Original Research

A DRUG UTILIZATION EVALUATION STUDY OF BROAD-SPECTRUM ANTIBIOTIC PRESCRIBING PATTERNS AND ANTIMICROBIAL RESISTANCE TRENDS IN AN INTENSIVE CARE UNIT - A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: Broad-spectrum antibiotics are widely used in intensive care units (ICUs) because of the severity of infections and the need for early empirical therapy. However, inappropriate and excessive use contributes to antimicrobial resistance (AMR), increased morbidity, prolonged hospitalization, and rising healthcare costs. Drug utilization evaluation (DUE) helps assess prescribing practices and supports rational antibiotic use.

Aim: To evaluate the utilization pattern of broad-spectrum antibiotics and assess antimicrobial resistance trends among patients admitted to the ICU of a tertiary care hospital.

Materials and Methods: A prospective observational study was conducted in the ICU of a tertiary care hospital from November 2017 to November 2018. A total of 200 adult patients (18–65 years) who received at least one broad-spectrum antibiotic were included. Data on demographics, clinical indications, antibiotic class, dose, duration, type of therapy (empirical or culture-guided), microbiological findings, and outcomes were collected using a structured case record form. Descriptive statistical analysis was performed.

Results: Of the 200 patients, 62% were male, with a mean age of 49.6 ± 11.2 years. Sepsis (36%) was the leading cause of ICU admission. Third-generation cephalosporins (32%), carbapenems (26%), and beta-lactam/beta-lactamase inhibitor combinations (21%) were most commonly prescribed. Empirical therapy accounted for 70% of prescriptions. Culture positivity was observed in 58% of cases, predominantly gram-negative organisms. *Klebsiella pneumoniae* (34.5%) and *Escherichia coli* (27.6%) were the most frequent isolates. High resistance to cephalosporins and fluoroquinolones and emerging carbapenem resistance were noted.

Conclusion: Extensive empirical use of broad-spectrum antibiotics and significant resistance trends highlight the urgent need for antimicrobial stewardship, culture-guided therapy, and continuous resistance surveillance in ICU settings.

Keywords: Drug Utilization Evaluation, Broad-Spectrum Antibiotics, Antimicrobial Resistance, Intensive Care Unit; Empirical Therapy, Antimicrobial Stewardship.

INTRODUCTION

Antibiotics play a critical role in the management of infections in intensive care units (ICUs), where patients are often critically ill, immunocompromised, and exposed to invasive procedures (1). Due to the high risk of life-threatening infections and diagnostic uncertainty at the time of admission, early initiation of broad-spectrum antibiotics is a common and often necessary practice in ICU settings (2). Prompt empirical therapy has been shown to reduce morbidity and mortality in severe infections such as sepsis and septic shock (3). However, inappropriate antibiotic selection, excessive use of broad-spectrum agents, prolonged treatment duration, and failure to de-escalate therapy based on microbiological findings contribute significantly to the growing problem of antimicrobial resistance (AMR) (4).

Antimicrobial resistance has emerged as a major global public health concern, threatening the effectiveness of existing antibiotics and increasing healthcare burden worldwide (5). Hospital environments, particularly ICUs, act as hotspots for the emergence and dissemination of resistant microorganisms (6). Factors such as high antibiotic consumption, prolonged hospital stays, frequent use of invasive devices, cross-transmission between patients, and the presence of multidrug-resistant organisms contribute to the rapid development of

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resistance in these settings (7). Several studies have reported that approximately 70–90% of ICU patients receive at least one antimicrobial agent during their hospital stay, highlighting the magnitude of antibiotic exposure in critical care units (8).

Broad-spectrum antibiotics, including third-generation cephalosporins, carbapenems, beta-lactam/beta-lactamase inhibitor combinations, and fluoroquinolones, are commonly prescribed in ICUs (9). While these agents provide extensive coverage against potential pathogens, their indiscriminate use is strongly associated with the selection of resistant bacteria such as *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and methicillin-resistant *Staphylococcus aureus* (10). The emergence of resistance to last-line antibiotics, particularly carbapenems, poses a serious challenge to effective infection management in critically ill patients (11).

Drug utilization evaluation (DUE) is a structured and ongoing process designed to assess the appropriateness, safety, and effectiveness of medication use (12). In the context of antibiotics, DUE studies help identify irrational prescribing patterns, deviations from treatment guidelines, and opportunities for optimizing therapy (13). When combined with antimicrobial resistance surveillance, DUE provides valuable insights into the relationship between prescribing practices and resistance trends, thereby supporting the implementation of antimicrobial stewardship programs (14).

Despite increasing awareness of antimicrobial resistance, there remains a lack of prospective data evaluating broad-spectrum antibiotic utilization and resistance patterns in ICUs of tertiary care hospitals in developing countries (15). Therefore, the present study was undertaken to evaluate the prescribing patterns of broad-spectrum antibiotics and assess antimicrobial resistance trends among ICU patients, with the aim of promoting rational antibiotic use and improving patient outcomes.

Aim and Objectives

Aim

The aim of the present study was to evaluate the utilization pattern of broad-spectrum antibiotics and to assess antimicrobial resistance trends among patients admitted to the intensive care unit of a tertiary care hospital.

Objectives

Primary Objectives

1. To analyze the prescribing patterns of broad-spectrum antibiotics in intensive care unit patients.
2. To assess the prevalence and patterns of antimicrobial resistance among isolated pathogens in ICU patients.

Secondary Objectives

1. To evaluate the proportion of empirical versus culture-guided antibiotic therapy in the ICU.
2. To identify the commonly prescribed classes of broad-spectrum antibiotics.
3. To determine the frequency of major microorganisms isolated from clinical samples.
4. To assess the association between antibiotic utilization patterns and antimicrobial resistance trends.
5. To generate evidence that supports rational antibiotic use and antimicrobial stewardship in intensive care settings.

MATERIALS AND METHODS

Study Design

The aim of this prospective observational study was to determine the trends in antimicrobial resistance and the use of broad-spectrum antibiotics by patients admitted to the intensive care unit (ICU). Because the study was observational in nature, the recommended treatment regimens were not altered or intervened in any way. Every patient got standard medical care, as determined by the treating physician's judgment and the institutional treatment guidelines.

Study Duration

Over the course of a year, from November 2017 to November 2018, the study was conducted. All eligible patients who were hospitalized to the intensive care unit during this time were screened for inclusion. From the start of antibiotic medication until treatment completion, ICU release, or any recorded clinical result, every enrolled patient was monitored prospectively.

Study Setting

The research was carried out in a tertiary care hospital's intensive care unit. The intensive care unit is a multidisciplinary facility that offers cutting-edge medical treatment to critically ill patients who need life-saving procedures, ventilatory support, and constant monitoring. Patients from the emergency, surgical, trauma, and medical departments were admitted to the intensive care unit.

Study Population

Adult ICU patients who were given at least one broad-spectrum antibiotic while in the hospital made up the study population. Antimicrobial drugs that exhibit activity against a broad spectrum of gram-positive and gram-negative organisms are referred to as broad-spectrum antibiotics. These included fluoroquinolones, glycopeptides, beta-lactam/beta-lactamase inhibitor combos, carbapenems, third-generation cephalosporins, and other comparable medications frequently used in intensive care units.

Inclusion Criteria

Patients who met each of the following requirements were accepted into the study:

- Age between 18 and 65 years

- ICU admission throughout the research period
- Prescription of at least one broad-spectrum antibiotic
- Completion of follow-up during ICU stay

Exclusion Criteria

Patients who satisfied any of the following requirements were not allowed to participate in the study:

- Age below 18 years or above 65 years
- ICU stay of less than 24 hours
- Pregnant or lactating women
- Patients with incomplete, missing, or inaccessible medical records

Sample Size

The study involved 200 patients in total. The typical ICU admission rate, the anticipated frequency of antibiotic use, and the study's viability were taken into consideration when determining the sample size. During the trial period, all eligible patients who satisfied the inclusion criteria were enrolled until the necessary sample size was reached.

Data Collection Procedure

A pre-made, structured case record form (CRF) was used to collect data prospectively. Records pertaining to microbiology, laboratory investigation reports, medication charts, and patient medical files all contained pertinent information. The information gathered consisted of:

- **Demographic details:** age and gender
- **Clinical details:** primary diagnosis, reason for ICU admission, associated comorbid conditions
- **Antibiotic-related details:** name of the antibiotic, therapeutic class, dose, route of administration, frequency, and duration of therapy
- **Type of therapy:** empirical therapy or culture-guided (targeted) therapy
- **Microbiological data:** type of clinical specimen collected, isolated microorganisms, and antibiotic susceptibility test results
- **Treatment outcomes:** clinical improvement, discharge from ICU, or other documented outcomes

Outcome Measures

The primary and secondary outcome measures of the study were:

- Evaluation of the pattern of broad-spectrum antibiotic utilization among ICU patients
- Determination of the proportion of empirical versus culture-guided antibiotic therapy
- Assessment of the distribution and prevalence of microorganisms isolated from various clinical samples
- Analysis of antimicrobial resistance patterns among the isolated pathogens

Statistical Analysis

A Microsoft Excel spreadsheet containing all of the acquired data was used for analysis using the relevant statistical software. Data analysis was conducted using descriptive statistical techniques. Means and standard deviations were used to represent continuous data, while frequencies and percentages were used to summarize categorical variables. When appropriate, tables and figures were used to display the data analysis.

Ethical Considerations

An Institutional Ethics Committee assessment and approval of the study protocol was obtained before the study started. Patient care was not altered because the study was observational. All gathered data was anonymised and utilized only for academic and research reasons, and patient confidentiality was rigorously upheld.

RESULTS

Demographic and Clinical Characteristics

A total of 200 ICU patients who received at least one broad-spectrum antibiotic were included in the study. Among them, 124 (62%) were male and 76 (38%) were female. The mean age of the study population was 49.6 ± 11.2 years. The majority of patients were admitted due to sepsis, respiratory infections, and post-operative complications.

Table 1: Demographic Characteristics of Study Population (n = 200)

Variable	Category	Number (%)
Age (years)	18–40	58 (29.0)
	41–65	142 (71.0)
Gender	Male	124 (62.0)
	Female	76 (38.0)
Mean age (years)	—	49.6 ± 11.2

Clinical Indications for ICU Admission

Sepsis was the most common indication for ICU admission, followed by respiratory tract infections and post-surgical complications.

Table 2: Indications for ICU Admission

Indication	Number (%)
Sepsis	72 (36.0)

Respiratory tract infections	54 (27.0)
Post-operative complications	38 (19.0)
Central nervous system infections	20 (10.0)
Others	16 (8.0)
Total	200 (100)

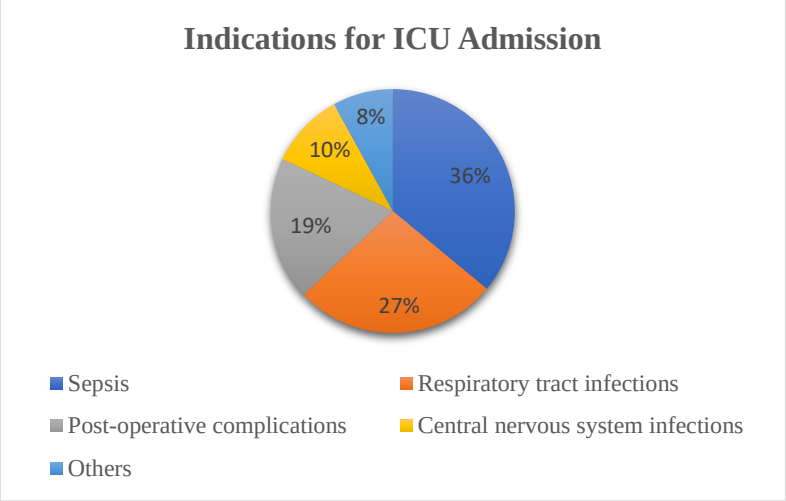

Figure 1: Indications for ICU Admission

Pattern of Broad-Spectrum Antibiotic Utilization
Broad-spectrum antibiotics were prescribed in 92% of ICU admissions. The most frequently prescribed antibiotics were third-generation cephalosporins (32%), followed by carbapenems (26%) and beta-lactam/beta-lactamase inhibitor combinations (21%).

Table 3: Distribution of Broad-Spectrum Antibiotics Prescribed

Antibiotic Class	**Number (%)**
Third-generation cephalosporins	64(32.0)
Carbapenems	52(26.0)
Beta-lactam/β-lactamase inhibitors	42(21.0)
Fluoroquinolones	22(11.0)
Glycopeptides	20(10.0)
Total	200 (100)

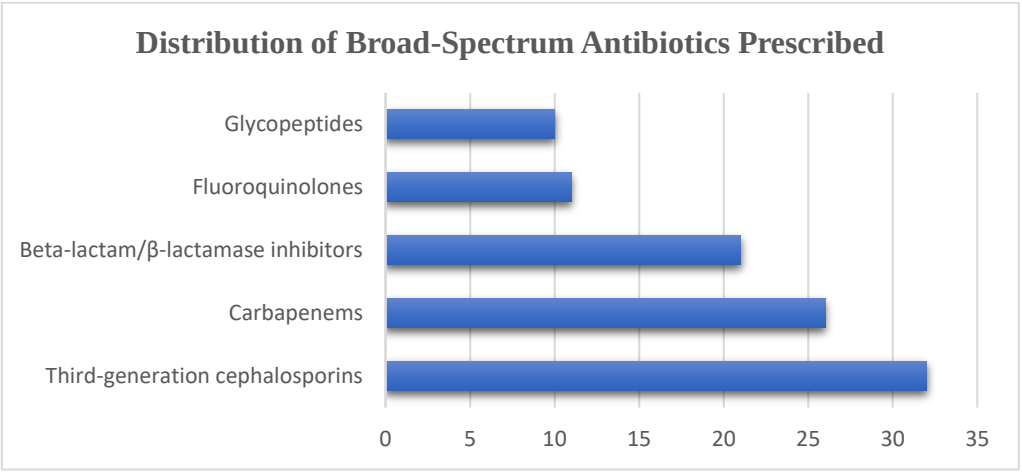

Figure 2: Distribution of Broad-Spectrum Antibiotics Prescribed

Empirical Versus Culture-Guided Therapy
Empirical antibiotic therapy was initiated in **140 (70%)** patients, while **60 (30%)** patients received culture-guided (targeted) therapy based on microbiological reports

Table 4: Type of Antibiotic Therapy

Type of Therapy	Number (%)
Empirical therapy	140 (70.0)
Culture-guided therapy	60 (30.0)
Total	100

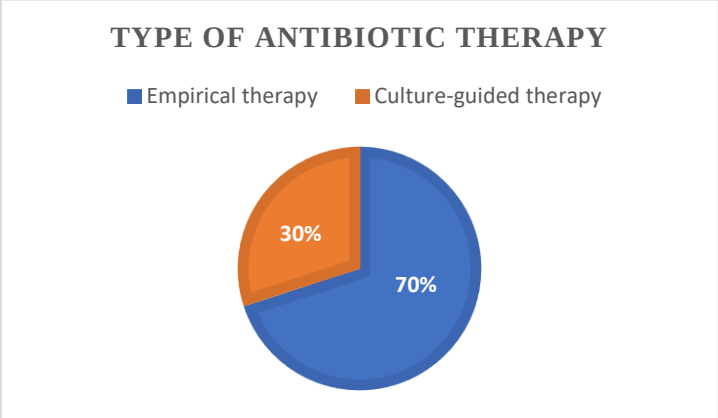

Figure 3: Type of Antibiotic Therapy

Microbiological Profile of Isolated Organisms

Culture positivity was observed in **116 (58%)** patients. Gram-negative organisms were the predominant isolates. *Klebsiella pneumoniae* was the most commonly isolated pathogen, followed by *Escherichia coli* and *Pseudomonas aeruginosa*.

Table 5: Distribution of Microorganisms Isolated (n = 116)

Microorganism	Number (%)
Klebsiella pneumoniae	40 (34.5)
Escherichia coli	32 (27.6)
Pseudomonas aeruginosa	21 (18.1)
Acinetobacter baumannii	14 (12.1)
Staphylococcus aureus	9 (7.7)
Total	116 (100)

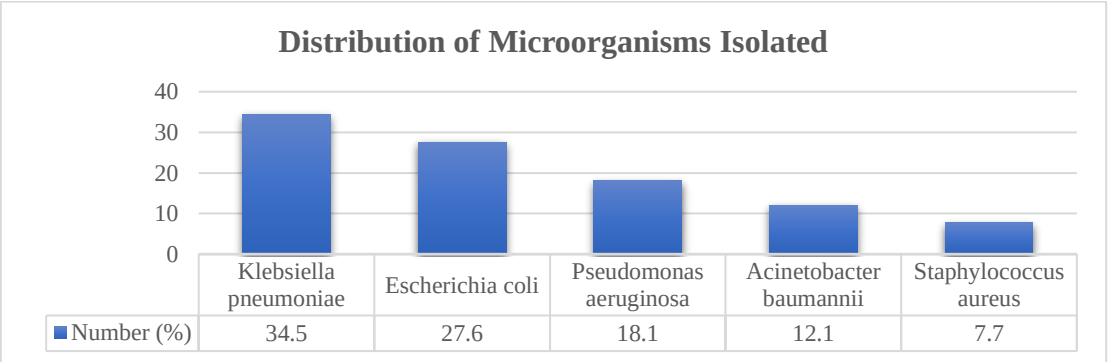

Figure 4: Distribution of Microorganisms Isolated (n = 116)

Antimicrobial Resistance Patterns

High resistance rates were observed against **third-generation cephalosporins** and **fluoroquinolones** among gram-negative isolates. Moderate resistance was noted with beta-lactam/beta-lactamase inhibitor combinations. Emerging resistance to **carbapenems** was observed, particularly among *Klebsiella pneumoniae* and *Acinetobacter baumannii* isolates.

Table 6: Summary of Antimicrobial Resistance Patterns

Antibiotic Class	Resistance Pattern
Third-generation cephalosporins	High resistance
Fluoroquinolones	High resistance
Beta-lactam/β-lactamase inhibitors	Moderate resistance

Carbapenems	Emerging resistance
Glycopeptides	Low resistance

Treatment Outcomes

The majority of patients showed clinical improvement and were discharged from ICU. A smaller proportion required prolonged ICU stay or referral for further management.

DISCUSSION

The present prospective observational study evaluated the utilization pattern of broad-spectrum antibiotics and antimicrobial resistance trends among ICU patients in a tertiary care hospital. The findings highlight extensive use of broad-spectrum antibiotics, a high reliance on empirical therapy, and an alarming burden of antimicrobial resistance, particularly among gram-negative pathogens.

Demographic and Clinical Characteristics

The majority of ICU patients were males (62%) with a mean age of 49.6 ± 11.2 years. Similar demographic distributions have been reported in other ICU-based drug utilization studies, where middle-aged and elderly males constituted the predominant patient population. The higher ICU admission rate among males may be attributed to increased exposure to risk factors, comorbid conditions, and delayed healthcare-seeking behaviour.

Indications for ICU Admission

Sepsis was the most common indication for ICU admission, accounting for 36% of cases, followed by respiratory tract infections and post-operative complications. These findings are consistent with previous studies that identify sepsis as a leading cause of ICU admission and a major driver of broad-spectrum antibiotic use. The high prevalence of infectious indications underscores the critical role of timely and appropriate antibiotic therapy in ICU settings.

Pattern of Broad-Spectrum Antibiotic Utilization

The antibiotic utilization pattern revealed that third-generation cephalosporins were the most frequently prescribed antibiotics, followed by carbapenems and beta-lactam/beta-lactamase inhibitor combinations. This prescribing trend reflects clinicians' preference for agents with wide antimicrobial coverage in critically ill patients. Similar utilization patterns have been documented in earlier studies conducted in tertiary care ICUs. However, excessive reliance on third-generation cephalosporins and carbapenems is concerning due to their strong association with the emergence of resistant organisms.

Empirical Versus Culture-Guided Therapy

Empirical therapy was initiated in 70% of patients, while only 30% received culture-guided therapy. This high proportion of empirical prescribing is comparable to findings from other ICU-based studies and is often justified by the severity of illness and the need for immediate treatment. Nevertheless, failure to modify therapy based on culture results can promote inappropriate antibiotic use and resistance. These findings emphasize the importance of early microbiological testing and timely de-escalation of therapy.

Microbiological Profile

Culture positivity was observed in 58% of cases, with gram-negative organisms predominating. *Klebsiella pneumoniae* and *Escherichia coli* were the most commonly isolated pathogens, followed by *Pseudomonas aeruginosa* and *Acinetobacter baumannii*. This microbial distribution aligns with global ICU surveillance data, which consistently report gram-negative bacteria as the leading cause of ICU-associated infections.

Antimicrobial Resistance Trends

The antimicrobial resistance patterns observed in this study revealed high resistance to third-generation cephalosporins and fluoroquinolones among gram-negative isolates. Moderate resistance to beta-lactam/beta-lactamase inhibitor combinations and emerging resistance to carbapenems were also noted. These findings are particularly concerning, as carbapenems are often considered last-line agents for severe infections. The observed resistance trends reinforce the urgent need for rational antibiotic prescribing and robust antimicrobial stewardship interventions in ICUs.

Clinical Implications

The results of this study highlight the critical balance between early empirical antibiotic therapy and the risk of antimicrobial resistance. Regular drug utilization evaluation studies, combined with continuous resistance surveillance, can help optimize antibiotic use. Implementation of antimicrobial stewardship programs, adherence to treatment guidelines, and promotion of culture-guided therapy are essential strategies to improve patient outcomes and limit the spread of resistant organisms.

CONCLUSION

This prospective observational study demonstrates extensive use of broad-spectrum antibiotics in ICU patients, with a high dependence on empirical therapy. Third-generation cephalosporins, carbapenems, and beta-lactam/beta-lactamase inhibitor combinations were most commonly prescribed. Gram-negative organisms, particularly *Klebsiella pneumoniae* and *Escherichia coli*, predominated, showing significant resistance, including emerging carbapenem resistance. These findings highlight the urgent need for rational antibiotic prescribing. Regular drug utilization

evaluation, antimicrobial resistance surveillance, early culture testing, and effective antimicrobial stewardship programs are essential to optimize antibiotic use, improve patient outcomes, and limit the spread of antimicrobial resistance.

Study Limitations

This study was conducted in a single tertiary care centre, which may limit the generalizability of the findings. The descriptive study design did not allow assessment of causal relationships between antibiotic utilization and resistance patterns. Additionally, standardized antibiotic consumption metrics such as defined daily dose (DDD) and days of therapy (DOT) were not used, and long-term outcomes, including post-discharge resistance patterns, were not evaluated.

Future Scope

Future multicentre studies with larger sample sizes are needed to improve generalizability. Use of standardized metrics such as DDD, DOT, and WHO Aware classification would allow better assessment of antibiotic utilization. Interventional studies focusing on antimicrobial stewardship programs and long-term resistance surveillance, including post-discharge follow-up, are recommended to strengthen efforts against antimicrobial resistance in ICU settings.

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