



Original Article

Assessment of Adherence to Antimicrobial Stewardship Program (ASP) In Intensive Care Unit (ICU) of A Tertiary Care Teaching Facility in Northern India

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ABSTRACT

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Background: Antimicrobial resistance (AMR) is a major global health concern driven by inappropriate antimicrobial use, particularly in intensive care units (ICUs). Antimicrobial stewardship programs (ASPs) are essential to optimize antimicrobial use and improve patient outcomes, yet data from resource-limited settings remain limited. Evaluation is important regarding antimicrobial utilization patterns, adherence to antimicrobial stewardship guidelines, microbiological practices, and the burden of multidrug-resistant organisms in ICU patients of a tertiary care teaching facility.

Methods: This observational retrospective study was conducted over six months (January–June 2023) in the Medicine ICU of a tertiary care hospital. A total of 300 case records of patients receiving at least one antimicrobial were analyzed. Data was collected retrospectively using a structured form based on guidelines from the Indian Council of Medical Research and the World Health Organization. Parameters assessed included demographic characteristics, antimicrobial prescribing patterns, adherence to stewardship practices during diagnostic and treatment phases, microbiological findings, adverse drug reactions, and clinical outcomes. Descriptive statistics were used for analysis.

Results: The mean age of patients was 54.62 ± 12.63 years, with a predominance of females (62.33%). Diagnostic investigations were performed in 79.7% of cases. Macrolides (26.0%) and cephalosporins (22.0%) were the most commonly prescribed antimicrobials, followed by carbapenems (18.0%). During the diagnostic phase, appropriate antimicrobial selection was observed in 73.0% of cases, while blood cultures prior to antibiotic initiation were obtained in 60.7%. In the treatment phase, adherence was highest for appropriate route (89.0%) and empirical therapy (83.7%), while de-escalation was implemented in 64.3% of patients. Gram-negative organisms, particularly *Escherichia coli* (16.0%) and *Klebsiella pneumoniae* (13.7%), predominated. Adverse drug reactions were observed in 9.3% of patients. Overall adherence to antimicrobial policy was 89.7%, with variability across antimicrobial classes and clinical conditions.

Conclusion: Antimicrobial stewardship practices in the ICU demonstrated generally good adherence, particularly in treatment-phase interventions; however, gaps remain in diagnostic stewardship and microbiology-driven decision-making. Strengthening culture-based therapy, improving laboratory-clinician communication, and reinforcing guideline adherence are essential to optimize antimicrobial use and combat AMR in critical care settings.

INTRODUCTION

Antimicrobial resistance (AMR) is a major and escalating global health threat driven largely by the inappropriate and excessive use of antibiotics [1]. The World Health Organization estimates that AMR could cause up to 10 million deaths annually by 2050 if current trends continue [2]. Antimicrobial stewardship (AMS) has therefore emerged as a critical strategy to optimize antimicrobial use through appropriate drug selection, dose, route, and duration, thereby improving clinical outcomes while minimizing toxicity and resistance [3,4].

Antimicrobial Stewardship Programs (AMSPs) in hospitals aim to reduce inappropriate prescribing, improve guideline adherence, and curb the emergence of resistant pathogens [5]. Nearly 30% of antibiotic use in hospitals is considered unnecessary, highlighting the importance of stewardship interventions [6]. Effective AMSPs employ multidisciplinary approaches, including formulary restriction, prospective audit and feedback, and pathogen-directed therapy [7]. Their effectiveness is assessed using process indicators such as guideline adherence and diagnostic stewardship, along with outcome measures including antibiotic consumption, resistance trends, mortality, and readmission rates [8–10].

Although AMSPs have shown substantial benefits in high-income countries, evidence from low- and middle-income countries, including India, remains limited due to inadequate surveillance systems, heterogeneous healthcare infrastructure, and inconsistent implementation [11,12]. Emerging technologies, including artificial intelligence-based platforms, may improve real-time surveillance and stewardship practices in resource-constrained settings [13]. However, barriers such as limited infrastructure, poor adherence, weak surveillance systems, and behavioral factors continue to hinder effective implementation [14–16].

In this context, the present study evaluates the real-world implementation of a structured AMSP in a tertiary care teaching hospital in India. The study compares process and outcome indicators over a three-year period, assessing antimicrobial utilization, guideline adherence, microbiological practices, and multidrug resistance patterns in the ICU setting.

MATERIALS AND METHODS

Study Design and Setting

This retrospective observational study evaluated antimicrobial utilization and adherence to antimicrobial stewardship practices in the Medicine ICU of Sardar Vallabh Bhai Patel (SVBP) Hospital, affiliated with Lala Lajpat Rai Memorial (LLRM) Medical College, Meerut, Northern India. The study was conducted from January 1 to June 30, 2023, under the Department of Pharmacology. Ethical approval was obtained from the Institutional Ethics Committee of LLRM Medical College, Meerut (Ref. No. SC-1/2024/5283). Patient confidentiality was strictly maintained.

Study Population

A total of 300 ICU patient records receiving at least one antimicrobial agent were included. Patients admitted to the Medicine ICU with complete medical records were eligible. Patients with ICU stay <24 hours, incomplete records, or transfer from other hospitals with insufficient treatment details were excluded.

Data Collection

Data were retrospectively collected from the Central Record Section and ICU records using a structured case record form based on Indian Council of Medical Research and World Health Organization guidelines. Information collected included demographic details, clinical diagnosis, antimicrobial prescriptions (drug, dose, route, frequency, duration), empirical and definitive therapy, laboratory investigations, and microbiological culture and sensitivity reports.

Assessment of Antimicrobial Stewardship Practices

Antimicrobial stewardship adherence was assessed using the WHO concept of the “Rights of Antimicrobial Safety,” including appropriate empirical therapy, guideline-based drug selection, dose optimization, duration, de-escalation/escalation practices, documentation, and adverse drug reaction monitoring. Diagnostic stewardship was evaluated through the timing and appropriateness of microbiological investigations and utilization of culture reports for therapy modification. Multidrug-resistant organisms were defined as resistance to at least one agent in three or more antimicrobial classes. Common infectious syndromes and infection control practices were also assessed.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed descriptively. Categorical variables were expressed as frequencies and percentages, while continuous variables were summarized as mean ± standard deviation or median with interquartile range, as appropriate. Results were presented using tables and graphs.

RESULTS AND DISCUSSION

Table 1: Demographic and Clinical Characteristics, Investigations, and Antimicrobial Prescribing Patterns among ICU Patients (n = 300)

Variable	Category	Number (n)	Percentage (%)
Age Group (years)	18–30	13	4.3
	31–40	22	7.3
	41–50	62	20.7
	51–60	114	38.0
	61–70	66	22.0
	≥70	23	7.7
	Mean ± SD	54.62 ± 12.63 years	—
Gender	Male	113	37.67
	Female	187	62.33
Investigations Advised	Yes	239	79.7
	No	61	20.3
Antimicrobials Prescribed	Macrolides (Azithromycin/Clarithromycin)	78	26.0
	β-lactam + β-lactamase inhibitor Cephalosporins (Ceftriaxone/Cefoperazone–Sulbactam)	66	22.0
	β-lactam + β-lactamase inhibitor (Amoxiclav/Piperacillin–Tazobactam)	45	15.0
	Carbapenems (Meropenem ± Vancomycin)	54	18.0
	Linezolid/Glycopeptide coverage (Linezolid ± Vancomycin)	24	8.0
	Fluoroquinolones (Levofloxacin/Ciprofloxacin)	18	6.0
	Others (Tigecycline/Reserve agents)	15	5.0

The study population had a mean age of 54.62 ± 12.63 years, with the majority of patients belonging to the 51–60 years age group (38.0%), followed by 61–70 years (22.0%) and 41–50 years (20.7%), while younger patients aged 18–30 years constituted only 4.3%. Females (62.33%) outnumbered males (37.67%). Investigations were advised in 79.7% of patients, whereas 20.3% did not undergo any laboratory investigations. Regarding antimicrobial prescribing patterns, macrolides were the most frequently prescribed class (26.0%), followed by β-lactam plus β-lactamase inhibitor cephalosporins (22.0%) and carbapenems (18.0%). Other commonly used agents included β-lactam plus β-lactamase inhibitors such as amoxiclav and piperacillin–tazobactam (15.0%), while linezolid/glycopeptide coverage accounted for 8.0% and fluoroquinolones for 6.0%. Reserve agents such as tigecycline were prescribed in 5.0% of cases. These findings highlight a predominance of broad-spectrum antimicrobial use and a high rate of diagnostic evaluation in ICU patients.(Table1)

Table 2: Adherence to Antimicrobial Stewardship Guidelines During Diagnostic and Treatment Phases in ICU Patients (n = 300)

Phase	Parameter	Yes (n)	Yes (%)	No (n)	No (%)
Diagnostic Phase	Agent appropriate	219	73.0	81	27.0
	Indication appropriate	214	71.3	86	28.7
	Blood culture before antimicrobials	182	60.7	118	39.3
	Sample sent for culture/sensitivity	193	64.3	107	35.7
Treatment Phase	Appropriate route	267	89.0	33	11.0
	Appropriate duration	213	71.0	87	29.0
	Laboratory information communicated	186	62.0	114	38.0
	Empirical therapy given	251	83.7	49	16.3
	Dose optimization	231	77.0	69	23.0
	De-escalation implemented	193	64.3	107	35.7
	Safe de-escalation	241	80.3	59	19.7

During the diagnostic phase, appropriate antimicrobial agent selection was observed in 73.0% of cases, while appropriate indication was documented in 71.3%. Blood cultures prior to antimicrobial initiation were obtained in 60.7% of patients, and culture/sensitivity samples were sent in 64.3%, indicating moderate compliance with diagnostic stewardship practices. In the treatment phase, adherence was highest for appropriate route of administration (89.0%), followed by empirical therapy initiation (83.7%) and safe de-escalation practices (80.3%). Dose optimization was achieved in 77.0% of patients, while appropriate duration of therapy was maintained in 71.0%. De-escalation based on microbiological findings was implemented in 64.3% of cases, and laboratory information was communicated in 62.0%, reflecting scope for improvement

in microbiology-driven decision-making. Overall, while adherence to several stewardship components was satisfactory, gaps persist in diagnostic evaluation and timely utilization of laboratory data.(Table 2)

Table 3: Microbiological Profile, Adverse Drug Reactions, Therapy Switch, and Clinical Diagnosis among ICU Patients (n = 300)

Variable	Category	Number (n)	Percentage (%)
Causative Microorganisms	No Growth	17	5.7
	<i>Escherichia coli</i>	48	16.0
	<i>Enterococcus faecalis</i>	43	14.3
	<i>Klebsiella pneumoniae</i>	41	13.7
	<i>Pseudomonas aeruginosa</i>	35	11.7
	<i>Acinetobacter baumannii</i>	21	7.0
	<i>Staphylococcus aureus</i>	29	9.7
	<i>Candida albicans</i>	40	13.3
Adverse Drug Reactions (ADR)	No ADR	272	90.7
	ADR Present	28	9.3
Parenteral to Oral Switch	No	115	38.3
	Yes	185	61.7
Definitive Diagnosis	COPD/Emphysema	45	15.0
	Pneumonia	37	12.3
	Bronchiectasis	23	7.7
	Bronchitis	22	7.3
	Post-TB defaulter/sequelae	11	3.7
	Enteric Fever	15	5.0
	Sepsis (non-respiratory)	31	10.3
	Sepsis with Pneumonia	32	10.7
	UTI (Uncomplicated)	36	12.0
	UTI (Complicated)	17	5.7
	Biliary Sepsis	21	7.0
	Cellulitis	18	6.0
	Post-operative Wound Infection	12	4.0
Post-surgical Infection	10	3.3	

Among the microbiological isolates, *Escherichia coli* was the most frequently identified organism (16.0%), followed by *Enterococcus faecalis* (14.3%), *Klebsiella pneumoniae* (13.7%), and *Candida albicans* (13.3%). Other notable pathogens included *Pseudomonas aeruginosa* (11.7%), *Staphylococcus aureus* (9.7%), and *Acinetobacter baumannii* (7.0%), while no growth was observed in 5.7% of samples. Adverse drug reactions (ADRs) were relatively infrequent, occurring in 9.3% of patients, whereas 90.7% experienced no ADRs. A parenteral-to-oral antimicrobial switch was implemented in 61.7% of cases, while 38.3% remained on parenteral therapy. Regarding definitive diagnoses, chronic respiratory conditions such as COPD/emphysema were most common (15.0%), followed by pneumonia (12.3%) and uncomplicated urinary tract infections (12.0%). Sepsis-related conditions, including sepsis with pneumonia (10.7%) and non-respiratory sepsis (10.3%), also constituted a substantial proportion. Other conditions included bronchiectasis (7.7%), bronchitis (7.3%), biliary sepsis (7.0%), cellulitis (6.0%), complicated UTI (5.7%), enteric fever (5.0%), post-operative wound infections (4.0%), post-surgical infections (3.3%), and post-tuberculosis sequelae (3.7%). These findings reflect a diverse spectrum of infections with a predominance of gram-negative organisms and respiratory-related conditions in ICU patients.(Table 3)

Table 4: Adherence to Antimicrobial Policy by Drug Class and Clinical Diagnosis among ICU Patients (n = 300)

Variable	Category	Adherence (n)	Adherence (%)	Non-adherence (n)	Non-adherence (%)
Antimicrobial Class	Macrolides	76	97.4	2	2.6
	Cephalosporins	63	95.5	3	4.5
	β -lactam + β -lactamase inhibitor	37	82.2	8	17.8
	Carbapenems	45	83.3	9	16.7
	Linezolid/Vancomycin	20	83.3	4	16.7
	Fluoroquinolones	15	83.3	3	16.7
	Others	13	86.7	2	13.3
	Total	269	89.7	31	10.3
Diagnosis	COPD/Emphysema	39	86.7	6	13.3

Pneumonia	32	86.5	5	13.5
Sepsis	25	80.6	6	19.4
Sepsis + Pneumonia	28	87.5	4	12.5
Uncomplicated UTI	33	91.7	3	8.3
Complicated UTI	15	88.2	2	11.8
Biliary Sepsis	20	95.2	1	4.8
Cellulitis	1	5.6	17	94.4
Post-operative/Surgical Infection	1	5.0	19	95.0

Overall adherence to antimicrobial policy was high, observed in 89.7% of cases, with only 10.3% demonstrating non-adherence. Among antimicrobial classes, macrolides showed the highest adherence (97.4%), followed by cephalosporins (95.5%). Moderate adherence was observed with other classes including β -lactam plus β -lactamase inhibitors (82.2%), carbapenems (83.3%), linezolid/vancomycin (83.3%), and fluoroquinolones (83.3%), while the “others” category showed 86.7% adherence. When analyzed according to clinical diagnosis, adherence was highest in biliary sepsis (95.2%), followed by uncomplicated urinary tract infections (91.7%) and complicated UTIs (88.2%). Respiratory conditions such as COPD/emphysema (86.7%) and pneumonia (86.5%), as well as sepsis with pneumonia (87.5%), also demonstrated good adherence. However, markedly poor adherence was observed in cellulitis (5.6%) and post-operative or surgical infections (5.0%), where non-adherence rates were notably high at 94.4% and 95.0%, respectively. These findings suggest generally good compliance with antimicrobial policies, although significant gaps remain in specific clinical conditions, particularly surgical and soft tissue infections.(Table 4).

DISCUSSION

The present study evaluated antimicrobial prescribing practices, stewardship adherence, microbiological patterns, and clinical outcomes in a high-risk ICU setting, providing insights into the implementation of antimicrobial stewardship programs (ASPs) in a resource-constrained tertiary care hospital. The findings highlight both strengths and persistent gaps in stewardship practices.

The study population predominantly comprised middle-aged and elderly patients (mean age 54.62 ± 12.63 years), consistent with previous ICU-based studies reporting higher antimicrobial utilization among older patients with multiple comorbidities [17–19]. In contrast to prior Indian studies, females constituted a higher proportion of cases, possibly reflecting local epidemiological factors such as increased respiratory and urinary tract infections.

Diagnostic stewardship was moderately satisfactory, with investigations advised in nearly 80% of patients, aligning with WHO and ICMR recommendations. However, pre-antibiotic culture sampling (60.7%) and culture sensitivity testing (64.3%) remained suboptimal, similar to previous reports [17,21], emphasizing the need for earlier microbiological evaluation before antimicrobial initiation.

Macrolides and β -lactam antibiotics were the most frequently prescribed agents, reflecting guideline-based empirical therapy for respiratory and community-acquired infections [17,18,20]. Carbapenem utilization (18.0%) was comparable to previous Indian ICU studies [19,23], likely reflecting treatment of severe or multidrug-resistant infections. Limited use of reserve agents and lower reliance on fluoroquinolones suggest relatively rational prescribing practices.

Stewardship adherence during treatment was high, particularly regarding appropriate route (89.0%), empirical therapy (83.7%), and dose optimization (77.0%). De-escalation was implemented safely in nearly two-thirds of patients, consistent with earlier studies [17,23]. Nevertheless, inadequate laboratory communication and limited microbiology-guided therapy modifications indicate suboptimal integration between microbiology and clinical services.

The microbiological profile was dominated by Gram-negative organisms, including *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Acinetobacter baumannii*, in agreement with Indian ICU surveillance data [17,24]. Adverse drug reactions were infrequent (9.3%), comparable with previous reports [17,20].

Overall antimicrobial policy adherence was moderate, with better compliance for first-line agents than for broad-spectrum and reserve antimicrobials [23,25]. Adherence varied across clinical conditions, with poorer compliance in cellulitis and post-surgical infections, highlighting areas requiring targeted stewardship interventions.

Overall, the findings suggest that ASP implementation in the ICU was largely aligned with stewardship principles, particularly in antimicrobial selection and treatment-phase management. However, persistent gaps in diagnostic stewardship, microbiological integration, and condition-specific policy adherence underscore the need for strengthened multidisciplinary collaboration, improved laboratory-clinician communication, and continuous audit-based stewardship interventions to combat antimicrobial resistance in critical care settings.

CONCLUSION

This study demonstrates generally high adherence to antimicrobial stewardship practices in the ICU of a tertiary care teaching hospital, particularly regarding appropriate antimicrobial selection, route, and empirical therapy. However, significant gaps persist in diagnostic stewardship, microbiological utilization, and de-escalation practices. The predominance of broad-spectrum antimicrobial use and Gram-negative pathogens highlights the continuing threat of antimicrobial resistance in critically ill patients. Although adherence was satisfactory across most antimicrobial classes and clinical conditions, poor compliance in cellulitis and post-surgical infections underscores the need for targeted stewardship interventions. Strengthening microbiology-driven decision-making, ensuring timely laboratory communication, and reinforcing guideline-based prescribing through multidisciplinary stewardship initiatives are critical to optimizing antimicrobial use and combating antimicrobial resistance in resource-limited ICU settings.

Ethics Approval and Consent to Participate

The study was conducted after obtaining approval from the Institutional Ethics Committee of Lala Lajpat Rai Memorial (L.L.R.M.) Medical College, Meerut, Uttar Pradesh (Ref. No. SC-1/2024/5283). As this was a retrospective observational study based on case record review, patient confidentiality was strictly maintained and no patient identifiers were used.

List of Abbreviations

- ADR – Adverse Drug Reaction
- AMR – Antimicrobial Resistance
- AMS – Antimicrobial Stewardship
- ASP – Antimicrobial Stewardship Program
- CRS – Central Record Section
- ICU – Intensive Care Unit
- ICMR – Indian Council of Medical Research
- MDR – Multidrug Resistant
- SVBP – Sardar Vallabh Bhai Patel Hospital
- UTI – Urinary Tract Infection
- WHO – World Health Organization

Data Availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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