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Original Research Article

Comprehensive Evaluation of Antimicrobial Usage in The Intensive Care Unit

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ABSTRACT

Background
Infections are a common and significant challenge in Intensive Care Units (ICUs), leading to widespread use of antimicrobial agents (AMAs) for both prophylaxis and treatment. Critically ill patients are especially susceptible to infections due to factors like invasive procedures, immune compromise, and cross-contamination, making effective antimicrobial management essential. However, the frequent use of AMAs also increases the risk of polypharmacy and antimicrobial resistance.

Objectives
This study aimed to assess the patterns of AMA usage in an ICU setting, determine the primary indications for AMA administration, and identify any adverse drug reactions associated with their use.

Methods
A retrospective study was conducted on 300 patients admitted to the Medical ICU of a tertiary care hospital. Data were collected from case records, including demographics, disease details, drug histories, laboratory results, and specifics on AMA regimens such as dosage, frequency, duration, and any reported adverse reactions. The study included patients aged 18-65 who received AMAs during their ICU stay. Descriptive statistics were used to analyze the data.

Results
The study found that 65.3% of patients were male, with an average age of 52 years. Respiratory tract infections (34%) were the most common reason for ICU admission, followed by abdominal infections (26%) and cardiovascular emergencies (24%). Ceftriaxone was the most frequently used AMA (52%), with common combinations including ceftriaxone + metronidazole and ceftriaxone + gentamicin. While 12% of patients received single-drug therapy, 52% were treated with a three-drug combination. Adverse drug reactions were observed in 7% of patients, including symptoms such as nausea, vomiting, and rashes.

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Conclusion
AMAs are extensively used in ICUs, underscoring their role in managing critically ill patients. However, the high incidence of multi-drug combinations highlights the potential for polypharmacy-related risks. Developing strict, evidence-based guidelines for AMA prescribing, supported by culture and sensitivity reports, are essential to minimize adverse interactions, prevent antimicrobial resistance, and optimize patient safety in ICU settings.
Keywords: Respiratory tract infections, antimicrobial resistance, Antimicrobial agents.

INTRODUCTION

The Intensive Care Unit (ICU) is designed for critically ill patients requiring continuous medical supervision and advanced specialized equipment to manage bleeding, support breathing, control toxaemia, and prevent shock. Patients typically enter the ICU from recovery rooms following surgery, hospital wards, or the admission section of the hospital [1].

Antimicrobial agents (AMAs) play a crucial role in the ICU, either for the prevention or treatment of infections, as critically ill patients are particularly vulnerable due to factors such as immobilization, invasive procedures (e.g., ventilators, catheters), compromised immune systems, and exposure to cross-infections.

AMAs encompass a variety of natural and semisynthetic antibiotics, as well as synthetic antimicrobials that target various pathogens, including bacteria, fungi, and protozoa. The selection of AMAs in the ICU is typically empirical, guided by the prevailing strains of pathogens; laboratory evidence for susceptibility is sought primarily in cases of inadequate response or suspected resistance [2,3].

The extensive use of broad-spectrum antibiotics, combined with patient overcrowding in confined areas and the increasing number of critically ill patients, may contribute to the emergence and spread of resistant organisms [4]. However, there are only a limited number of comprehensive studies addressing infections and antibiotic use within ICUs [5,6], resulting in a lack of understanding regarding the indications for antibiotic therapy across various patient populations in a general ICU setting.

The aim of our study was to assess the patterns and criteria for selecting antimicrobials (AMAs) used in the ICU and to identify any adverse drug reactions associated with the administration of these antimicrobials.

MATERIALS AND METHODS

A retrospective study was conducted at a tertiary care hospital involving 300 patients admitted to the Medical Intensive Care Unit. Data were collected from the patients' case records using a standardized proforma, which included demographic information, disease details, laboratory investigations, current and past drug histories, and specifics regarding the antimicrobials used during the ICU stay, such as formulation, dosage, route of administration, frequency, duration of treatment, tolerability, adverse reactions, and drug interactions. Additionally, culture and sensitivity reports were noted, along with the criteria for selecting and combining antimicrobials, to identify any adverse drug reactions associated with their administration.

Inclusion Criteria

The study included patients aged between 18 and 65 years, regardless of gender, who were admitted to the Intensive Care Unit (ICU) and received antimicrobial agents (AMAs) during

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their stay. This age range was selected to focus on adults who are more likely to experience complex health issues necessitating ICU admission and AMA treatment.

Exclusion Criteria

Patients who were not receiving any antimicrobial agents during their ICU stay were excluded from the study. This exclusion was important to ensure that the analysis focused specifically on the effects and outcomes related to AMA administration.

Statistical Method

The data collected from the patient records were analysed using descriptive statistics. This involved summarizing and organizing the data to highlight key characteristics and trends. Wherever applicable, the results were presented in the form of percentages and graphical representations, such as charts and graphs, to facilitate a clearer understanding of the findings and to illustrate patterns related to demographic variables, treatment outcomes, and adverse drug reactions associated with AMA usage in the ICU setting.

RESULT

In this study, 300 patients admitted to the ICU were analysed, of whom 196 (65.3%) were male and 104 (34.6%) were female. The mean age of patients was 52 years, with 168 patients (56%) being over 50 years old, and 132 (44%) below 50 years.

The most common reason for ICU admission was respiratory tract infection (34%), followed by abdominal infections (26%), cardiovascular emergencies (24%), poisoning (10%), septicemia (4%), and urinary tract infections (2%).

Ceftriaxone was the most commonly used antimicrobial agent (AMA), prescribed to 52% of patients, and followed by amoxicillin+clavulanic acid (34%), piperacillin/tazobactam (31%), and metronidazole (29%).

The duration of ICU stays ranged from 2 to 20 days, with an average stay of 4.8 days. Comorbidities were present in 188 patients, accounting for 62.6% of ICU admissions.

In terms of antimicrobial therapy, 12% of patients received a single AMA, while 29% received a two-drug combination, 52% a three-drug combination, and 7% a four-drug combination. The most frequently used medications included ceftriaxone, metronidazole, gentamicin, piperacillin/tazobactam, cefotaxime, linezolid, and amoxicillin/clavulanic acid. The most common AMA combinations were ceftriaxone+metronidazole and ceftriaxone+gentamicin.

Of the patients admitted to the ICU, 92% were eventually transferred to general wards, while 8% were referred to other centres. Adverse drug reactions occurred in 7% of patients, presenting as nausea, vomiting, abdominal pain, rashes, pruritus, and headache.

The details of the various AMAs used are summarized in the table below.

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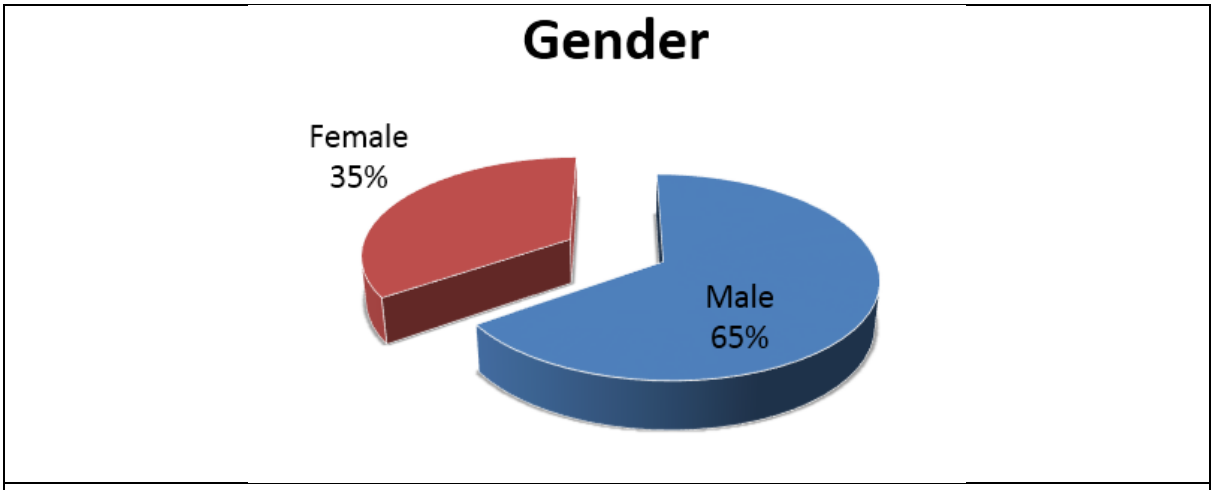
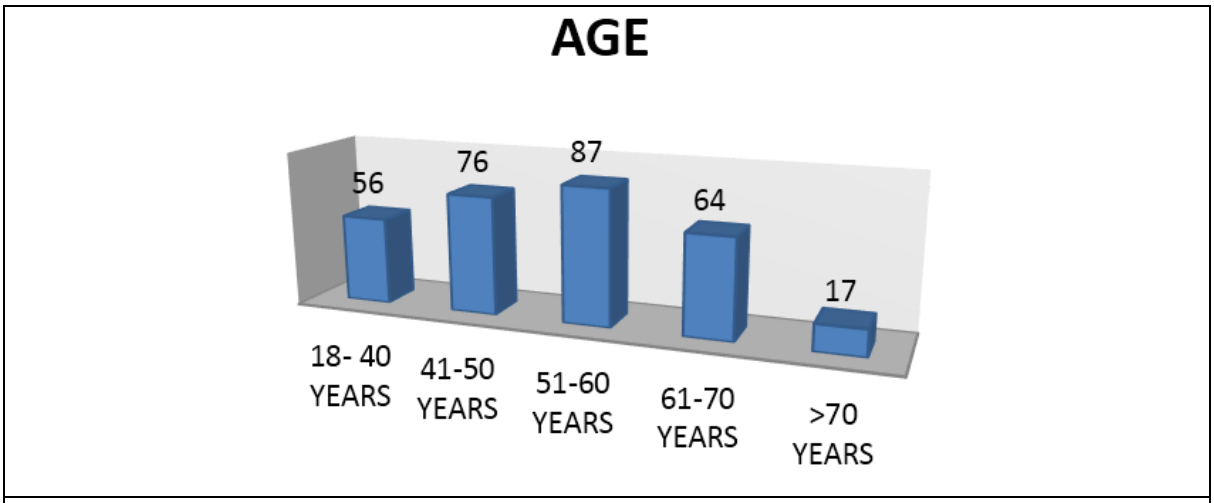
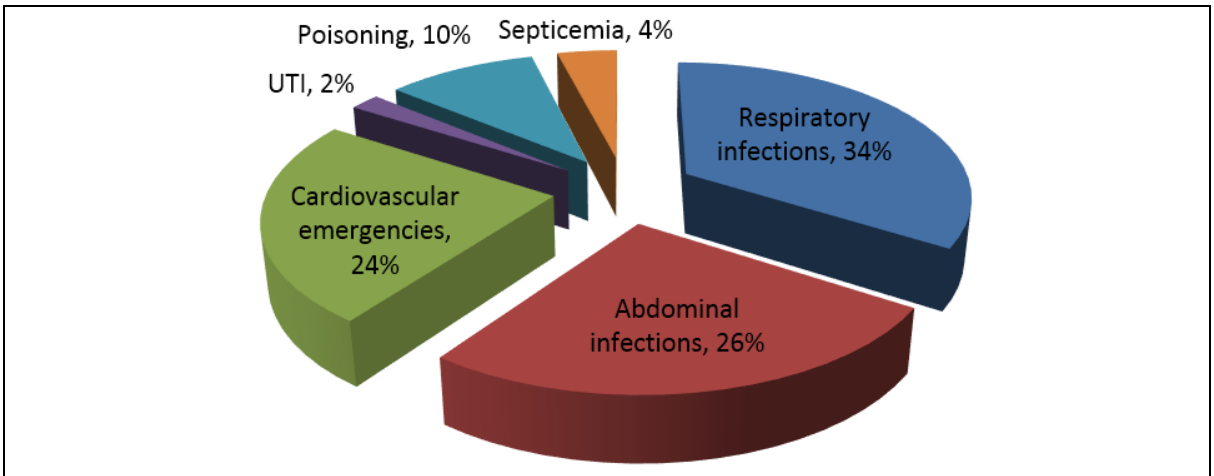


Graph 1



Graph 2



Graph 3: Reason for ICU admission

Antibiotic name	Number of prescriptions	Percentage

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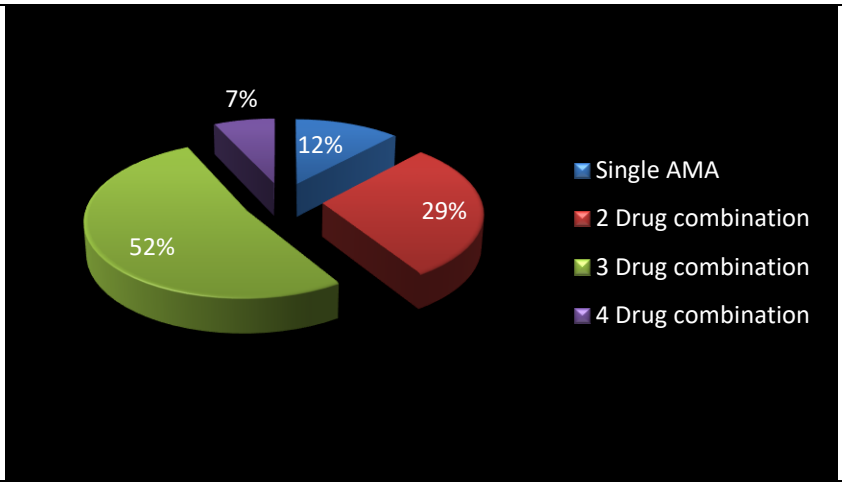
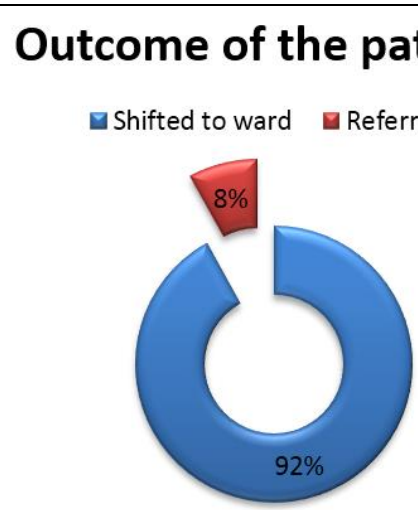
Ceftriaxone	253	33.20%
Metronidazole	146	19.16%
Gentamycin	127	16.60%
Piperacilin/Tazobactum	56	7.34%
Cefotaxime	47	6.16%
Linezolid	31	4%
Amoxicillin/Clavulinic acid	26	3.40%
Meropenem	22	2.88%
Doxycycline	19	2.50%
Cefaperazone/salbactum	12	1.57%
Azithromycin	8	1%
Vancomycin	5	0.65%
Clindamycin	5	0.65%
Ornidazole	3	0.40%
Nitrofurantoin	2	0.26%

Table 1: Antimicrobials prescribed



Graph 4: Percentage of patients with drug combinations



Graph 5

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DISCUSSION

Infections are a frequent challenge in intensive care units (ICUs), leading to the common use of antibiotics in this setting.[7] This study, conducted in the Medicine ICU of a tertiary care hospital with a sample of 300 patients, found that male admissions outnumbered female admissions, with a mean patient age of 52 years, a trend similar to studies conducted in Nepal.[8] In contrast, Smythe et al. observed an equal distribution of male and female admissions with a mean age of 65 years[9], while another study in India also noted a predominance of male patients.[10]

The primary indications for antimicrobial agent (AMA) use in this study were abdominal infections (26%), cardiovascular emergencies (24%), poisoning (10%), and septicemia (4%). This differs from the study by Lisa Jenny John et al., [11] which identified sepsis, acute renal failure, acute respiratory distress syndrome, pneumonia, and lower respiratory tract infections as the most common reasons for AMA administration.

In terms of antibiotic selection, ceftriaxone was the most frequently prescribed AMA, followed by metronidazole, gentamicin, piperacillin/tazobactam, and cefotaxime. These findings differ from those in a study of 35 German ICUs, where penicillin with a beta-lactamase inhibitor was the most commonly used, followed by quinolones and second-generation cephalosporins.[12] Similarly, Shankar et al. found ceftriaxone widely prescribed as an initial therapy, followed by ampicillin, amoxicillin, metronidazole, ciprofloxacin, and crystalline penicillin.[13] The increased use of cephalosporins in this study aligns with the findings of Usluer G et al., who reported that cephalosporins are favoured for their relatively lower toxicity and broad-spectrum effectiveness.[14] They are also commonly combined with aminoglycosides to achieve synergistic effects and provide broader coverage against gram-negative infections.

Regarding AMA combinations, 12% of patients in our study received a single AMA, while 29% received a two-drug combination, 52% a three-drug combination, and 7% a four-drug combination. This contrasts with data from other literature, where the average AMA count per patient is higher, around five.[15] Vandana A. Badar et al. also reported a trend toward using multiple AMAs.[16] In this study, ceftriaxone + metronidazole and ceftriaxone + gentamicin were the most common combinations, contrasting with Biswal et al. and John et al., who found cefoperazone + sulbactam to be the preferred combination.[11,17]

The high number of AMAs per patient increases the risk of drug interactions, bacterial resistance, and hospital costs. Implementing strict antibiotic restriction policies and standardized protocols for antibiotic use is essential to reduce these risks and promote optimal antimicrobial therapy across hospitals.

The culture tests identified a range of isolated organisms in this study, including *Klebsiella*, *Pseudomonas*, *Escherichia coli*, *Staphylococcus aureus*, and *Acinetobacter*.. These pathogens represent common and clinically significant bacteria found in ICU settings, often associated with hospital-acquired infections and known for their potential to develop resistance to multiple antimicrobial agents.

CONCLUSION

AMA’s are commonly administered medications in ICUs, reflecting their essential role in managing critically ill patients. However, the frequent use of these drugs contributes to a high incidence of polypharmacy, which can increase the risk of adverse drug interactions and complications. To address these challenges, establishing clear, evidence-based prescribing guidelines is essential. Such guidelines would help minimize unnecessary polypharmacy,

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ensuring that antimicrobial therapy is not only clinically appropriate but also guided by culture and sensitivity reports whenever possible. This approach promotes targeted, effective treatment strategies while also helping to prevent antimicrobial resistance and improve patient safety in the ICU setting.

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