



Received on 04 June 2025; received in revised form, 26 June 2025; accepted, 02 July 2025; published 01 December 2025

DRUG UTILIZATION PATTERN OF ANTIMICROBIALS IN MEDICAL INTENSIVE CARE UNIT

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Keywords:

Drug utilization study, Antimicrobial use, Intensive care unit, Adverse drug reactions, Rational prescribing, Antibiotic resistance

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ABSTRACT: Background: Drug utilization studies (DUS) assess the marketing, distribution, prescription, and use of drugs, emphasizing their medical, social, and economic impacts. In intensive care units (ICUs), rational drug use is essential due to the complexity of treatment and the risk of antimicrobial resistance. **Aim:** This study analyzes antimicrobial utilization patterns in the Medical ICU. **Methods:** A cross-sectional, quantitative observational study was conducted at the Medical ICU of Jawahar Lal Nehru Medical College, Ajmer, from November 2022 to December 2023. The study included 400 patients aged ≥ 18 years. Data on demographics, comorbidities, drug prescriptions, and adverse drug reactions (ADRs) were collected. The WHO Anatomical Therapeutic Chemical/Defined Daily Dose (ATC/DDD) methodology was used for drug classification and consumption analysis. **Results:** The most common age group was 61-75 years (26%), with a male predominance (58%). Hypertension (29.75%) and diabetes (23.75%) were the most prevalent comorbidities. Ceftriaxone (55.25%) was the most frequently prescribed antimicrobial, followed by Piperacillin + Tazobactam (19.25%). ADRs were observed in 44 cases (11%), with thrombophlebitis being the most common (8%). Antimicrobials were prescribed prophylactically in 61.55% of cases, empirically in 28.13%, and definitively in 10.30%. **Conclusion:** The study highlights the widespread use of antimicrobials in ICU settings, with a significant proportion of prophylactic prescriptions. Regular drug utilization reviews and adherence to antimicrobial stewardship guidelines are necessary to optimize prescribing practices, reduce ADRs, and combat antibiotic resistance.

INTRODUCTION: Drug utilization studies (DUS) have been defined by the World Health Organization (WHO) as the marketing, distribution, prescription, and use of drugs in society, emphasizing their medical, social, and economic consequences¹.

These studies are particularly crucial in developing countries where healthcare resources are limited, necessitating rational drug use to optimize patient outcomes. Rational prescribing ensures appropriate drug selection, dosage, duration, and cost-effectiveness.

Conversely, irrational prescribing such as over prescription, under prescription, or inappropriate medication use can lead to antibiotic resistance, adverse drug reactions (ADRs), increased healthcare costs, and inefficient resource utilization. The WHO defines ADRs as noxious and unintended responses occurring at therapeutic

QUICK RESPONSE CODE 	DOI: 10.13040/IJPSR.0975-8232.16(12).3410-16 This article can be accessed online on www.ijpsr.com DOI link: https://doi.org/10.13040/IJPSR.0975-8232.16(12).3410-16
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doses. ADRs are a significant cause of iatrogenic diseases, leading to hospital admissions, prolonged stays, increased healthcare costs, disability, and even death. Annually, over 2 million serious ADRs occur, with 350,000 cases in nursing homes alone². ADRs account for one-third of hospital adverse events and approximately 280,000 hospital admissions per year, prolonging hospital stays by 1.7 to 4.6 days³.

DUS interest has grown due to the increasing number of new drugs, variations in prescribing patterns, delayed adverse effects, and rising drug costs⁴. The primary goal of DUS is to promote rational drug use by understanding prescribing habits and optimizing pharmaceutical care. Pharmacists play a key role in this process.

Medical ICU patients often suffer from multiple organ dysfunctions and require close monitoring. The selection of appropriate drug therapy in critical care is complex. Antimicrobials, frequently prescribed in ICUs, are prone to misuse, contributing to antibiotic resistance⁵. Implementing guidelines and monitoring antimicrobial use can enhance patient outcomes.

Medical audits help assess drug use patterns, prescriber behavior, and polypharmacy-related risks. DUS, a key component of pharmaco-epidemiology, provides insights into prescribing practices, drug quality, and outcomes. Rational drug prescribing aims for optimal therapeutic effects with minimal risk and cost, whereas irrational prescribing leads to ineffective treatments⁶.

The WHO Anatomical Therapeutic Chemical/Defined Daily Dose (ATC/DDD) methodology standardizes drug classification and consumption analysis. The Defined Daily Dose (DDD) facilitates global drug utilization comparisons, aiding policymakers in optimizing prescribing practices. However, discrepancies between DDD and prescribed daily dose (PDD) exist⁷.

In ICUs, empirical prescribing often lacks quantitative precision, leading to suboptimal antibiotic use.⁸ Conducting DUS in ICUs is essential to develop rational antibiotic prescription policies, curb antibiotic overuse, and improve patient care. This study aims to analyze

antimicrobial utilization patterns in the medical ICU.

MATERIAL AND METHOD: The present cross-sectional quantitative observational study was conducted at the Medical Intensive Care Unit of Jawahar Lal Nehru Medical College and associated hospitals, Ajmer (Rajasthan), from November 2022 to December 2023. Ethical approval was obtained from the institutional ethics committee. The sample size was calculated at a 95% confidence level, assuming 50% male patients with a 5% absolute allowable error, resulting in a required sample size of 384, sufficient to address all study objectives.

Inclusion Criteria: The study included all male and female patients above 18 years admitted to the Medical ICU and those willing to provide informed consent.

Exclusion Criteria: Patients or their relatives who refused consent, as well as those with incomplete data or an ICU stay of less than 24 hours, were excluded.

Study Instruments: The study utilized a standard socio-demographic data collection form, patient consent forms, the MNDY drug list, WHO core drug use indicator guidelines, and the WHO ATC classification and DDD metric system.

Data Collection: After obtaining consent, socio-demographic and clinical data, including age, gender, occupation, IPD/OPD number, diagnosis, medical history, treatment details, adverse drug reactions, investigations, and patient knowledge of drug use, were recorded. Data were collected directly from patients or their relatives.

Defined Daily Dose (DDD) Calculation: The DDD represents the assumed average maintenance dose per day for a drug's main indication in adults. Each drug was classified based on the ATC system, and DDD was calculated using the formula:

Total dose in mg in selected patients $\times \frac{100}{\text{DDD per 100 bed days}}$

RESULT AND DISCUSSION: In our study, the most common age group in MICU was 61-75 years

(26%). Among 400 patients, 232 (58%) were male and 168 (42%) female (M:F = 1:0.72). Age distribution was 18-30 years (19%), 31-45 years (24.5%), 46-60 years (19.5%), 61-75 years (26%), and >75 years (11%). Hypertension (29.75%) was

the most prevalent comorbidity, followed by diabetes (23.75%), CLD (7.5%), COPD (7.25%), CAD (6%), and hypothyroidism and CKD (2.75% each), while 43.5% had no chronic disease.

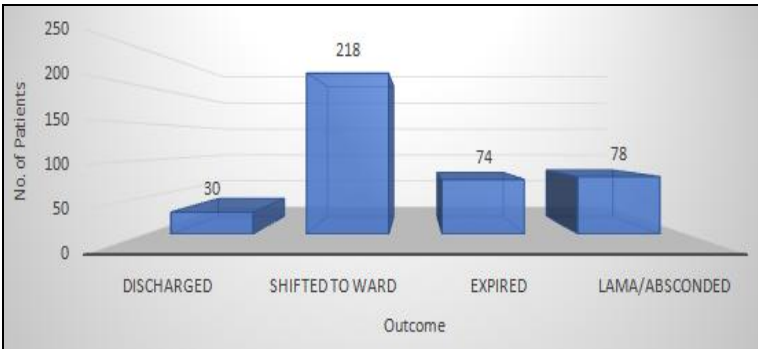


FIG. 1: DISTRIBUTION OF CASES ACCORDING TO OUTCOME

Out of 400 patients, 248 (62%) improved (discharged or shifted), 74 (18.5%) expired, and 78 (19.5%) went LAMA or absconded. The highest improvement was in the 31-45 age group (30%), while the most LAMA cases occurred in 61-75 years (32.05%). Mortality was highest in 31-45 years (25.68%). Among females, 54.17% improved, 19.64% expired, and 19.64% went LAMA, while among males, 54.74% improved, 17.67% expired, and 19.40% went LAMA. Hospital stays were mostly 1-7 days (86.25%), with a mean of 4.84 days (SD: 3.73).

TABLE 1: DISTRIBUTION OF CASES ACCORDING TO ADRs

Adverse Drug Reactions	No. of Patients	Percentage (%)
Thrombophlebitis	33	8
Diarrhoea	4	1
Nausea, Vomiting	4	1
Hypokalaemia	2	0.5
QT Prolong	1	0.25

Among the 44 adverse drug reactions (ADRs) observed, 41 were associated with antimicrobial agents (AMA). Thrombophlebitis was the most common ADR (8%), followed by diarrhea (1%), nausea and vomiting (1%).

Additionally, hypokalemia was reported in 0.5% of patients, and QT prolongation in 0.25%. The most common MICU admission indication was CNS conditions (20%), including CVA, encephalopathy, and meningitis (80 cases), followed by respiratory illnesses (16%, 62 cases), cardiovascular diseases

(14%, 56 cases), MODS (11%, 45 cases), GIT conditions (10%, 38 cases), poisoning (8%, 32 cases), DKA (7%, 29 cases), renal diseases (6%, 23 cases), snake bites (2%, 9 cases), and other conditions (7%, 26 cases).

Hypertension (30.36% females, 29.31% males) and diabetes (25% males, 22.02% females) were the most common comorbidities, followed by CAD (7.74% females), COPD (7.76% males), and CLD (9.91% males). A significant proportion had no comorbidities (46.43% females, 41.38% males).

Ceftriaxone was the most frequently prescribed antimicrobial agent (AMA), given to 221 patients (55.25%), followed by Piperacillin + Tazobactam in 77 patients (19.25%) and Cefotaxime in 35 patients (8.75%). Ciprofloxacin and Azithromycin were used in 42 (10.5%) and 52 (13%) patients, respectively. Metronidazole was administered to 63 patients (15.75%), while Artesunate was prescribed to 59 (14.75%). Doxycycline and Linezolid were given to 54 (13.5%) and 32 (8%) patients, respectively. Other AMAs included Amikacin (3.5%), Fluconazole (0.75%), and Rifampicin (2.75%), whereas Moxifloxacin, Quinine, and Artemether + Lumefantrine were not prescribed at all.

In the study, antimicrobial agents (AMA) were added to the treatment of 75 patients (18.75%), while a reduction in AMA usage was observed in 9 patients (2.25%).

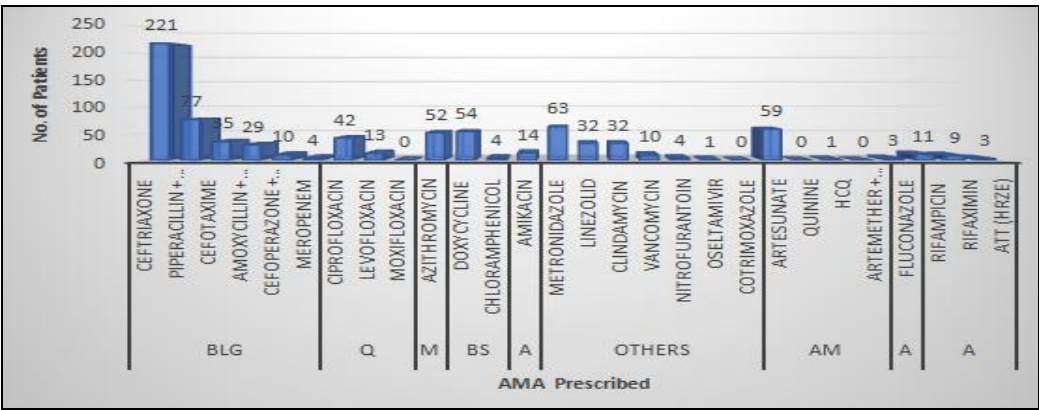


FIG. 2: DISTRIBUTION OF CASES ACCORDING TO AMA PRESCRIBED

TABLE 2: DISTRIBUTION OF TOTAL NO. OF AMA USED SYSTEM WISE IN MICU IN OUR STUDY

S. no.	Systems	No. of AMA Used	Total no of AMA Used in Study (%)n=28
1.	CNS	19	67.85%
2.	GIT	17	60.71%
3.	Respiratory illness	16	57.14%
4.	Renal Disease	13	46.42%
5.	DKA	6	21.42%
6.	Others	12	42.85%

In the study, 28 AMAs were used over one year, with the highest usage in CNS conditions (19; 67.85%), followed by GIT issues (17; 60.71%), respiratory illnesses (16; 57.14%), renal diseases (13; 46.42%), other conditions (12; 42.85%), and the least in DKA (6; 21.42%).

TABLE 3: DISTRIBUTION OF CASES ACCORDING TO SUSPECTED CAUSE OF ADR

Suspected Drugs	ADR	No. of Patients
Levofloxacin	Diarrhoea	4
Amoxicillin+ Clavulanic acid	Thrombophlebitis	8
Ceftriaxone	Thrombophlebitis	14
	Nausea, Vomiting	2
Furosemide	Hypokalaemia	2
Meropenem	Thrombophlebitis	2
Piperacillin + Tazobactam	Thrombophlebitis	8
	Nausea, Vomiting	2
Digoxin	QT Prolongation	1
Cefoperazone+Sulbactam	Thrombophlebitis	1

Thrombophlebitis was the most common ADR, associated with Ceftriaxone (14 patients), Amoxicillin + Clavulanic Acid (8), Piperacillin + Tazobactam (8), Meropenem (2), and Cefoperazone + Sulbactam (1). Levofloxacin caused diarrhea in 4 patients, while Ceftriaxone and Piperacillin + Tazobactam led to nausea and vomiting in 2 patients each. Other ADRs included hypokalemia with Furosemide (2 patients) and QT prolongation with Digoxin (1 patient). AMA selection in MICU was predominantly prophylactic (221; 61.55%), followed by empirical (101; 28.13%) and definitive treatment (37; 10.30%). Antibiotic use increased with comorbidities: 1.86 (SD = 1.33) for one, 2.23 (SD = 1.36) for two, and 2.15 (SD = 1.14) for three comorbidities.

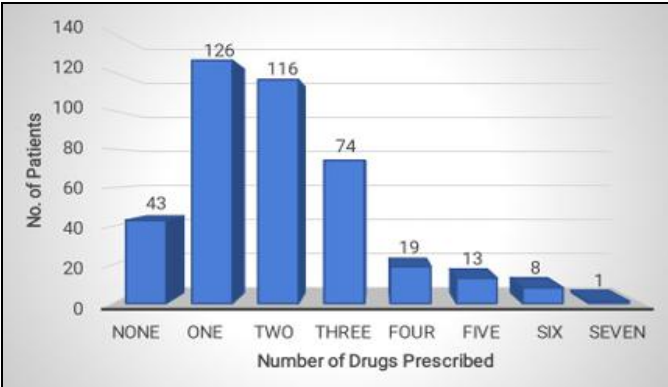


FIG. 3: DISTRIBUTION OF CASES ACCORDING TO AVERAGE NUMBER OF AMA PER PRESCRIPTION

Out of 400 patients, 43 (10.75%) received no AMA, while 357 (89.25%) were prescribed at least one. One AMA was given to 126 patients (31.5%),

two to 116 (29%), three to 74 (18.5%), four to 19 (4.75%), five to 13 (3.25%), six to 8 (2%), and seven to 1 (0.25%), with an average of 1.94 AMA (SD = 1.34). Among 359 AMA recipients, 84 (23.39%) had substitutions or additions, primarily due to culture reports (75; 20.89%), while the rest were based on clinical judgment. The most altered AMA were Piperacillin + Tazobactam (18;

21.42%), Ciprofloxacin (16; 19.04%), and Linezolid (15; 17.85%). Other changes included Doxycycline (9; 1.07%), Clindamycin (7; 8.33%), Amoxiclav (6; 0.71%), Amikacin (5; 0.59%), and a few others. Only 39 patients (5.38%) were switched from parenteral to oral AMA, while 361 (90.25%) remained on parenteral therapy.

TABLE 4: AMA USE CHARACTERISTICS

S. no.	Variable	No. of AMA Prescription (%) n=724
1.	Prescription containing injectable AMA	576 (79.5%)
2	Prescription containing AMA from EML	700 (96.6%)
3	Prescription containing Generic AMA	720(99.44%)

Out of 724 AMA used, 576 (79.5%) were administered intravenously. A majority (700; 96.6%) were from NLEM 2023, and 720 (99.44%) were prescribed by their generic names. The PDD of various AMA was compared to WHO DDD, showing variations in adherence. Metronidazole (J01XD01) had a PDD equal to its DDD (1.5 g), whereas Amikacin (J01GB06) had a lower PDD (0.84 g vs. 1 g DDD). Beta-lactam antibiotics, such as Ceftriaxone (J01DD04), had a higher PDD (2.65 g vs. 2 g DDD), and Piperacillin + Tazobactam (J01CR05) showed an even greater increase (15.06 g vs. 14 g DDD). Fluoroquinolones displayed variability, with Levofloxacin (J01MA12) having a notably higher PDD (2.2 g vs. 0.5 g DDD). While drugs like Doxycycline (J01AA02) and Chloramphenicol (J01BA01) adhered to recommended dosing, Fluconazole (J02AC01) exceeded its DDD (1.01 g vs. 0.2 g). Overall, Piperacillin + Tazobactam, Amoxicillin + Clavulanic acid, and Ceftriaxone had higher PDDs than WHO DDD, while Ciprofloxacin and Cefoperazone + Sulbactam had lower PDDs, and Linezolid and Nitrofurantoin matched WHO DDD.

DISCUSSION: The WHO defines drug utilization studies as the analysis of drug marketing, distribution, prescription, and use, emphasizing medical, social, and economic impacts. Interest in such studies has grown due to the increasing number of newly marketed drugs, variations in prescribing patterns, concerns over delayed adverse effects, and rising medication costs. ICU patients, often with multiple organ dysfunctions, require intensive monitoring and complex drug therapy. Antimicrobials are frequently prescribed in ICUs but are often misused, contributing to antibiotic

resistance, highlighting the need for proper guidelines and monitoring ⁵. Managing ICU patients with multiple comorbidities requires a balanced approach to pharmacotherapy for optimal outcomes.

In our study, 7.5% of patients were discharged, 54.5% were transferred to a ward, 18.5% expired, and 19.5% either left against medical advice (LAMA) or absconded. Khirasaria R *et al.* ⁹ reported that antimicrobial therapy effectively prevented infections in 34% of patients (n = 176), while 42% (n = 220) succumbed to other complications, and 24% were discharged against medical advice (DAMA). Their overall mortality rate of 42% was 23% higher than the 19% mortality rate reported by Vincent *et al.* ¹⁰

In our study, adverse drug reactions (ADRs) included thrombophlebitis (8%), diarrhea (1%), nausea and vomiting (1%), hypokalemia (0.5%), and QT prolongation (0.25%). Dhar K *et al.* ¹¹ reported that most ADRs related to antibiotics were classified as possible (61.9%), with fewer categorized as probable or definite. In contrast, ANN S J *et al.* ¹² found a higher incidence of probable ADRs (30.77%), potentially due to polypharmacy, which was present in 65.85% of prescriptions. Their study reported nausea (30.77%), gastritis and hypersensitivity (23.08% each), diarrhea (15.38%), and urticaria (7.69%) as common ADRs, suggesting that rational prescribing practices could help minimize ADR occurrences. In our study, Ceftriaxone was the most frequently prescribed antibiotic (55.25%), followed by Piperacillin+Tazobactam (19.25%), Metronidazole (15.75%), Artesunate (14.75%), and

Doxycycline (13.5%). Less commonly used drugs included Amikacin (3.5%), Fluconazole (0.75%), and Rifampicin (2.75%), while Moxifloxacin, Quinine, and Artemether + Lumefantrine were not prescribed. Similarly, ANN S J *et al.*¹² reported Ceftriaxone as the most used antibiotic (29.95%), followed by Metronidazole (24.06%) and Piperacillin + Tazobactam (16.58%), with other antibiotics like Vancomycin, Ciprofloxacin, and Linezolid each used in less than 3%. Nibrad *et al.*¹³ also found Cephalosporins to be the most prescribed antibiotics (65.33%), followed by Aminoglycosides (27.6%), Penicillins (17.07%), Quinolones (6.48%), and others (4.52%).

Our analysis showed Ceftriaxone caused thrombophlebitis in 14 patients and nausea/vomiting in 2, while Amoxicillin + Clavulanic acid and Piperacillin + Tazobactam each led to thrombophlebitis in 8 patients, with the latter also causing nausea/vomiting in 2. Levofloxacin was linked to diarrhea in 4 patients, Furosemide to hypokalemia in 2, Meropenem to thrombophlebitis in 2, Digoxin to QT prolongation in 1, and Cefoperazone + Sulbactam to thrombophlebitis in 1. Khirasaria R *et al.*⁹ reported similar patterns, with Piperacillin + Tazobactam causing thrombophlebitis in 10 patients, Ceftriaxone leading to thrombophlebitis and hypersensitivity in 6, Amoxicillin + Clavulanate causing thrombophlebitis in 3, Levofloxacin associated with diarrhea in 5, Metronidazole triggering severe allergic reactions in 7, and Vancomycin linked to rash in 2.

In our study, 10.75% of patients received no AMA, while 31.5% received one, 29% received two, 18.5% received three, 4.75% received four, 3.25% received five, 2% received six, and 0.25% received seven, with an average of 1.94 AMA per patient. Badar V A *et al.*¹⁴ reported an average of 7.5 drugs per ICU patient, with another study showing 12.1 ± 7.6 drugs, while Gawali U P *et al.*¹⁵ found an average of 8.0 drugs per patient, ranging from 5 to 10, indicating our findings are comparatively lower but within the reported range. In our study, 576 (79.5%) of the 724 administered antibiotics were given intravenously, 700 (96.6%) were from the National List of Essential Medicines (NLEM) 2023, and 720 (99.44%) were prescribed by their generic names. Marasine N.R. *et al.*¹⁶ reported 365

antibiotics prescribed, averaging two per patient, aligning with findings by Shankar P.R. *et al.*¹⁷ who observed a range of 1.73 to 5.1 antibiotics per patient across different regions and patient groups.

CONCLUSION: Our 12-month MICU study on AMA utilization highlights the alarming overuse and irrational prescribing of antibiotics, particularly in India, contributing to rising morbidity, mortality, and economic burden. Strict regulations are needed to curb inappropriate AMA use. The study underscores the need for local antibiograms and robust antibiotic stewardship programs, especially for ventilated patients, to optimize treatment and combat antimicrobial resistance. Encouragingly, adherence to generic prescribing and NLEM guidelines was high. These findings provide baseline data for future drug utilization studies post-implementation of hospital antibiotic policies.

ACKNOWLEDGEMENTS: Nil

CONFLICTS OF INTEREST: Nil

REFERENCES:

1. Lee D and Bergmen U: Studies of utilization. In: Strom BC, editor. Pharmacoeconomics. 1st ed. New York: Churchill Livingstone 1989; 259-73.
2. Wachter TM and Shojania KG: Internal bleeding: the truth behind american's terrifying epidemic of medical mistakes. New York: Rugged Land 2004.
3. U.S. Office of Disease Prevention and Health Promotion (ODPHP). National Action Plan for Adverse Drug Event Prevention; 2015. Available from: <http://www.health.gov/hcq/pdfs/ADE-Action-Plan-508c.pdf>.
4. Introduction to drug utilization research by World Health Organization. http://www.whocc.no/filearchive/publications/drug_utilization_research.pdf.
5. Alamchandani RR and Khubchandani PR: A study evaluating appropriateness of utilization pattern of antimicrobials in patients admitted in medical intensive care unit of tertiary care teaching rural hospital. Int J Pharm Pharm Sci 2015; 7: 101-104.
6. Gross F: Drug utilization therapy and practice. The present situation in Federal Republic of Germany. Eur J Clin Pharmacol 1981; 19: 387-394.
7. Mittal N, Mittal R, Singh I, Shafiq N and Malhotra S: Drug utilisation study in a tertiary care center: Recommendations for improving hospital drug dispensing policies. Indian J Pharm Sci 2014; 76: 308-14.
8. Williams A, Mathai AS and Phillips AS: Antibiotic prescription patterns at admission into a tertiary level intensive care unit in Northern India. J Pharm Bioallied Sci 2011; 3: 531-6.
9. Khirasaria R, Kanani N and Batta A: Utilization of antimicrobial agents in patients on ventilator in medical Intensive Care Unit at a tertiary care teaching hospital: A prospective study. Perspect Clin Res 2019; 10: 130-6.

10. Vincent JL, Rello J, Marshall J, Silva E, Anzueto A and Martin CD: International study of the prevalence and outcomes of infection in Intensive Care Units. *JAMA* 2009; 302: 2323-9.
11. Dhar K, Sinha A, Gaur P, Goel R, Chopra VS and Bajaj U: Pattern of adverse drug reactions to antibiotics commonly prescribed in department of medicine and pediatrics in a tertiary care teaching hospital, Ghaziabad. *J Appl Pharm Sci* 2015; 5(04): 78-82.
12. Ann SS, Gangadhar R and Priyanga R: Utilisation pattern, safety profile and cost analysis of antimicrobials prescribed in an intensive care unit of a teaching hospital. *J of Clinical and Diagnostic Research* 2020; 14(3): 01-05.
13. Nibrad VV, Nayak BB, Raul AR and Vijayprasad S: Drug utilization pattern in medical intensive care unit (Micu) in a tertiary care teaching hospital in rural area of Maharashtra. *IJABPT* 2015; 6(1): 148-153.
14. Badar VA and Navale SB: Study of prescribing pattern of antimicrobial agents in medicine intensive care unit of a teaching hospital in central India. *JAPI* 2012; 60: 20-23.
15. Gawali UP and Khobragade RS: Drug utilization and prescription pattern study in medicine intensive care unit at tertiary care teaching hospital. *Natl J Physiol Pharm Pharmacol* 2019; 9(7): 674-677.
16. Marasine N R, Shrestha S, Sankhi S and Paudel N: Antibiotic utilization, sensitivity, and cost in the medical intensive care unit of a tertiary care teaching hospital in Nepal. *SAGE Open Medicine* 2021; 9: 1 –7.
17. Shankar PR, Partha P, Dubey AK, Mishra P and Deshpande VY: Intensive care unit drug utilization in a teaching hospital in Nepal. *Kathmandu Univ Med J (KUMJ)* 2005; 3(2): 130-7.

How to cite this article:

Sankhla S, Rajalwal R, Verma M and Kavita: Drug utilization pattern of antimicrobials in medical intensive care unit. *Int J Pharm Sci & Res* 2025; 16(12): 3410-16. doi: 10.13040/IJPSR.0975-8232.16(12).3410-16.

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