).

AMA selection pattern
A total of 492 AMAs were prescribed for 324 patients. Of these, 61.2% were prescribed empirically, 31.5% definitively, and 7.3% prophylactically (Table 3).

Number of AMAs prescribed per patient
The range of antibiotics prescribed per patient was 1–4, with an average of 1.7.

One-third of patients (36.7%) received one antibiotic, 42.3% received two antibiotics, 17.4% received three antibiotics, and 3.6% of patients received four antibiotics.

Assessment of rationality
When the rationality of the selection of AMAs was assessed considering adherence to HAP, only half of the prescriptions (53.3%) were found to be rational, 42.7% were irrational, while for 4% rationality could not be assessed due to inadequate information. Rationality for AMA prescription was similar for ICU and medical ward patients (52.4% and 48.8% respectively). Applying the Chi-square test for proportions, p=0.6. Since p=0.61>0.05, there is no statistically significant difference in the rationality of AMA prescriptions between ICU and medical ward patients.

Ceftriaxone is by far the most commonly prescribed antibiotic, accounting for 40% of all AMAs. This high use, especially if empirical and not guided by culture reports, raises concerns about overuse and potential resistance. Macrolides and broad-spectrum beta-lactams are also common.

Azithromycin (13%) and amoxicillin-clavulanic acid (11%) are also frequently prescribed, likely reflecting treatment of community-acquired respiratory and soft-tissue infections.

Table 1: Gender distribution of the population screened for sample collection

Antibiotic given	ICU		Medicine		Total
	Yes	No	Yes	No	
Male	39	05	153	418	615
Female	21	02	111	317	451
Total	60	07	264	735	1066

ICU: Intensive care unit

Table 2: Culture sensitivity of the patients who received antibiotics

Place of admission	Culture sensitivity		
	No (%)	Yes (%)	Total (%)
ICU	34 (56.7)	26 (43.3)	60 (100.0)
Medicine ward	164 (62.1)	100 (37.9)	264 (100.0)
Total	198 (61.1)	126 (38.9)	324 (100.0)

ICU: Intensive care unit

Table 3: AMA selection pattern in the patients who received antibiotics

Definitive/empirical/prophylaxis				
Place of admission	Definitive *n* (%)	Empirical *n* (%)	Prophylaxis *n* (%)	Total *n* (%)
ICU	30 (35.7)	52 (61.9)	2 (2.4)	84 (100.0)
Medicine	125 (30.7)	249 (61.0)	34 (8.3)	408 (100.0)
Grand total	155 (31.5)	301 (61.2)	36 (7.3)	492 (100.0)

ICU: Intensive care unit, AMA: Antimicrobial agent

Piperacillin-tazobactam (10%) and carbapenems/linezolid (4%) are high-end or reserve antibiotics. Their relatively high use may indicate inappropriate escalation, particularly if not supported by culture-sensitive results. Metronidazole (10%) is commonly used, likely for anaerobic or mixed infections. Quinolones and other cephalosporins (each 6%) show moderate usage but are still notable due to known associations with resistance and side effects. Other AMAs (2%) category may include antifungals, antivirals, or less commonly used antibiotics and suggest a diverse spectrum of prescribing in limited cases.

The analysis of allied clinical parameters revealed significant differences in infection risk factors between ICU and medicine ward patients, impacting antimicrobial prescribing patterns (Table 5):

Presence of implant

Implants were present in 75% of ICU patients compared to 25% in the ward, significantly increasing the risk of device-associated infections and influencing the initiation of prophylactic or empirical AMAs.

Comorbidities

A higher proportion of ICU patients (71.66%) had comorbid conditions versus 28.33% in the ward, reflecting a greater vulnerability to infections and the need for prompt antimicrobial therapy.

Hemodynamic instability

This condition was observed in 54.28% of ICU and 45.71% of ward patients, often warranting early empirical therapy due to the potential for sepsis or systemic infection.

Central line presence

Detected in 62.83% of ICU patients and 37.16% in the ward, central lines are a known risk factor for bloodstream infections, justifying vigilant antimicrobial initiation and monitoring.

Catheter use

Reported in 55.73% of ICU and 44.26% of ward patients, catheter-associated infections remain a significant concern and often trigger the use of antimicrobials.

These findings emphasize the need for targeted antimicrobial stewardship interventions, particularly in ICU settings, where the prevalence of high-risk factors is greater. Rational use of AMAs in these patients should be guided by timely culture testing, clinical judgment, and strict adherence to the hospital's antimicrobial policy.

Infections treated with the AMAs

The most common infections for which AMAs were used were acute enteritis, gastritis, acute hepatitis, catheter-related infections, upper respiratory tract infections, lower respiratory tract infections, urinary tract infections, and pneumonia.

AMAs were used as prophylactic therapy in colonoscopy, endoscopy, gastroscopy, and cystoscopy.

Drug interactions and compatibility

No drug interactions, as well as physical or chemical incompatibility, were observed among the antibiotics prescribed.

Length of stay

The hospitalization period ranged from 1 to 23 days, with an average length of stay of 5.7 days.

DISCUSSION

Antibiotic resistance is a global issue and rational use of AMAs is the key point. Ensuring the appropriate and effective use of medications (AMAs) requires ongoing drug utilization studies [16].

Following a pilot study, a larger investigation with an adequate sample size was conducted at a tertiary care center as a prelude to the initiation of an antimicrobial stewardship program. At this tertiary care teaching hospital, nearly one-third of admitted patients received at least one AMA, which was subsequently evaluated for rationality. A total of 492 AMAs were prescribed, of which 61.2% (301) were prescribed empirically, 31.5% (155) definitively, and 7.3% (36) prophylactically. The assessment of rationality took into account various factors, including the selection of AMAs, adherence to the hospital's antibiotic policy, culture sensitivity reports, presence of comorbidities, implants, and central lines, and other investigations supporting the need for AMAs.

The appropriateness of the chosen treatment was found to be only 53.7% among the patients studied. This finding indicates that nearly half of the patients did not receive AMAs as per the HAP. In research conducted by Rajalingam *et al*., which included patients from the general medicine and pulmonary departments of tertiary care hospitals, the rationality of antibiotic prescriptions was assessed using guidelines prepared by Micromedex and NFI 2011 [17]. They observed that 60.1% of the antibiotic medications administered were appropriate according to the indications. In a multi-center study through the Global Point Prevalence Survey by Singh *et al*., it was observed that 77.4% of prescriptions complied with the guidelines [18]. In our study, the rationality was slightly higher (52.4%) in ICU patients than in the medicine ward (48.8%). This difference may be attributed to the fact that ICU patients often have multiple comorbid conditions and complications, making the use of antibiotics necessary.

The culture sensitivity test is a crucial factor for initiating, de-escalating, or modifying AMAs. In our study, culture sensitivity tests were conducted for only 38.9% of the patients, more so in ICU patients (43.3%) compared to the medicine ward (34%). Khavane *et al*. conducted a study on the prescribing patterns of antibiotics and the sensitivity patterns of microorganisms toward different antibiotics, revealing that information on antibiotic use and resistance patterns of common microorganisms is lacking in hospitals in India [19]. In addition, a study by Rathinavelu *et al*., conducted in a secondary care referral hospital in India, highlighted the deficiency of culture sensitivity testing when prescribing AMAs and emphasized the necessity for such testing [20]. In the study by Rajalingam *et al*., out of 200 patients, only 37 (18.5%) did their sensitivity tests. Ideally, according to the National Treatment Guidelines for Antimicrobial Use in Infectious Diseases, the appropriate sample should be sent for culture sensitivity testing before prescribing the AMAs [17]. However, the studies mentioned above observed that this practice is often lacking. Instead, antimicrobials are primarily prescribed empirically. The main reasons for not performing the test are the time required for the report, cost and availability of laboratory facilities, especially in rural areas. Therefore, there is a need to cultivate the habit of sending samples for culture sensitivity testing before prescribing AMAs for admitted patients [21].

We could not assess the rationality of 4% of prescriptions due to a lack of adequate information for the diagnosis or initiation or termination of antibiotics. In the pilot study, non-accessibility was 18%. This study supersedes the pilot study as we have included the additional supportive parameters (Fig. 1) in deciding rationality. That could be the reason why we could analyze more prescriptions compared to a pilot study.

At times, AMA prescription audits were conducted; however, the authors did not comment on rationality [22]. A study on ICU patients reported that 72.2% of patients were started on broad-spectrum antibiotics on admission. Among these patients, 22.4% received an incorrect dosage, and 62% did not complete their prescribed treatment course [23]. A tertiary care hospital from India reported that the overall appropriateness of antibiotics was 57.85%; however, on examining specific aspects, the appropriateness rates were 60.61% for indication, 55.38% for duration, 59.07% for dose, and 56.31% for frequency [24].

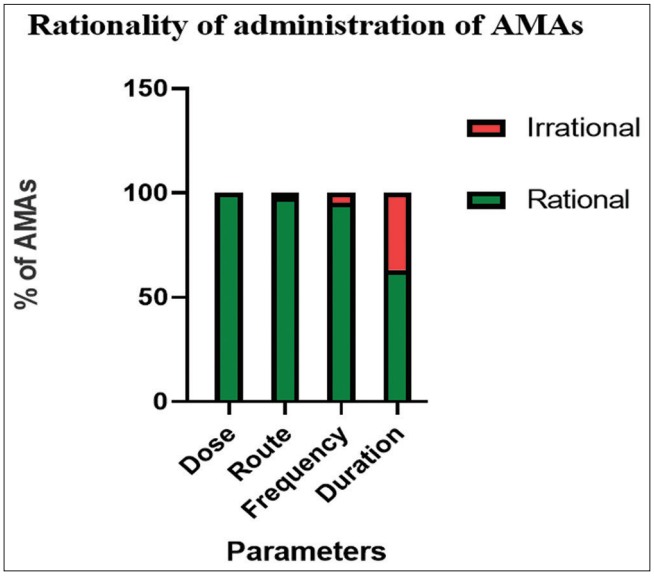

Fig. 1: Assessment of rationality in antimicrobial agent administration based on prescription parameters

Overall, 7.3% of AMAs were used prophylactically. In the global point prevalence survey, prophylactic use was 28.7, while in the European Surveillance of Antimicrobial Consumption, it was 6.7%.

During this period, 492 AMAs were prescribed. Among the AMAs, ceftriaxone was found to be prescribed for the largest number (40%), followed by azithromycin (13%) and metronidazole (10%) (Table 4). These observations are consistent with the study results of Rajalingam *et al*., who reported that the private tertiary care teaching hospital at Coimbatore used ceftriaxone most commonly, although in a much lesser percentage (15.4%) than ours [17]. The wide spectrum of action and fewer adverse effects were considered probable reasons for its excessive use. Itsexcessive use may be alarming due to its contribution to antimicrobial resistance [25].

The cephalosporin group was the most commonly prescribed group, as reported by Jokandan and Jha, although it was prescribed in only 22% of cases [26]. Similar results were observed about cephalosporins by Remesh *et al*. at the tertiary care hospital at Trivandrum [13].

Amoxicillin-clavulanic acid (10%) and piperacillin-tazobactam (10%) were determined to be the most frequently prescribed fixed-dose combinations (FDCs) in our study. Cefepime-tazobactum (14.6%) and piperacillin-tazobactum (14.7%) were the commonly prescribed FDCs in the study conducted by Rajalingam *et al*. [17] and amoxicillin-clavulanic acid was a commonly prescribed FDC (11%) in the survey conducted by Bade *et al*. [27]. Manyauthors had reported that penicillin with beta-lactamase inhibitors (24%) was the most commonly prescribed FDC. This could be because these antibiotics are effective against extended-spectrum beta-lactamase producing Gram-negative organisms that are endemic in our country [28]. In the present study, high-end antibiotics such as linezolid, meropenem, and carbapenem were used minimally (4%) in ICU patients with comorbidities and complications.

Comorbidities are also a crucial compounding factor in deciding the need for AMAs. Fifty percentages of ICU patients and 35.6% of medicine ward patients had comorbidities in terms of diabetes mellitus, hypertension, chronic kidney disease, liver disease, chronic obstructive pulmonary disease, asthma, etc. Remesh *et al*. also considered patients' comorbidities and reported that 39% of patients had comorbidities [13].

Data collection is an essential task in antibiotic stewardship [29].

Table 4: Commonly prescribed AMAs in the tertiary care hospital

Antimicrobial agents	No. of cases	*n* (%)
Ceftriaxone	196	40
Other cephalosporins	30	06
Amoxicillin-clavulanic acid	54	11
Azithromycin	62	13
Piperacillin-tazobactum	50	10
Feropenum, meropemun, and linid	20	04
Metronidazole	50	10
Quinolones	30	6
Other AMAs	9	2

AMA: Antimicrobial agent

Table 5: Allied parameters of ICU and medicine ward patientswho received antibiotics

Parameter	ICU *n* (%)	Medicine ward *n* (%)	Total *n* (%)
Presence of implant	45 (75.0)	15 (25.0)	60 (100.0)
Comorbidities	43 (71.7)	17 (28.3)	60 (100.0)
Hemodynamic instability	38 (54.3)	32 (45.7)	70 (100.0)
Central line presence	44 (62.8)	26 (37.2)	70 (100.0)
Catheter use	39 (55.7)	31 (44.3)	70 (100.0)

ICU: Intensive care unit

While considering the need for AMAs, other factors must be taken into account, especially for patients admitted to the ICU, such as whether the patient was on a ventilator, had a central line, catheter, implants, or comorbidities. Similarly, laboratory and radiological investigations also need to be considered. Sepsis-related laboratory investigations such as TLC, neutrophilia, presence of toxic granules on hemogram, raised CRP, or procalcitonin suggest sepsis and the physicians consider initiating the AMAs. In our pilot study, determining the AMA's rationality became challenging due to the inadequate information available on these parameters. Therefore, we have included them in the present study to assess their rationality. During the pilot study, we encountered lapses in the data collection system. As a result, we modified the data collection form to include several relevant parameters, creating a strong foundation for the upcoming antibiotic stewardship program.

CONCLUSION

This study revealed a significant gap in the rationality of AMA prescription practices. It is essential to conduct culture sensitivity tests to justify the need for antibiotics, which subsequently also guides the escalation or de-escalation of the AMAs. Establishing an antibiotic stewardship program, a coordinated initiative promoting the appropriate use of AMAs, is necessary. Selecting an appropriate AMA is a grey area that requires intervention through training for prescribers. The AMSP team can take the lead in such training programs. Antimicrobial prescription audits should be periodically conducted as a part of the AMSP program to monitor the rational use of AMAs, which will eventually help in reducing antimicrobial resistance.

AUTHORS' CONTRIBUTIONS

Dr. Bhagyashri Rajopadhye (BR): Correspondence; conceptualization; literature search; data curation; tables/figures; formal analysis; and writing original draft. Dr. Sonali Palkar (SP): Methodology; data verification; and review and editing. Dr. Vasundhara Londhe (VL): Tables/figures; and review and editing.

ACKNOWLEDGMENT

Declared none.

CONFLICTS OF INTEREST

None.

REFERENCES

1. CDC. Core Elements of Hospital Antibiotic Stewardship Programs. Atlanta: US Department of Health and Human Services, CDC; 2019. Available from: https://www.cdc.gov/antibiotic-use/core-elements/hospital.html
2. Laxminarayan R, Matsoso P, Pant S, Brower C, Røttingen JA, Klugman K, *et al*. Access to effective antimicrobials: A worldwide challenge. Lancet. 2016;387(10014):168-75. doi: 10.1016/S0140-6736(15)00474-2, PMID 26603918
3. Vanitha M, Vineela M, Kumar PB, Sandeep P. Prescribing pattern of antibiotics in patients attending ENT OPD in a tertiary care hospital. ISOR J Dent Med Sci. 2017;16(9):30-3.
4. Chambers HF. General principles of antimicrobial therapy. In: Brunton LL, Lazo JS, Parker KL, editors. Goodman and Gillman's: The Pharmacological Basis of Therapeutics. 11th ed. New York: McGraw-Hill Press; 2006. p. 1095-110.
5. Adiveni T, Chandra DS, Sundresh NJ, Kumar BA, Padmini P, Haritha K. Analysing the rationality of antibiotics in comparing the different departments in Rmmch. J Biomed Pharm Res. 2013;2(3):74-6.
6. Alanis AJ. Resistance to antibiotics: Are we in the post-antibiotic era? Arch Med Res. 2005;36(6):697-705. doi: 10.1016/j.arcmed.2005.06.009, PMID 16216651
7. Ganguly NK, Arora NK, Chandy SJ, Fairoze MN, Gill JP, Gupta U, *et al*. Rationalizing antibiotic use to limit antibiotic resistance in India. Indian J Med Res. 2011 Sep;134(3):281-94. PMID 21985810
8. World Health Organization, Ministry of Health and Family Welfare. National Action Plan on Antimicrobial Resistance (NAP-AMR) 2017-2021. Switzerland: World Health Organization; 2017. p. 1-57.
9. Ahmad A, Patel I. Schedule H1: Is it a solution to curve antimicrobial misuse in India? Ann Med Health Sci Res. 2013 Nov;3:55-6.
10. DiazGranados CA. Prospective audit for antimicrobial stewardship in intensive care: Impact on resistance and clinical outcomes. Am J Infect Control. 2012 Aug;40(6):526-9. doi: 10.1016/j.ajic.2011.07.011, PMID 21937145
11. Lee CF, Cowling BJ, Feng S, Aso H, Wu P, Fukuda K, *et al*. Impact of antibiotic stewardship programmes in Asia: A systematic review and meta-analysis. J Antimicrob Chemother. 2018;73(4):844-51. doi: 10.1093/jac/dkx492, PMID 29340609
12. Singh S, Menon VP, Mohamed ZU, Kumar VA, Nampoothiri V, Sudhir S, *et al*. Implementation and impact of an antimicrobial stewardship program at a tertiary Care Center in South India. Open Forum Infect Dis. 2019 Apr;6(4):ofy290. doi: 10.1093/ofid/ofy290, PMID 31024967
13. Remesh A, Salim S, Gayathri AM, Nair U, Retnavally KG. Antibiotics prescribing pattern in the in-patient departments of a tertiary care hospital. Arch Pharma Pract. 2013;4(2):71-6. doi: 10.4103/2045-080X.112987.
14. Tolpadi A, Purandare B, Shah J, Iyer S, editors. Antibiotic Policy. 3rd ed. Pune, India: Bharati Hospital and Research Centre; 2017. p. 1-52.
15. Littmann J, Viens AM. The ethical significance of antimicrobial resistance. Public Health Ethics. 2015 Nov 1;8(3):209-24. doi: 10.1093/phe/phv025, PMID 26566395
16. Rajopadhye BD, Palkar SH, Pandit VA, Dhande PP, Kumar M, Lalwani SK. Antimicrobial prescribing pattern in a tertiary care teaching hospital: A pilot study. Int J Basic Clin Pharmacol. 2020;9(3):465-9. doi: 10.18203/2319-2003.ijbcp20200723
17. Rajalingam B, Susan Alex A, Godwin A, Cherian C, Cyriac C. Assessment of rational use of antibiotics in a private tertiary care teaching hospital. Indian J Pharm Pract. 2016;9(1):14-8. doi: 10.5530/ijopp.9.1.4
18. Singh SK, Sengupta S, Antony R, Bhattacharya S, Mukhopadhyay C, Ramasubramanian V, *et al*. Variations in antibiotic use across India: Multi-centre study through Global Point Prevalence survey. J Hosp Infect. 2019 Nov 1;103(3):280-3. doi: 10.1016/j.jhin.2019.05.014, PMID 31170422
19. Khavane K, Addepalli V, Bhusare K, Payghan SA, Patweakar S, Kate V. Prescribing patterns of antibiotics and sensitivity patterns of microorganisms towards different antibiotics in multidisipinary health care hospital. Int J Pharm Biol Arch. 2010;1(2):115-22.
20. Rathinavelu M, Satyagama S, Reddy R, Reddy YP. Drug use evaluation of antimicrobials in healthcare resource limited settings of India. Indian J Pharm Pract. 2015;8(4):191-5.
21. Vachhani PK, Singh AP. A prospective study of the impact of microbiological cultures on antibiotic prescribing pattern in a tertiary care hospital. Int J Pharm Pharm Sci. 2021;13(3):26-9. doi: 10.22159/ijpps.2021v13i3.40341
22. Al-Yamani A, Khamis F, Al-Zakwani I, Al-Noomani H, Al-Noomani J, Al-Abri S. Patterns of antimicrobial prescribing in a tertiary care hospital in Oman. Oman Med J. 2016 Jan;31(1):35-9. doi: 10.5001/omj.2016.07, PMID 26816567
23. Kumari A, Goyal J, Chandalia S, Rustage K, Attri R, Gupta B. Evaluation of rational use of antibiotics in intensive care unit of a tertiary care hospital in north India. MedPlus Int J Pharmacol. 2019 Aug;11(2):21-4. doi: 10.26611/10101122
24. Sonawane RC, Mahajan HM. A prospective observational study on usage of antibiotics in a tertiary care hospital of Northwest Maharashtra. Int J Curr Pharm Rev Res. 2025;17(8):796-9.
25. Ayele AA, Gebresillassie BM, Erku DA, Gebreyohannes EA, Demssie DG, Mersha AG, *et al*. Prospective evaluation of ceftriaxone use in medical and emergency wards of Gondar university referral hospital, Ethiopia. Pharmacol Res Perspect. 2018 Feb;6(1):e00383. doi: 10.1002/prp2.383, PMID 29417764
26. Jokandan SS, Jha DK. A study of prescribing pattern of antibiotics in a tertiary care hospital - an observational study. Int J Pharm Sci Res. 2019;10(5):2285-89.
27. Bade D, Shivashankaramurthy KG, Kiran LJ, Raghuprasada MS, Harishkumar VS, Pradeep AN. A cross sectional study on prescription pattern of drugs in upper respiratory tract infections in a tertiary care hospital. Int J Basic Clin Pharmacol. 2020;9(2):271-5. doi: 10.18203/2319-2003.ijbcp20200175.
28. Zarb P, Goossens H. European surveillance of antimicrobial consumption (ESAC): Value of a point-prevalence survey of antimicrobial use across Europe. Drugs. 2011;71(6):745-55. doi: 10.2165/11591180-000000000-00000, PMID 21504250
29. Karuniawati HI, Yulianti T, Aini DK, Nurwienda FI. Impact of antimicrobial stewardship program on the use of antibiotics in pneumonia patients at teaching hospital in Surakarta Indonesia. Int J Appl Pharm. 2021;13(1):20-3. doi: 10.22159/ijap.2021.v13s1.Y0067