Original Article

A retrospective study on bacteriological profile and antibiotics prescription practice in a tertiary level intensive care unit

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ABSTRACT

BACKGROUND

Antibiotics are the most commonly prescribed medicines in intensive care units (ICU). The irrational use of antibiotics leads to the development of multidrug-resistant organisms (MDR). The aim of the study is to determine the bacteriological profile of infections in our ICU and antibiotic prescription practice, before and after the culture results.

METHODOLOGY

This is a retrospective study conducted in a tertiary-level, 33-bedded ICU in Nepal to evaluate the bacteriological profile and antibiotic prescription practice. The patients who were admitted between a period of 3 months (January 2023 to March 2023) were enrolled. The data variables collected were; patients' details, culture samples sent (blood, urine, endotracheal (ET) aspirate, sputum, cerebrospinal fluid (CSF), wound swab, pleural fluid, ascitic fluid, tissue culture, and peritoneal fluid), gram stain results, culture sensitivity results, empirical antibiotics used, and change in antibiotics following culture results.

RESULTS

A total of 378 culture samples were obtained from 230 patients. A positive culture report was obtained for 165 (43.65%) of the 378 samples sent. Urine was the most common sample sent for microbiology (28%), followed by blood (25.3%) and sputum (22.75%). The percentage occurrence of gram-negative bacteria was 84%, while that of gram-positive bacteria was 16%. Methicillin- resistant coagulase-negative staphylococcus (MRCONS) was the most common gram-positive organism isolated (46.15%), and Klebsiella pneumoniae was the most common gram-negative organism (38.84%). Cephalosporin was the commonest group of empirical antibiotics used in our ICU, followed by carbapenem. Empirical antibiotic treatment was continued in 108 patients (47%), changed following the culture results in 92 patients (40%), and discontinued in 30 patients (13%). Escalation of antibiotics was done in 78 patients (85%) and de-escalation in 14 patients (15%).

CONCLUSION

Antimicrobial resistance and the irrational prescription of antibiotics can lead to a global economic burden. Hence, antibiotic stewardship programs are required to reduce the irrational prescribing patterns of antibiotics.

KEYWORDS

Antibiotics, Multi-drug resistance, Microorganisms, Escalation, De-escalation

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INTRODUCTION

Intensive care units (ICUs) have always been the epicenter of infections in the hospital setting, and many patients admitted to ICUs become infected with a variety of infections. Although ICUs account for fewer than 5% of total hospital beds, it is believed that they account for 25% - 30% of MDR infections. [1] Pneumonia and bacteremia are the most prevalent infections worldwide, and they are by far the leading cause of death from infections in critically ill patients. [2]

There are distinct patient populations with varying risks and susceptibilities to infections and specific pathogens within ICUs. Appropriate prescription practices should be developed through studies and research in the ICUs. There is wide institutional diversity in the relative prevalence of predominant pathogens and their antimicrobial susceptibilities. [3] The practice of prescribing antibiotics is determined by the microbiological pattern of infection in a particular ICU. The antibiotic resistance pattern is thus distinct for a specific ICU.

It is generally accepted that antibiotics should be administered empirically as soon as possible once an infection is identified. Decisions regarding empiric antibiotic therapy are based on two approaches: (1) a judgment that the likely agent has "normal antibiotic susceptibility" and can therefore be treated as such with a possible need for "escalation" to second-line drugs after microbiological identification; (2) a judgment, based on local microbiology patterns and clinical presentation, that the infecting microorganism may be MDR and should be treated as such with a possible "de-escalation" to a simpler antibiotic regimen after identification and antibiotic susceptibilities of the causative microorganism are known. More frequently, the latter approach is used in the ICU to ensure that all possible causative organisms are initially covered. [4-5]

Although the importance and safety of de-escalation have been well documented, the rate of antibiotic de-escalation is still reported to be inadequate. Antibiotic de-escalation is only accomplished in approximately 35-50% of patients with severe sepsis. Several reasons could explain these unsatisfying rates of antibiotic de-escalation by physicians in the critical care setting, such as the reluctance to change an antibiotic regimen that was proven to be effective, clinically deteriorating patients, lack of microbiological data or lack of confidence in the obtained culture and sensitivity results, fear or poor understanding of how to de-escalate, and the controversial data about its effectiveness and safety. [6]

Antimicrobial resistance (AR) has always been a concerning topic in western medical societies. AR due to inappropriate usage of antibiotics has led to the development of many infections due to multidrug resistant (MDR) organisms. The rise of MDR infections is a source of concern. Patients infected with MDR strains are given high-end medicines such as glycopeptides and carbapenems. These antimicrobial classes are not only hazardous but also expensive, putting a financial strain on the patient. [7]

In this study, we aim to find the most common bacterial infections encountered in our ICU and the pattern of antibiotic use, along with the change in antibiotic prescription practice following culture sensitivity results.

METHOD AND MATERIALS

This is a retrospective study on microbiological patterns and antimicrobial prescribing practices at a tertiary-level intensive care unit. The study was conducted in a 33-bedded intensive care unit of a tertiary-level hospital for a period of 3 months (January 2023 to March 2023). A total of 230 patients were included in the study. The study included a daily collection of data on patients' details (hospital registration number, age, gender), date of admission, diagnosis, initial antibiotics used (empirically), culture samples (blood, urine, endotracheal (ET) aspirate, sputum, cerebrospinal fluid (CSF), wound swab, pleural fluid, ascitic fluid, tissue culture, and peritoneal fluid), antibiotic susceptibility patterns of the microorganism, and the course of antibiotic therapy.

The study included patients admitted to the ICU and started on empirical antibiotics. All patients over 18 years of age were included in the study. Patients who were not on antibiotic therapy and died within 24 hours of admission were excluded from the study. The antibiotic prescription pattern before and after the culture sample results of the patients were obtained and analyzed. Escalation and de-escalation of antibiotic therapy was done based on the culture reports and the clinical status of the patient.

The study variables were collected manually in a specially designed Performa from the patient's record and entered into an Excel sheet. The data were analyzed using percentage proportions.

RESULTS

The clinical samples of the patients that were sent for culture and sensitivity were noted, and their sensitivity pattern was analyzed.

A total of 378 culture samples obtained from 230 patients were analyzed. This included 106 samples sent for urine culture, 96 for blood culture, 86 for sputum culture, 48 for endotracheal aspirate culture, followed by other samples; 14 CSF samples, 10 wound swabs, 8 pleural fluid samples, 6 ascitic fluid samples, and 4 tissue culture samples. (Figure 1)

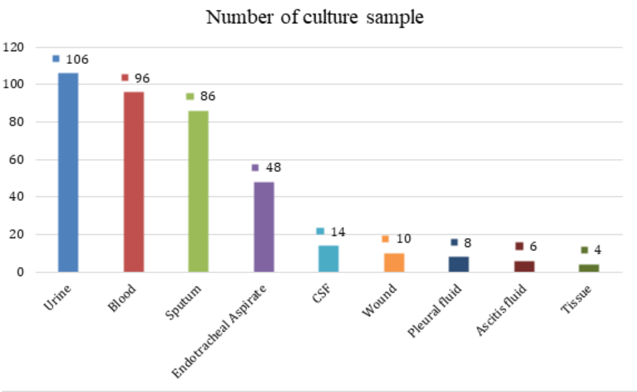

Figure 1: The number of culture samples sent from patients.

The percentage occurrence of gram-positive and gram-negative bacteria in our ICU is given in Figure 2. Results showed that there were a greater number of gram-negative bacteria isolated than gram-positive bacteria.

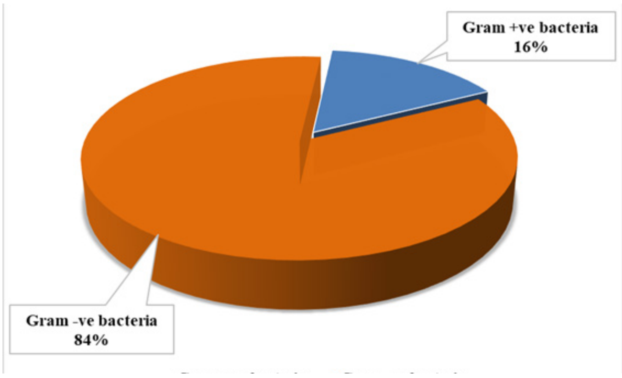

Figure 2: Percentage occurrence of Gram-positive and Gram-negative bacteria

A positive culture result was obtained for 165 (43.65%) of the 378 samples sent. Methicillin-resistant coagulase-negative staphylococci (MRCON) was the commonest gram-positive organism isolated (46.15%), followed by Enterococcus faecium (23.07%), Streptococcus pyogenes (11.50%), Staphylococcus aureus (7.69%), Methicillin-resistant staphylococcus aureus (MRSA), Vancomycin-resistant enterococci (VRE), and Methicillin-sensitive staphylococcus aureus (MSSA) with 3.84% each. (Figure 3)

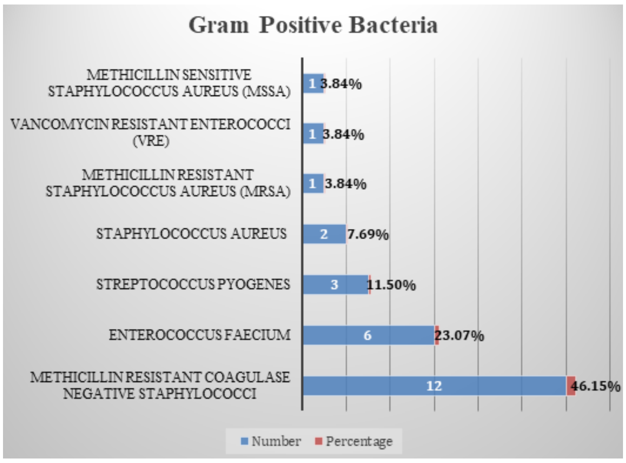

Figure 3: The number of gram-positive bacteria grown in culture samples

Klebsiella pneumoniae was the commonest gram-negative organism isolated (38.84%), followed by Pseudomonas aeruginosa (18.70%), Acinetobacter baumannii (15.10%), Escherichia coli (12.94%), Enterobacter cloacae (5.03%), Citrobacter koseri, and Enterobacter aerogenes (2.87% each), Citrobacter freundii (2.15%), and Klebsiella oxytoca (1.43%). (Figure 4)

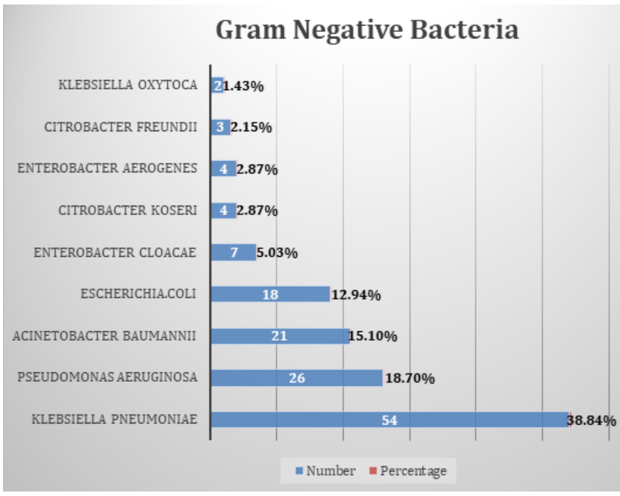

Figure 4: The number of gram-negative bacteria grown in culture samples

The patients were started empirically with one or more antibiotics such as penicillin derivatives (Amoxicillin, Flucloxacillin), cephalosporins (Ceftriaxone, Cefotaxime, Cefuroxime, Cefepime), carbapenems (Meropenem, imipenem/cilastatin), aminoglycosides (Amikacin, Gentamycin), macrolides (Azithromycin), tetracycline (Doxycycline, Tigecycline), glycopeptide derivative (Vancomycin, Teicoplanin), lincosamide antibiotic (Clindamycin), and oxazolidinone (Linezolid), Floroquinolones (Ciprofloxacin, Levofloxacin), Polymyxins (Polymyxin-B, Colistimethate sodium), Nitromidazole (Metronidazole), and sulfonamides (sulfamethoxazole/trimethoprim). The antibiotics in formulation with beta-lactam were also prescribed empirically, such as Amoxicliin/ Clavulanic acid, Piperacillin/ Tazobactam, Cefoperazone/ Sulbactam, Ceftazidime/ Sulbactam, Cefepime/ Sulbactam, and Ceftazidime/ Avibactam). (Figure 5)

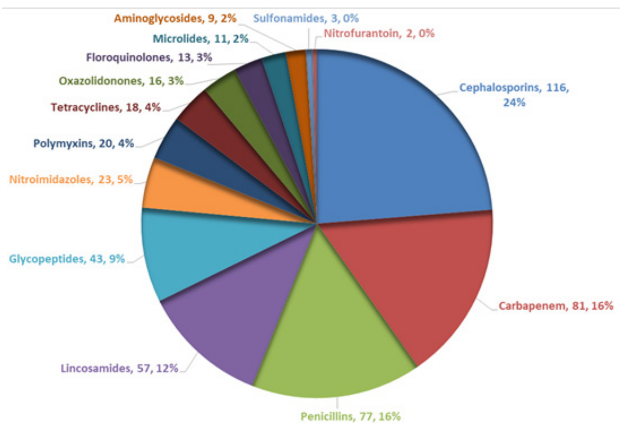

Figure 5: The number of Antibiotics prescribed for patients.

Following the culture sensitivity reports, the empirical antibiotic treatment was continued in 108 patients (47%), there was a change in antibiotics following the culture report in 92 patients (40%), and the antibiotics were discontinued in 30 patients (13%). (Figure 6)

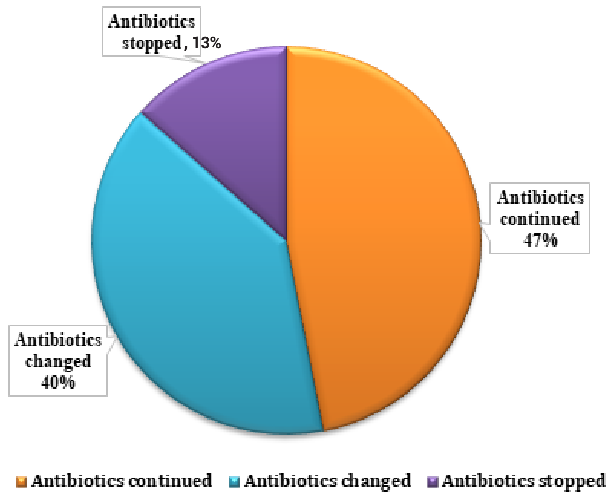

Figure 6: The course of antibiotics therapy

Out of 92 patients for whom antibiotics were changed after culture reports, there was an escalation of antibiotics in 78 patients (85%), whereas there was a de-escalation of antibiotics in 14 patients (15%). (Figure 7)

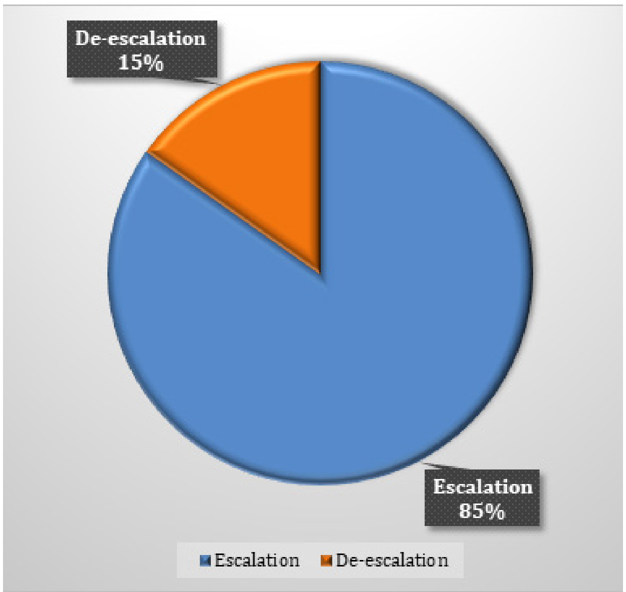

Figure 7: Escalation and de-escalation of antibiotics

DISCUSSION

Infection is a common problem for patients admitted to intensive care units (ICUs) and is associated with significant morbidity, mortality, and costs [8-11]. The EPIC II study demonstrated a high prevalence of infection in critically ill patients (51.4%), the commonest being respiratory tract infections (63.5%). [12] This retrospective, single-center study assesses microbiological patterns and antimicrobial prescription practice in one of the largest tertiary-level ICUs in Nepal.

In our study, the commonest sample sent for microbiology was urine (28%). The commonest sample sent in the study by Rajendran et al. was blood (34.5%) [7]. The reason for high urine sampling in our ICU could be attributed to a larger population of geriatric patient admissions and cases referred from other centers with Foley catheter in situ.

The percentage of gram-negative organisms isolated in our study was 84%. The prevalence of gram-negative infections in the ICU is a common finding in most studies done around the world. In the EPIC II study, the incidence of gram-negative infections was 62.2%. The incidence of MRSA infection in our study was 3.84%, which was significantly lower in comparison to the finding in the EPIC II study (10.2%). [12] This could be attributable to health care providers' greater understanding of hand hygiene and isolation protocols during the last decade.

The majority of pathogens isolated in the ICU were from the ESKAPE group (i.e., Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa, and Enterobacter species). The ESKAPE group accounted for 81% of the pathogens in our study. This is comparable to the studies by Llaca-Diaz et al. (64.5%) and Masoud et al. (68.4%). [13-14]

The commonest group of empirical antibiotics used in our ICU was cephalosporin (24%), and the second commonest group was carbapenem (16%). A study done by Kayambankadzanja et al. stated Ceftriaxone (73.4%) as the most commonly used antibiotic for empirical therapy. [15] The common use of carbapenems as empiric therapy in our study could be attributed to the high proportion of patients received from other centers who had already received one or more broad-spectrum antibiotics with no clinical improvement. Additionally, the prevalence of carbapenem-resistant organisms is increasing in South Asia due to irrational antimicrobial use.

A significant proportion of patients (47%) were continued on empirical antibiotics even after culture reports were available, the reasons being: sensitivity to empirical antibiotics, acceptable clinical improvement on empirical therapy, the primary physician's choice, and unacceptable pharmacokinetics of the sensitive antibiotics. (e.g., polymyxin-B sensitivity for urosepsis).

In our study, a change of antibiotics following culture results was done in 40% of patients. A study by Malacarne et al. stated that antibiotics had to be changed or added for 37.6% of patients after the culture reports, and the most commonly used antibiotic was third-generation cephalosporins or carbapenems. [16] Another study by Rajendran et al. stated that antibiotics were changed in 39% of patients after culture results. [7]

LIMITATIONS

Our study had several limitations, including a small sample size, a limited time duration, and a lack of previous research on the topic.

CONCLUSION

A wide range of microbiological patterns is observed in critically ill patients with suspected infections. The microbiological tests should be prescribed based on the pattern of the prevalence of infections. The lack of an antibiotic policy or antibiotic stewardship program can lead to a wide variety of antibiotic prescribing patterns, which in turn can lead to the development of MDR strains. Antimicrobial resistance and the irrational prescription of antibiotics can lead to a global economic burden. Hence, it is crucial to test the feasibility and acceptance of clinical guidelines among surgeons and treating physicians and try to achieve consensus before implementing them.

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