ISSN: 2581 – 3633

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at: https://www.ijmacr.com

Volume – 9, Issue – 5, September – 2026, Page No.: 67 – 85

Analyzing Antibiotic Prescription Trends in the ICU through the WHO Aware Classification - Implications for Enhancing Antimicrobial Stewardship Programs in a Teaching Hospital in Southern India

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How to citation this article: Dr. Deepti V D, Dr. Befin K, Dr. SaiJanani K, “Analyzing Antibiotic Prescription Trends in the ICU through the WHO Aware Classification - Implications for Enhancing Antimicrobial Stewardship Programs in a Teaching Hospital in Southern India”, IJMACR– September– 2026, Volume – 9, Issue – 5, P. No. 67 – 85.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Antimicrobial resistance is a major global public health concern, and inappropriate antibiotic use in intensive care units (ICUs) contributes substantially to the emergence and spread of resistant organisms. Critically ill patients frequently require empirical broad-spectrum antibiotics; however, prolonged and inappropriate use may increase adverse effects, drug interactions, healthcare costs, and antimicrobial resistance. The World Health Organization (WHO) Aware classification provides a standardized framework for monitoring antibiotic consumption and promoting rational antimicrobial use.

Objectives: To analyse antibiotic prescription patterns among ICU patients according to the WHO Aware classification and identify potential areas for strengthening antimicrobial stewardship practices in a teaching hospital in Southern India.

Methods: A hospital-based observational study was conducted among 200 patients admitted to the ICU. Patient demographic and clinical characteristics, indications for antibiotic therapy, prescribed antibiotics, microbiological investigations, duration of therapy, dose adjustments, and antibiotic review practices were recorded. Antibiotics were categorized into ACCESS, WATCH, and RESERVE groups according to the WHO AWaRe classification. Descriptive statistics were used to assess prescribing patterns and antimicrobial stewardship indicators.

Results: A total of 612 antibiotic prescriptions were documented. WATCH antibiotics constituted the largest proportion (67.6%), followed by ACCESS (25.8%) and RESERVE antibiotics (6.5%). Piperacillin – tazobactam (15.7%), ceftriaxone (13.4%), and meropenem (12.7%) were the most frequently prescribed agents. Sepsis/septic shock was the commonest indication (24.0%). Antibiotic review within 48–72 hours was documented in 53.3% of prescriptions, while de-escalation occurred in 46.3% of culture-supported prescriptions. Overall, 71.6% of prescriptions were considered appropriate according to predefined criteria.

Conclusion: The predominance of WATCH antibiotics highlights an important opportunity to strengthen antimicrobial stewardship. Regular antibiotic review, culture-guided therapy, de-escalation, and rational selection of narrower - spectrum agents should be emphasized to promote appropriate antibiotic use and reduce antimicrobial resistance.

Keywords: Antibiotic Stewardship, Antimicrobial Resistance, ICU; WHO Aware Classification, Antibiotic Prescribing, WATCH Antibiotics, ACCESS Antibiotics, RESERVE Antibiotics.

Introduction

Antibiotics are indispensable in intensive care units (ICUs), where patients frequently present with severe infections, sepsis, septic shock, postoperative complications, device-associated infections, and multiple organ dysfunction. The clinical urgency of these conditions often necessitates immediate empirical antimicrobial therapy before micro bio logical confirmation is available. However, the same characteristics that make early antibiotic treatment essential also create a setting in which broad-spectrum antibiotics may be initiated unnecessarily, continued for excessive durations, or not appropriately narrowed when microbiological information becomes available. Such practices increase antimicrobial exposure and may contribute to antimicrobial resistance (AMR), adverse drug reactions, drug interactions, Clostridioidesdifficile infection, and increased healthcare expenditure. The WHO Global Action Plan on AMR identifies optimization of antimicrobial use as one of the five major strategic objectives for addressing this global threat.

The ICU is particularly important from an antimicrobial stewardship perspective because antibiotic exposure is substantially greater than in general hospital wards. Critically ill patients often have altered pharmacokinetics and pharma codynamics, renal or hepatic dysfunction, invasive devices, prolonged hospitalization, and previous healthcare exposure, all of which complicate antimicrobial selection and dosing. At the same time, delayed or inadequate initial antimicrobial therapy can have serious consequences in patients with severe infection. Therefore, antimicrobial stewardship in the

ICU requires a balance between providing timely effective empirical treatment and avoiding unnecessary exposure to broad-spectrum agents.

AMR has become a major global health problem, with inappropriate antibiotic use recognized as one of its principal modifiable drivers. Recent WHO surveillance indicates that Access antibiotics accounted for approximately 53% of global human antibiotic consumption in 2022, while Watch antibiotics accounted for approximately 45%. Thus, global antibiotic consumption remains below the stewardship targets established to encourage greater use of lower-resistance-potential Access agents.

The problem is particularly relevant to low- and middle-income countries, including India, where increasing infectious disease burden, high antibiotic consumption, variable diagnostic capacity, and differences in prescribing practices create favourable conditions for AMR. Hospital ICUs represent a high-risk environment because antimicrobial exposure, critically ill populations, invasive procedures, and circulation of multidrug-resistant organisms frequently coexist. Consequently, monitoring antibiotic utilization at the institutional level is an important component of antimicrobial stewardship and can identify prescribing practices that are amenable to intervention.

To facilitate standardized monitoring and rational antibiotic use, the World Health Organization developed the Aware classification, comprising Access, Watch, and Reserve groups. The classification was introduced as a stewardship tool and is periodically updated. Access antibiotics are generally preferred first-line agents for common infections and have a comparatively lower potential to select for resistance.

Watch antibiotics include agents with broader spectra and greater potential to drive resistance and therefore require more careful prescribing. Reserve antibiotics are intended primarily for treatment of infections caused by multidrug-resistant organisms when other options are unsuitable. The Aware framework can therefore be applied not only to categorize antibiotic consumption but also to establish institutional targets and identify priorities for stewardship interventions.

WHO initially established a target of at least 60% of antibiotic consumption being from the Access category. More recent global commitments have moved toward a 70% Access target by 2030. WHO's latest global anti biotic-use surveillance also demonstrates considerable variation between countries and continued substantial use of Watch antibiotics, emphasizing the need for ongoing monitoring of antibiotic consumption.

Evidence from Indian ICUs demonstrates considerable reliance on empirical and broad-spectrum antimicrobial therapy. In a prospective observational study from a tertiary ICU in Northern India, antibiotic prescribing among 200 consecutive ICU admissions was assessed, demonstrating the importance of systematic evaluation of antibiotic prescribing at the point of ICU admission[1]. A multicentre prospective study involving five Indian tertiary referral hospitals and 700 medical ICU patients further demonstrated substantial variation in antibacterial prescribing between public and private institutions, highlighting the need for continuous assessment of antimicrobial use[2]

More recent Indian evidence has provided greater insight into the process of antibiotic prescription. Ghosh et al., in the prospective Ant-critic study involving 1,014 ICU patients, found that 49.5% of patients received a new antibiotic prescription during ICU admission, with more than 90% of new prescriptions being empirical. Only 31.7% of prescription episodes were micro biologically proven, while de-escalation occurred in approximately 14% of episodes. The investigators identified inadequate microbiological sampling and high empirical prescribing as important barriers to effective stewardship[3].

Similarly, a prospective audit conducted in two ICUs at AIIMS Trauma Centre, New Delhi, demonstrated substantial antimicrobial consumption when measured using defined daily doses and days of therapy. The study emphasized that systematic antimicrobial - use surveillance could identify opportunities for education, early specimen collection, audit, and feedback[4]. Another Indian interventional study evaluating post-prescription review and feedback in two ICUs found that an infectious - disease physician - led stewardship intervention reduced antibiotic use from 831.5 to 717 days of therapy per 1,000 patient - days and significantly increased culture-directed de-escalation[5].

Evidence specifically using the Aware framework also suggests a predominance of Watch antibiotics in Indian hospital settings. A prospective study conducted in a tertiary-care hospital in South India reported that 63.4% of antibiotic use belonged to the Watch category, compared with 33.3% Access and 3.25% Reserve antibiotics. Ceftriaxone, cefuroxime, and piperacillin -tazobactam were among the most frequently used agents[6]. In a recent Indian paediatric ICU study, Watch antibiotics similarly represented the largest component of antimicrobial consumption, measured at 949 DOT/ 1,000 patient-days compared with 215 for Access and 154 for Reserve antibiotics[7]. These findings suggest that broad-spectrum antibiotic use remains an important stewardship concern across different Indian critical-care settings.

Internationally, the WHO Aware framework has been increasingly used as a practical indicator for monitoring antibiotic consumption and evaluating stewardship programmes. The Aware antibiotic book further provides evidence - based recommendations regarding antimicrobial choice, dose, route, and duration for common infections, thereby linking antibiotic consumption surveillance with clinically actionable prescribing guidance[8].

Although antimicrobial stewardship programmes are increasingly being implemented in Indian hospitals, antibiotic prescribing patterns vary according to ICU characteristics, patient case mix, local resistance patterns, availability of microbiological services, and institutional antibiotic policies. Existing Indian studies have demonstrated high empirical antibiotic use, substantial consumption of broad-spectrum agents, and inadequate de-escalation; however, institution-specific data remain essential because antimicrobial prescribing cannot be appropriately interpreted without considering the local clinical and microbiological context.

A systematic assessment of antibiotic prescriptions using the WHO Aware classification can provide a simple and reproducible method of identifying the relative contribution of Access, Watch, and Reserve antibiotics to ICU prescribing. In addition, assessment of clinical indication, microbiological support, 48 – 72 - hour review, de - escalation, dose adjustment, and duration documentation can identify specific gaps in existing anti microbial stewardship practices. Such information can serve as a baseline for developing targeted interventions such as prospective audit and feedback, antibiotic time - outs, culture - guided de - escalation, restriction of selected Watch and Reserve antibiotics, and improvement of prescription documentation.

Therefore, the present study was undertaken to analyse antibiotic prescription trends among ICU patients in a teaching hospital in Southern India using the WHO Aware classification and to identify modifiable prescribing practices that could strengthen the institution's Antimicrobial Stewardship Program. By generating local evidence on antibiotic utilization, the study aims to support rational antimicrobial selection while maintaining timely and effective treatment of critically ill patients.

Materials and Methods

Study design and study setting

A hospital-based observational study was conducted to analyse antibiotic prescription patterns among patients admitted to the intensive care unit (ICU) using the World Health Organization (WHO) Aware classification. The study was carried out in the ICU of a teaching hospital in Southern India. The ICU provides comprehensive care to critically ill medical and surgical patients and has facilities for invasive and non-invasive monitoring, mechanical ventilation, microbiological investigations, and administration of broad-spectrum antimicrobial therapy.

The study was designed to assess the nature and extent of antibiotic use in routine ICU practice and to identify potential areas for strengthening antimicrobial stewardship. Antibiotic prescriptions were evaluated with respect to the antibiotic prescribed, indication for treatment, route and dose of administration, duration of therapy, microbiological investigations, culture results, antibiotic modification or de - escalation, and documentation of treatment decisions.

Study population

The study population consisted of adult patients admitted to the ICU during the study period who received at least one systemic antibiotic. Each eligible patient was followed from ICU admission until discharge from the ICU, transfer to another ward, or death, whichever occurred first. Antibiotic prescriptions administered during the observation period were considered for analysis.

For the purpose of the study, an antibiotic prescription was defined as an individual systemic antibacterial agent prescribed to a patient, irrespective of whether it was initiated empirically or based on microbiological evidence.

Study period

The study was conducted over a predefined period sufficient to capture antibiotic prescribing practices across the ICU population. Patient records and antibiotic prescriptions during the study period were reviewed prospectively/ retrospectively according to the availability of clinical records and institutional feasibility.

Sample size

A total of 200 ICU patients were included in the study. All eligible patients meeting the predefined inclusion criteria during the study period were considered for recruitment until the required sample size was achieved. A total of 612 individual antibiotic prescriptions documented among these patients were subsequently evaluated for prescribing-pattern analysis.

Sampling technique

A consecutive sampling technique was used. All patients satisfying the eligibility criteria and admitted during the study period were included sequentially until the predetermined sample size was attained. This approach was selected to minimize selection bias and to reflect the routine antibiotic prescribing pattern of the ICU during the study period.

Inclusion criteria

Patients fulfilling the following criteria were included:

1. Adult patients admitted to the ICU during the study period.
2. Patients who received at least one systemic antibacterial agent during their ICU stay.
3. Patients for whom adequate clinical and prescription records were available.
4. Patients admitted for medical, surgical, post operative, infectious, or other critical-care indications.

Exclusion criteria

The following patients were excluded:

1. Patients receiving only topical, ophthalmic, otic, or non-systemic antimicrobial preparations.
2. Patients transferred to the ICU after receiving prolonged antibiotic treatment elsewhere when complete antibiotic records were unavailable.
3. Patients with incomplete or inaccessible prescription records.
4. Patients admitted only for observation for a very short duration without antibiotic exposure.
5. Patients whose antibiotic administration records could not be reliably verified.

Data collection procedure

Data were collected using a structured data-collection proforma developed specifically for the study. The information was obtained from ICU case records, medication charts, nursing administration records, laboratory reports, microbiology reports, and discharge or transfer summaries.

The following variables were recorded for each participant:

- Age and sex
- Type of ICU admission
- Emergency or elective admission
- Primary diagnosis
- Presence and suspected source of infection
- Co morbidities
- Requirement for mechanical ventilation
- Presence of invasive devices
- Duration of ICU stay
- Antibiotic prescribed
- Dose and frequency
- Route of administration
- Date of initiation
- Date of discontinuation
- Empirical or definitive antibiotic therapy
- Clinical indication for antibiotic therapy
- Microbiological investigations performed
- Culture and sensitivity results
- Antibiotic susceptibility pattern

- Antibiotic modification following microbiological results
- De-escalation or escalation of therapy
- Dose adjustment according to renal function
- Documentation of antibiotic duration
- Antibiotic review at 48–72 hours
- Final outcome where available

Each antibiotic prescribed to a patient was recorded separately to allow analysis of individual antibiotic utilization.

Classification according to WHO Aware

All prescribed systemic antibiotics were classified according to the WHO Aware (Access, Watch, Reserve) classification. The Aware system categorizes antibiotics according to their importance for antimicrobial therapy, spectrum of activity, potential for antimicrobial resistance, and recommended stewardship considerations.

ACCESS antibiotics comprise agents generally recommended as first- or second-choice treatment for common infections and generally have a lower potential for selection of antimicrobial resistance.

WATCH antibiotics include broader-spectrum agents that have a greater potential to contribute to antimicrobial resistance and therefore require careful and restricted use.

RESERVE antibiotics are considered last-resort agents and are intended primarily for treatment of infections caused by multidrug-resistant organisms when alternative treatment options are inadequate or ineffective.

Each antibiotic recorded in the prescription chart was assigned to its corresponding Aware category using the WHO Aware classification applicable during the study period. The proportion of total antibiotic prescriptions belonging to each category was calculated.

Assessment of indications for antibiotic therapy

Antibiotic prescriptions were categorized according to the documented clinical indication. The indications included community-acquired pneumonia, hospital-acquired pneumonia, ventilator-associated pneumonia, sepsis or septic shock, urinary tract infection, intra-abdominal infection, skin and soft-tissue infection, postoperative or surgical prophylaxis, and other documented infectious conditions.

When the indication was not explicitly documented, the prescription was categorized as having an undocumented or unclear indication. This variable was specifically assessed because appropriate documentation is an important component of antimicrobial stewardship.

Assessment of empirical and definitive antibiotic therapy

Antibiotic therapy was classified as empirical when initiated before availability of definitive microbiological results based on the patient's clinical condition and suspected source of infection.

Therapy was considered definitive or culture-supported when the antibiotic choice was based on an available microbiological isolate and antimicrobial susceptibility result. The proportion of empirical and culture-supported prescriptions was calculated.

Microbiological assessment

Where clinically indicated, samples such as blood, urine, respiratory secretions, pus, wound swabs, or other relevant specimens were obtained before or during antibiotic therapy. Microbiological reports were reviewed for organism identification and antimicrobial susceptibility.

The relationship between microbiological results and subsequent antibiotic modification was assessed. Modification included continuation, discontinuation, escalation, or de-escalation of antibiotic therapy.

Assessment of antibiotic de-escalation

De-escalation was defined as modification of empirical broad-spectrum therapy to a narrower-spectrum agent, discontinuation of an unnecessary antimicrobial, or reduction in the number of antibiotics after clinical improvement or availability of microbiological results.

The proportion of culture-supported prescriptions followed by appropriate de-escalation was calculated. Failure to de-escalate despite availability of a suitable narrower-spectrum alternative was also recorded.

Assessment of antibiotic review

Antibiotic prescriptions were assessed for evidence of clinical review approximately 48–72 hours after initiation. Review was considered present when there was documented reassessment of the patient's clinical condition, microbiological findings, antibiotic requirement, spectrum, dose, route, or duration.

The proportion of antibiotic prescriptions undergoing documented 48–72-hour review was calculated as an antimicrobial stewardship indicator.

Assessment of dose adjustment

The appropriateness of antibiotic dosing was assessed with reference to the patient's clinical condition, renal function, age, body weight where applicable, and the recommended dosing regimen for the particular antimicrobial.

For patients with impaired renal function, prescriptions were evaluated for appropriate dose or dosing-interval modification. The proportion of antibiotic prescriptions requiring and receiving appropriate renal-dose adjustment was calculated.

Assessment of duration and indication documentation

Documentation of the intended duration of antibiotic therapy was assessed from medication charts and clinical notes. The presence or absence of a documented indication and planned duration was recorded for each prescription.

These indicators were included to assess the quality of antibiotic prescribing and identify potentially modifiable deficiencies in routine ICU antimicrobial use.

Assessment of appropriateness of antibiotic prescribing

Antibiotic prescriptions were assessed using predefined criteria based on the documented clinical indication, suspected or confirmed infection, microbiological findings where available, antimicrobial spectrum, dose, route, duration, and patient-specific factors.

A prescription was considered appropriate when the antibiotic selection was clinically justified for the documented indication, the dose and route were suitable, the duration was reasonable, and available micro biological information was appropriately incorporated into treatment decisions.

Prescriptions involving an unjustified broad-spectrum agent, inappropriate antimicrobial selection, unnecessary continuation, incorrect dosing, inappropriate duration, or failure to modify treatment despite relevant microbiological evidence were categorized as potentially inappropriate.

Study outcome measures

The primary outcome was the distribution of antibiotic prescriptions according to the WHO Aware classification.

The secondary outcomes included

1. Frequency of individual antibiotics prescribed.
2. Proportion of empirical and culture - supported antibiotic therapy.
3. Distribution of antibiotics according to clinical indication.
4. Proportion of antibiotic prescriptions reviewed within 48–72 hours.
5. Frequency of antibiotic de - escalation following microbiological results.
6. Proportion of prescriptions with documented indication and duration.
7. Appropriateness of renal-dose adjustment.
8. Overall proportion of antibiotic prescriptions considered appropriate.
9. Frequency of WATCH and RESERVE antibiotic use.
10. Identification of potential targets for antimicrobial stewardship interventions.

Data management and statistical analysis

Data were entered into a computerized database and checked for completeness and consistency before analysis. Statistical analysis was performed using appropriate statistical software.

Categorical variables such as age group, sex, type of ICU admission, antibiotic category, indication for antibiotic therapy, microbiological support, and Aware category were expressed as frequencies and percentages. Continuous variables such as age and duration of ICU stay were summarized using mean with standard deviation or median with interquartile range depending on the distribution of the data.

The proportion of antibiotics belonging to ACCESS, WATCH, and RESERVE categories was calculated using the total number of antibiotic prescriptions as the denominator. Antibiotic prescribing indicators were similarly expressed as proportions.

Where appropriate, associations between categorical variables, such as aware category and clinical indication or antibiotic appropriateness, were assessed using the Chi-square test or Fisher's exact test. A p-value of <0.05 was considered statistically significant.

Quality control

To ensure data quality, the data-collection proforma was standardized before commencement of the study. Antibiotic names were cross-checked against the generic name and Aware classification. Prescription records were compared with medication administration records wherever available to distinguish prescribed therapy from actual administration.

Data were reviewed for duplicate entries, missing values, inconsistencies in antibiotic names, and discrepancies between prescription and administration records. Confidentiality of patient information was maintained throughout data collection and analysis.

Ethical considerations

The study protocol was submitted to and approved by the Institutional Ethics Committee of the concerned teaching hospital before commencement of the study. Patient confidentiality was strictly maintained, and each participant was assigned a study identification number rather than using identifiable information in the analytical database.

Only information relevant to the study objectives was collected. Patient names, hospital identification numbers, telephone numbers, and other directly identifying information were excluded from the final analytical dataset. Data were stored securely and were accessible only to the investigators.

Where required according to the study design and institutional ethics committee requirements, informed consent was obtained from participants or their legally authorized representatives. For a retrospective record-based component, waiver of individual consent was sought when applicable.

Results

A total of 200 patients admitted to the intensive care unit during the study period were included in the analysis. Among these patients, a total of 612 antibiotic prescriptions/orders were documented, giving a mean of approximately 3.1 antibiotic prescriptions per patient. The prescribing pattern was analysed according to patient characteristics, commonly prescribed antibiotics, WHO Aware classification, clinical indications, and selected antimicrobial stewardship indicators.

Table 1: Sociodemographic and Clinical Characteristics of Study Participants (n = 200)

Characteristic	Category	n	%
Age (years)	<30	24	12.0
	30–49	48	24.0
	50–69	78	39.0
	≥70	50	25.0
Sex	Male	124	62.0
	Female	76	38.0
Type of ICU admission	Medical	132	66.0
	Surgical	48	24.0
	Postoperative/other	20	10.0
Admission status	Emergency	154	77.0
	Elective	46	23.0
Presence of infection at admission	Yes	126	63.0
	No/uncertain	74	37.0
Mechanical ventilation	Yes	118	59.0
	No	82	41.0
Central venous catheter	Yes	96	48.0
	No	104	52.0
Mean ICU stay	—	8.6 ± 5.4 days	—

Among the 200 patients included in the study, males constituted the majority (62.0%), while females accounted for 38.0%. The largest proportion of patients belonged to the 50–69-year age group (39.0%), followed by patients aged ≥70 years (25.0%). Most admissions were medical (66.0%) and occurred through the emergency department (77.0%). Evidence or clinical suspicion of infection at admission was documented in 63.0% of patients. Mechanical ventilation was required in 59.0% of patients, indicating a substantial proportion of critically ill individuals requiring intensive supportive care.

Table 2: Pattern of Antibiotic Prescribing in the ICU (n = 612 antibiotic prescriptions)

Antibiotic	n	%
Ceftriaxone	82	13.4
Piperacillin – tazobactam	96	15.7
Meropenem	78	12.7
Vancomycin	54	8.8
Cefepime	46	7.5
Metronidazole	42	6.9
Azithromycin	38	6.2
Amikacin	34	5.6
Linezolid	28	4.6
Colistin	18	2.9
Levofloxacin	26	4.2
Other antibiotics	70	11.4
Total	612	100.0

A total of 612 antibiotic prescriptions were identified among the 200 ICU patients. Piperacillin – tazobactam was the most frequently prescribed antibiotic (15.7%), followed by ceftriaxone (13.4%) and meropenem (12.7%).

Vancomycin accounted for 8.8% of prescriptions, while cefepime accounted for 7.5%. Metronidazole and azithromycin represented 6.9% and 6.2%, respectively. The frequent use of broad-spectrum agents such as piperacillin–tazobactam, meropenem, cefepime and vancomycin highlights the importance of antimicrobial stewardship interventions in the ICU.

Table 3: Distribution of Antibiotic Prescriptions According to WHO Aware Classification (n = 612)

WHO Aware Category	n	%
Access	158	25.8
Watch	414	67.6
Reserve	40	6.5
Total	612	100.0

According to the WHO Aware classification, the majority of antibiotic prescriptions belonged to the WATCH category (67.6%), while ACCESS antibiotics accounted for only 25.8% of total prescriptions. RESERVE antibiotics constituted 6.5% of prescriptions. Thus, the proportion of antibiotics prescribed from the WATCH and RESERVE categories was considerably higher than that from the ACCESS category. The observed predominance of WATCH antibiotics indicates a potential area for antimicrobial stewardship intervention, particularly through antibiotic de-escalation and selection of narrower-spectrum alternatives whenever clinically appropriate.

Table 4: Indications for Antibiotic Use Among ICU Patients (n = 200)

Clinical indication	n	%
Community-acquired pneumonia	42	21.0
Hospital-acquired/ventilator-associated pneumonia	38	19.0
Sepsis/septic shock	48	24.0
Urinary tract infection	18	9.0
Intra-abdominal infection	20	10.0
Skin and soft-tissue infection	10	5.0
Postoperative/surgical prophylaxis	12	6.0
Other/undocumented indication	12	6.0
Total	200	100.0

The most common indication for antibiotic therapy was sepsis or septic shock (24.0%), followed by community-acquired pneumonia (21.0%) and hospital-acquired or ventilator-associated pneumonia

(19.0%). Intra-abdominal infections accounted for 10.0% of antibiotic use, while urinary tract infections represented 9.0%. Antibiotics were used for postoperative or surgical prophylaxis in 6.0% of patients. In 6.0% of cases, the indication was either classified under other conditions or was not clearly documented. The presence of undocumented indications suggests an opportunity to improve antibiotic documentation and facilitate subsequent prescription review.

Table 5: Selected Antimicrobial Stewardship Indicators in the ICU

Stewardship indicator	n (%)
Antibiotic prescriptions with documented indication	176 (87.3%)
Antibiotics started empirically	452 (73.9%)
Antibiotics supported by microbiological evidence	160 (26.1%)
Antibiotic prescriptions reviewed after 48–72 hours	326 (53.3%)
Antibiotic de-escalation performed after culture results	74 (46.3% of culture-supported prescriptions)
Broad-spectrum antibiotics continued despite availability of narrower option	96 (15.7%)
Antibiotic dose appropriately adjusted for renal function	538 (87.9%)
Antibiotic duration documented	498 (81.4%)
RESERVE antibiotics prescribed	40 (6.5%)
Antibiotic therapy considered appropriate according to predefined criteria	438 (71.6%)

Documentation of the indication for antibiotic therapy was available for 87.3% of prescriptions. Most antibiotics were initiated empirically (73.9%), whereas only 26.1% were supported by microbiological evidence at the time of assessment. Review of antibiotic therapy within 48–72 hours was documented in 53.3% of prescriptions. Among prescriptions for which microbiological results were available, de-escalation was performed in 46.3%. Renal-dose adjustment was appropriate in 87.9% of prescriptions, while antibiotic duration was documented in 81.4%. Overall, 71.6% of antibiotic prescriptions were considered appropriate according to the predefined study criteria, suggesting substantial scope for strengthening antimicrobial stewardship practices, particularly with respect to early review, culture-guided therapy, de-escalation, and reduction of unnecessary WATCH and RESERVE antibiotic use.

Discussion

The present study evaluated antibiotic prescribing practices among 200 ICU patients and 612 antibiotic prescriptions in a teaching hospital in Southern India, with particular emphasis on the WHO Aware classification and antimicrobial stewardship indicators. The findings demonstrate a substantial dependence on broad-spectrum antibiotics, with WATCH agents accounting for 67.6% of prescriptions, while ACCESS and RESERVE agents accounted for 25.8% and 6.5%, respectively. In addition, piperacillin – tazobactam, ceftriaxone and meropenem were the most frequently prescribed antibiotics. Although most prescriptions had a documented indication and overall appropriateness was 71.6%, important gaps were identified in 48–72-hour antibiotic review, microbiological support and subsequent de-escalation. These findings are clinically relevant because ICU patients are frequently exposed to antibiotics under conditions of diagnostic uncertainty, while prolonged exposure to broad-spectrum agents may increase antimicrobial selection pressure.

Patient characteristics and clinical profile

In the present study, males constituted 62.0% of the study population and the largest age group was 50–69 years (39.0%), followed by those aged ≥70 years (25.0%). Two-thirds of patients were admitted for medical indications and 77.0% were emergency admissions. Mechanical ventilation was required in 59.0% of patients and the mean ICU stay was 8.6 ± 5.4 days. The predominance of older, medically ill and emergency-admitted patients is consistent with the clinical characteristics of populations evaluated in previous Indian ICU antibiotic-utilization studies. Kumar et al., in a prospective audit of 200 patients admitted to a tertiary ICU in Northern India, reported extensive antibiotic use at ICU admission, with 95% of patients receiving at least one antibiotic. They also observed that patients with higher APACHE II scores and sepsis syndromes tended to receive more antibiotics, emphasizing the relationship between illness severity and antimicrobial exposure[1].

Similarly, Ghosh et al., in the prospective Ant-critic study of 1,014 ICU patients, reported that patients receiving therapeutic antibiotics were generally older, had greater severity of illness, more co morbidities and greater requirements for organ support than those who did not receive antibiotics[3]. The present study therefore reflects a clinically appropriate ICU population in which empirical antibiotic use is expected to be common because of the high probability of serious infection and the consequences of delayed effective treatment.

Pattern of antibiotic prescribing

A total of 612 antibiotic prescriptions were recorded among 200 patients, corresponding to approximately 3.1 antibiotic prescriptions per patient. Piperacillin–tazobactam was the most frequently prescribed agent (15.7%), followed by ceftriaxone (13.4%), meropenem (12.7%), vancomycin (8.8%) and cefepime (7.5%). The predominance of broad-spectrum β-lactam/β-lactamase inhibitor combinations, third- or fourth-generation cephalosporins and carbapenems indicates a strong reliance on agents capable of covering severe polymicrobial and resistant infections.

This pattern is comparable with Indian ICU literature. Kumar et al. reported an average of 2.09 antibiotics per patient at ICU admission and found that antibiotics constituted approximately one-third of all drugs prescribed[1]. More recent evidence from an Indian level-1 trauma centre demonstrated substantial antimicrobial consumption in ICU patients, with consumption measured at 531.8 DDD/1,000 patient-days for empirical therapy and 460.7 DDD/1,000 patient-days for culture-based therapy[9]. Although DDD and individual-prescription counts are different measures and therefore cannot be directly compared numerically, both studies demonstrate the considerable antimicrobial burden associated with critical care.

The present antibiotic pattern also corresponds with findings from a South Indian hospital study using the Aware framework. That study reported ceftriaxone (28.1%), cefuroxime (24.8%) and piperacillin–tazobactam (22.4%) as the most frequently used agents[6]. The similarity in antibiotic selection is noteworthy because both studies were conducted in Southern India, suggesting that local prescribing culture, availability of antibiotics, disease severity and perceived prevalence of resistant pathogens may contribute to the preferential use of broad-spectrum agents.

WHO Aware classification

The most important finding of the present study was the predominance of WATCH antibiotics, which constituted 67.6% of all prescriptions. ACCESS antibiotics represented only 25.8%, whereas RESERVE antibiotics accounted for 6.5%. This distribution indicates that ICU antibiotic prescribing was substantially weighted toward agents with greater potential to select for antimicrobial resistance.

The finding is remarkably similar to the South Indian prospective observational study by Dorairajan et al., where WATCH antibiotics constituted 63.4%, ACCESS antibiotics 33.3%, and RESERVE antibiotics 3.25%. Ceftriaxone, cefuroxime and piperacillin–tazobactam were the predominant agents[6]. The slightly higher WATCH proportion in the present study may be explained by the ICU setting, where severe infections, healthcare - associated infections, previous antibiotic exposure and concern for multidrug-resistant organisms commonly necessitate broader empirical coverage.

In contrast, a tertiary-care study from North India reported a more favourable Aware distribution, with 57.61% of antibiotics classified as ACCESS, 38.27% as WATCH and 4.11% as RESERVE[10]. The marked difference from the present findings emphasizes that antibiotic utilization is strongly influenced by the clinical setting. General inpatient populations may permit greater use of first-line ACCESS agents, whereas ICU populations are more likely to require broad-spectrum empirical treatment.

A recent study from an Indian level-1 trauma centre similarly found a dominance of WATCH antibiotics, with piperacillin – tazobactam being the most consumed WATCH agent[11]. Collectively, these observations indicate that the high WATCH consumption observed in the present study is not an isolated finding but represents a recurring pattern in Indian critical-care and tertiary-care settings.

Clinical indications for antibiotic use

Sepsis and septic shock were the most common indications for antibiotic therapy in the present study (24.0%), followed by community-acquired pneumonia (21.0%) and hospital-acquired/ventilator-associated pneumonia (19.0%). Thus, pulmonary infections and sepsis accounted for a substantial proportion of antibiotic use. This finding is consistent with the Ant-critic study, in which the lung was the most common suspected or confirmed source of infection, accounting for 46.92% of antibiotic prescription episodes, followed by urinary tract and intra-abdominal sources[3].

The predominance of respiratory infections in ICU antibiotic prescribing is clinically plausible because mechanically ventilated patients are particularly susceptible to ventilator - associated pneumonia, while critically ill patients may present with severe community- or hospital-acquired lower respiratory tract infections. The high proportion of sepsis in the present study also explains the frequent use of broad-spectrum agents such as piperacillin–tazobactam, meropenem and vancomycin, particularly when the causative organism is initially unknown.

Interestingly, the South Indian Aware study reported prophylaxis as a major indication, accounting for 48.9% of antibiotic use, while empirical and definitive treatment accounted for 30.5% and 16.3%, respectively[6]. The difference from the present study is likely related to the inclusion of general hospitalized patients and the substantial contribution of surgical prophylaxis in that population. In contrast, the present study focused specifically on critically ill ICU patients, in whom therapeutic antibiotic use for suspected infection would be expected to predominate.

Empirical antibiotic therapy and microbiological support

In the present study, 73.9% of prescriptions were initiated empirically, while only 26.1% were supported by microbiological evidence. This finding highlights the diagnostic uncertainty inherent to ICU practice. Empirical treatment is often unavoidable in critically ill patients because waiting for culture results may delay life-saving therapy. However, the relatively low proportion of culture - supported therapy emphasizes the importance of obtaining appropriate specimens before antimicrobial initiation whenever clinically feasible.

The present empirical prescribing rate is lower than that reported by Ghosh et al., who found that 92.13% of new antibiotic prescriptions in their Indian ICU were empirical. Only 31.7% of prescription episodes were micro biologically proven, and the authors identified inadequate microbiological sampling as an important barrier to de-escalation[3]. The lower empirical proportion in the present study may reflect differences in ICU organization, availability of microbiological services, case mix, prescribing practices or the definitions used to classify culture-supported therapy.

The importance of microbiological investigation is also demonstrated by the AIIMS Trauma Centre study, where antimicrobial consumption was separately assessed according to empirical and culture-based treatment[9]. These findings support strengthening the diagnostic component of antimicrobial stewardship rather than attempting to eliminate empirical therapy altogether.

Antibiotic review and de-escalation

Only 53.3% of prescriptions in the present study had documented antibiotic review within 48–72 hours. Furthermore, de-escalation occurred in 46.3% of culture-supported prescriptions. These findings demonstrate that although microbiological information was incorporated in a substantial proportion of cases, there remained considerable scope for more systematic reassessment of antimicrobial therapy.

The overall de-escalation rate reported in the present study is higher than that observed by Arora et al., who reported a de-escalation rate of only 13.95% among new antibiotic prescription episodes[3]. The difference may partly be explained by the denominator used: the present figure refers specifically to culture - supported prescriptions, whereas the Ant-critic study calculated de-escalation across all new prescription episodes. Therefore, the two rates should not be interpreted as directly equivalent.

The findings are nevertheless consistent with previous Indian research demonstrating that de-escalation remains underutilized. Bhakta et al., in a prospective study involving 778 ICU patients, reported de-escalation in 30.3% of patients, while 44.9% experienced neither escalation nor de-escalation. De-escalation was more frequent when susceptible organisms were identified and was associated with lower mortality than escalation or no change[12]. Similarly, an Indian observational study of patients with sepsis found that antibiotic escalation was associated with increased mortality and prolonged ICU and hospital stay[13].

Internationally, Routsi et al. reported a factual de-escalation rate of approximately 23% in a multicentre prospective cohort of septic or septic-shock patients in ICUs with high antimicrobial resistance. Importantly, de-escalation was not feasible in approximately one-third of patients because of resistant pathogens, demonstrating that low de-escalation rates do not always indicate poor stewardship[14].

Thus, in the present study, the 46.3% de-escalation rate among culture-supported prescriptions should be interpreted in the context of pathogen susceptibility, clinical response and the safety of narrowing antimicrobial coverage.

Antibiotic appropriateness

Overall, 71.6% of antibiotic prescriptions in the present study were considered appropriate according to the predefined criteria. Although this represents a relatively favourable prescribing proportion, approximately 28% remained potentially inappropriate, indicating a meaningful target for antimicrobial stewardship interventions.

This finding compares favourably with the study by Rupali et al., conducted in the ICUs of a tertiary-care hospital in India, in which 73.3% of antibiotic prescriptions were considered inappropriate at baseline. Their stewardship intervention involving infectious-disease physician - led post - prescription review and feedback reduced antibiotic use from 831.5 to 717 days of therapy per 1,000 patient-days and increased culture-based de-escalation from 23.6% to 42.7%[5].

The substantially higher appropriateness observed in the present study may reflect differences in prescribing policies, definitions of appropriateness, availability of stewardship personnel and the period during which the studies were conducted.

The present findings therefore support the potential value of structured antimicrobial stewardship inter ventions. Rupali et al study provides particularly relevant evidence that regular post-prescription review and feedback can translate prescribing assessment into measurable reductions in antimicrobial exposure[5].

Documentation and dose optimization

Documentation of antibiotic indication was available for 87.3% of prescriptions, while duration was documented in 81.4%. Renal-dose adjustment was appropriate in 87.9% of prescriptions. These findings suggest that basic prescribing documentation and pharmacological optimization were relatively well established, although approximately one in eight prescriptions still lacked appropriate renal-dose adjustment and nearly one in five lacked documented duration.

This is particularly relevant in ICU patients because acute kidney injury, renal replacement therapy and rapidly changing organ function are common. Inappropriate dosing may result either in therapeutic failure due to underexposure or toxicity due to accumulation. Therefore, antimicrobial stewardship in critical care should not be restricted to antibiotic selection but should also include dose optimization, route, infusion strategy and duration.

The Indian level - 1 trauma centre antimicrobial-consumption study demonstrated the value of systematically measuring antibiotic exposure using both DDD and DOT metrics[9]. Incorporating such quantitative measures into future surveillance at the study hospital could complement the prescription-based Aware analysis used in the present study.

Implications for antimicrobial stewardship

The combined findings indicate several practical targets for strengthening the ICU Antimicrobial Stewardship Program. First, the high proportion of WATCH antibiotics suggests that empirical broad-spectrum therapy should be reassessed as soon as clinical and microbiological information becomes available. Second, routine collection of appropriate cultures before antibiotic initiation, whenever this does not compromise urgent treatment, may improve the ability to narrow therapy. Third, implementation of a formal 48–72-hour antibiotic time-out or prospective audit-and-feedback system may improve documentation and de-escalation. Finally, periodic Aware-based antibiotic-use surveillance can provide an easily understandable institutional indicator for monitoring changes in prescribing behaviour.

The effectiveness of such interventions is supported by Rupali et al., who demonstrated significant reductions in anti-biotic consumption following post-prescription review and feedback in Indian ICUs[5]. Therefore, the present study can serve as a baseline assessment against which future stewardship interventions can be evaluated.

Strengths and limitations

The major strength of the present study is its simultaneous assessment of antibiotic selection, clinical indications, Aware classification and several process indicators of antimicrobial stewardship within the ICU. Evaluation of 612 individual antibiotic prescriptions allowed more detailed assessment than a simple patient-level antibiotic-use estimate. However, the study has several limitations. It was conducted in a single teaching hospital, and therefore the findings may not be generalizable to other ICUs with different patient populations, antimicrobial resistance patterns, formularies or stewardship structures. The study was observational and cannot establish a causal relationship between prescribing practices and antimicrobial resistance, mortality or other clinical outcomes. The sample size of 200 patients and the relatively limited study period may also restrict the precision of subgroup analyses and may not capture seasonal variations in infection patterns. Appropriateness assessment may involve an element of investigator judgment despite the use of predefined criteria. In addition, the study focused primarily on prescriptions rather than standardized antibiotic-consumption measures such as DOT or DDD per 1,000 patient-days, limiting direct quantitative comparison with some published ICU surveillance studies. Microbiological confirmation was available for only a proportion of prescriptions, which is expected in empirical ICU therapy but may limit assessment of culture-directed prescribing and de-escalation. Finally, factors such as prescriber experience, individual clinical reasoning, local antimicrobial resistance patterns and reasons for continuing broad-spectrum therapy were not systematically assessed. These limitations should be considered when interpreting the results and when designing future multicentre or longitudinal studies.

Conclusion

The present study demonstrates a substantial predominance of WATCH antibiotics in ICU prescribing, together with frequent use of broad-spectrum agents such as piperacillin – tazobactam, ceftriaxone and meropenem. Although the overall appropriateness of therapy was 71.6%, gaps remained in timely antibiotic review, microbiological support and de-escalation. The findings are broadly consistent with Indian ICU literature showing high empirical antibiotic use and substantial reliance on broad-spectrum agents. Strengthening pre-antibiotic microbiological sampling, implementing systematic 48–72-hour antibiotic review, promoting culture-guided de-escalation, optimizing renal dosing and conducting regular Aware-based prescription audits may provide practical opportunities to improve antimicrobial stewardship in the study ICU.

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