Original Article

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Antibiotic Prescribing Practice in the Intensive Care Unit of a Nigerian Teaching Hospital

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ABSTRACT

Background: *Antibiotics are vital in the prevention and treatment of bacterial infections. However, prescribing practices often deviate from established guidelines with prolonged durations of surgical prophylaxis, redundant antibiotic combinations, and a significant reliance on broad-spectrum agents. This study aims to determine antibiotic prescribing practices at our teaching hospital.*

Methods: *This was a prospective, descriptive, cross-sectional study of adult patients admitted to the ICU at the University of Ilorin Teaching Hospital, Ilorin, Kwara State, Nigeria. The study participants were critically ill patients between the ages of 6 months and 65 years who were admitted to the ICU. Using a questionnaire, information such as age, sex, diagnosis, antibiotic prescription, regularity of administration, use of microbiological investigations, and outcome of ICU care was extracted from the patients' hospital files and recorded. Data from this study were summarized and reported as means ± standard deviation, frequencies, or proportions of the total. A p-value of less than 0.05 was considered statistically significant.*

Results: *A total of 128 ICU patients were enrolled in the study. One hundred and twenty-four (96.88%) patients were prescribed antibiotics. Antibiotic prescriptions were for prophylactic reasons in 56 (45.16%) patients and for therapeutic reasons in 68 (54.84%) patients. All antibiotic prescriptions were empirical. The most frequently prescribed antibiotic was ceftriaxone. The most frequently prescribed antibiotic combination was Ceftriaxone/Metronidazole. There was no statistically significant difference in gender (0.7651) and age (p = 0.0775) between those who survived to ICU discharge and those who died. Prophylactic antibiotic prescription was associated with survival to ICU discharge compared to therapeutic prescription (p = 0.0018).*

Conclusion: *Ceftriaxone was the primary empirical ICU antibiotic therapy, while metronidazole was used strategically for anaerobic coverage. In this study, critical care physicians favored empirical therapy over targeted therapy.*

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1. Introduction

It is not only important to select the right medications; the prescribing pattern must also be appropriate. Medication must be administered in the right dosage, frequency, and for the appropriate duration. Antibiotics are vital in the prevention and treatment of bacterial infections. Their use has contributed to the control of life-threatening diseases. However, when they are not prescribed appropriately, the beneficial results may not be apparent. An appropriate prescription involves using the right antibiotic at the right dose for the right duration.

In Africa, and especially in Nigeria, the prevalence of antibiotic use among hospitalized patients is notably high, with rates ranging from 37.7% in South Africa[1] to 80.1% in Nigeria.[2] Within the hospital, the ICU is associated with a higher rate of antibiotic usage than other wards.[3] The Intensive Care Unit (ICU) is a specialized section of the hospital devoted to the care of critically ill patients, many of whom either have sepsis or have a high risk of healthcare-associated infections due to invasive procedures and compromised immunity. Antibiotics play an important role in the management of these patients.

Despite their benefits, antibiotics have side effects, some of which may be serious adverse effects; therefore, patients should not be exposed to them unnecessarily.[4] The misuse of antibiotics contributes to the development of antibiotic resistance, which compromises the effectiveness of antibiotics.[5,6] Antibiotic resistance has the potential to reduce the availability of antibiotics effective in the fight against infections, which may threaten critical care management and lead to millions of deaths worldwide if not addressed.

To prevent the inappropriate use of antibiotics, organizations such as the World Health Organization have established guidelines to guide physicians in the prevention and treatment of infection.[7] While the use of these guidelines is encouraged, it has been suggested that prescribing practices often deviate from established guidelines, with prolonged durations of surgical prophylaxis, redundant antibiotic combinations, and a significant reliance on broad-spectrum agents observed in Nigerian settings.[2] Antibiotic stewardship programs are important to ensure strict adherence to established guidelines.

Despite recognition of these challenges, there remains a substantial gap in the literature regarding detailed antibiotic prescribing patterns, particularly in Nigerian ICUs. The objective of this study is to determine the most frequently prescribed antibiotics, their duration of use, the regularity of administration, and their association with the outcome of ICU admission. This knowledge is required in designing appropriate antimicrobial stewardship interventions and guiding policy development.

2. Method

Study setting

This study was carried out at the Intensive Care Units of the University of Ilorin Teaching Hospital, Ilorin, Kwara State, Nigeria. Our hospital is a tertiary health institution located in the north-central region of Nigeria. The hospital has two adult ICUs with a total of 13 beds where surgical and medical critical care cases are managed.

Study design

This was a prospective, observational cross-sectional study of adult patients admitted into the ICU.

Study population

The study participants were critically ill patients between the ages of 6 months and 65 years who were admitted to the ICU. Exclusion criteria included the patient's or relatives' refusal to participate in the study.

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Ethical consideration

Ethical approval was obtained from the University of Ilorin Teaching Hospital Ethical Review Committee before the commencement of the study. Also, in accordance with the Declaration of Helsinki, written informed consent, signed and dated, was obtained from all participants after the investigator provided them with a detailed explanation of the procedure. All information obtained from the patients was treated with strict confidentiality, and the data obtained was used strictly for research purposes.

Sample size determination

The sample size was determined using the Cochran formula[8] for observational studies, with the estimated proportion of the attribute in the population set at 0.8, as reported in a previous study.[2] After adjusting for a finite population and considering the attrition factor, the final sample size was 117.

Data collection

The participants were enrolled in the study on the day of admission. Using a questionnaire developed by the authors, demographic information, including age and sex, was extracted from patients' hospital files and recorded. Other information, such as diagnosis, antibiotic prescription, regularity of administration, use of microbiological investigations, and outcome of ICU care, was also documented. The patients were visited every day to update information on antibiotic usage and the outcome of ICU care. Data were collected by two resident doctors in the department of anaesthesia, who had been trained to use the questionnaire.

Methods to minimize bias/errors

To ensure reliability and validity and prevent measurement errors, a pilot test was conducted to identify potential challenges with the questionnaire. The pilot test was conducted in the surgical ward and the operating theatre on 20 adult patients scheduled for elective surgical procedures. The Cronbach's alpha was 0.76. Pilot test participants were not subsequently included in the research. Necessary adjustments were subsequently made to the questionnaire before the study commenced. Furthermore, measurement errors were addressed by ensuring that the anaesthesia residents who collected the data had been specifically trained to use the questionnaire.

Variables

The study's outcome variables are the type of antibiotic prescribed, the frequency of antibiotic prescription, and the regularity of antibiotic administration. The exposure variable was the availability of microbiological evidence at the time of prescription. The predictors were patient demographics (age and sex).

Data analysis

Data from this study were summarized and reported as means ± standard deviation, frequencies, or proportions. Qualitative variables, such as gender and surgical outcome, were analyzed with the chi-square test, while quantitative variables, such as antibiotic duration, were analyzed with the Student's t-test. The computer software package was SPSS version 21.0. A p-value of less than 0.05 was considered statistically significant.

3. Result

Demographic data and indication for admission

A total of 128 ICU patients were enrolled in the study. There were 70 males and 58 females. The mean age of the participants was 40.16 years, with a range of 6 months to 80 years.

ICU admission

The indications for ICU admission were postoperative care 134, stroke 8, traumatic brain injury 8, ecclampsia/pre-ecclampsia 6, sepsis 4, burns 4, and acute chest syndrome 4. There were also two

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admissions each of viral encephalitis, aspiration pneumonia, acute pulmonary oedema, pulmonary embolism, HELLP syndrome, and penetrating thoracic injury.

The ICU admission days were a total of 382 days, with a range of 1-16 days. The mean ICU admission duration was 2.98 days.

Antibiotic prescription pattern

One hundred and twenty-four (96.88%) patients were prescribed antibiotics, while 4 (3.12%) patients were not. Antibiotic prescriptions were for prophylactic reasons in 56 patients and for therapeutic reasons in 68 patients.

All 124 patients who were prescribed antibiotics had their prescriptions written before ICU admission, and none had microscopy, culture, or sensitivity tests performed before antibiotic prescription. Therefore, all prescriptions were empirical.

The most frequently prescribed antibiotic was ceftriaxone 94. Others were metronidazole (78), levofloxacin (20), meropenem (16), gentamicin (6), ceftazidime (4), and azithromycin (4). The most frequently prescribed combination of antibiotics was Ceftriaxone/Metronidazole 56, meropenem/metronidazole 14, amoxicillin/clavulanic acid 14, levofloxacin/ceftriaxone 10, levofloxacin/meropenem 6, ciprofloxacin/metronidazole 6, piperazine/tazobactam 4, piperazine/tazobactam/metronidazole 4. The most frequently prescribed antibiotics as second-line treatment were Meropenem 12, Levofloxacin 10, and piperazine/tazobactam 4.

Antibiotic administration

Thirty-six (29.03%) patients had one antibiotic prescribed and administered, and 60 (48.39%) patients had two antibiotics prescribed and administered. Eighteen (14.52%) patients received three antibiotics, while 10 (8.07%) received four.

Antibiotic administration was regular in 108 (87.10%) patients and irregular in 16 (12.90%) patients. Twelve (9.68%) patients missed less than 25% of the scheduled doses, while 4 (3.23%) missed between 25% and 50% of the scheduled doses.

Outcome of ICU admission

Sixty-eight (53.13%) patients were discharged from the ICU, while 60 (46.88%) died. There was no statistically significant difference in sex with a p value of 0.7651 (fig 1). Also, those who survived to ICU discharge had a mean age of 42.45 (16.27) years, while those who did not survive had a mean age of 37.57 (14.53) years ($p = 0.0775$), which was not statistically significant. The indication for antibiotic prescription differed significantly between survivors to ICU discharge and those who died, with prophylactic antibiotics associated with survival to ICU discharge ($p = 0.0018$). The mean duration of antibiotic use ($p = 0.3512$), the number of antibiotics used ($p = 0.2472$), and the regularity of antibiotic administration ($p = 0.5828$) did not differ significantly between ICU outcomes (Table 1).

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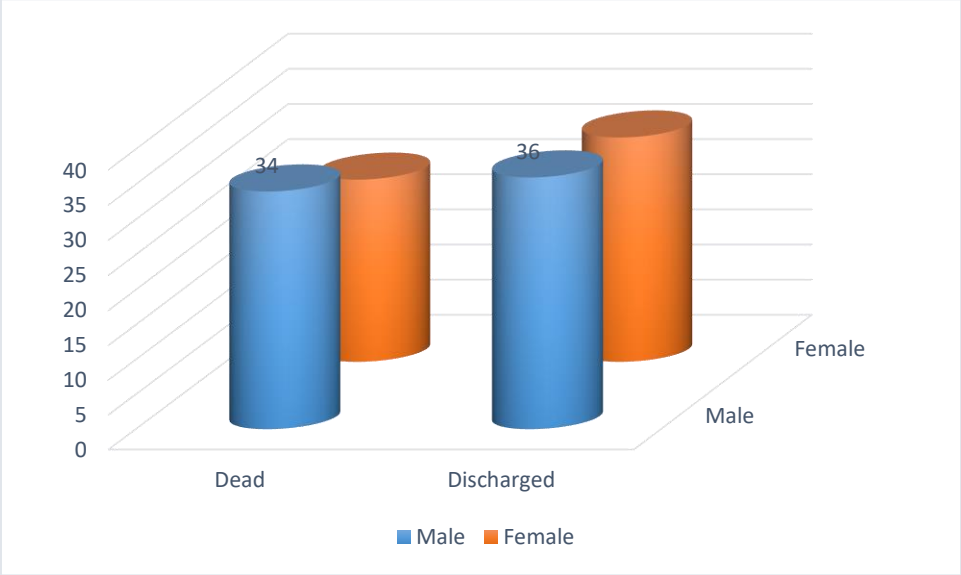

Fig 1: Outcome of ICU admission with gender

Table 1: Outcome of ICU admission and antibiotic use

	Dead	Discharged		
Sex			0.0893	0.765114
Male	34	36		
Female	26	32		
Indication for AB			9.7236	0.001819
Prophylactic	14	42		
Therapeutic	44	24		
Mean duration of AB use	3.344827586 (1.12)	3.088235294 (1.03)	0.9396	0.3512
Number of AB use			5.4156	0.2472
None	2	2		
1	24	12		
2	20	40		
3	8	10		
4	6	4		
Regularity			1.0798	0.5828
Regular	48	60		
< 25%Missed doses	8	4		
25-50% Missed doses	2	2		

4. Discussion

The findings of this study reveal a high rate of antibiotic use (96%) in the ICU. All antibiotic prescriptions were empirical, as none were preceded by prior microbiological testing. This practice underscores a critical reliance on empirical therapy, reflecting the urgency of managing severe infections in critically ill patients and potential system-

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ic challenges in the ICU setting related to diagnostic resources and protocols.

The high rate of antibiotic use in this study reflects the findings of previous studies that the rate of antibiotic use is much higher in the African continent than in Europe. This is probably due to the impression that communicable diseases are more of a challenge in developing countries than in the developed ones.[9] Infectious diseases like acute respiratory infections, diarrheal diseases, and HIV/AIDS result in significant morbidity, loss of productivity, and mortality within the African continent.[9] Inadequate water, sanitation facilities, and hygiene make the spread of infectious diseases more likely.[10] The increased burden of infectious diseases in Africa creates an availability bias (the tendency for something to be judged more frequently if it readily comes to mind), which may increase the likelihood of the diagnosis of sepsis in critical care units within Africa.[11]

Also, the high rate of antibiotic use may reflect the study's location. Antibiotic prescription is reported to be higher among critically ill patients admitted to the ICU when compared to other patients in regular wards. [12] This is due to the severity of the cases managed there and the fact that many patients are susceptible to infections from reduced immunity. The use of multiple procedures, such as central line catheterization, which breaches the skin and mucous membranes, also makes patients vulnerable to infections.

There are conditions in the ICU that mimic infections, exhibiting nonspecific signs such as fever and tachycardia. These may result in diagnostic challenges and inappropriate prescriptions. The availability of rapid point-of-care tests that reliably distinguish infection from non-infection will help prevent unnecessary prescriptions of broad-spectrum antibiotics.[13] A study compared the administration of antibiotics to ICU patients on clinical evidence of infection (aggressive strategy) with similar antibiotic administration only after objective evidence of infection (conservative strategy) and found that the conservative approach was associated with lower all-cause mortality, more initial appropriate therapy, and shorter duration of therapy.[14] The clinical application of this finding may be challenging in the setting of severe infection when time is of the essence and only microbiological cultures that take days to yield results are available. The availability of rapid, reliable point-of-care tests would encourage appropriate antibiotic stewardship.

The increasing use of biomarkers of sepsis has improved the ability to differentiate infectious from non-infectious diseases. In critically ill patients, both procalcitonin and C-reactive protein were useful for diagnosing sepsis, but procalcitonin has been found to have greater specificity, sensitivity, and positive and negative predictive values than C-reactive protein.[15]

Empirical antibiotic use is often necessary in critically ill patients with life threatening infections to permit immediate treatment. However, the absence of microbiological testing to guide antibiotic prescribing prevents targeted therapy. In this study, all the patients were prescribed antibiotics empirically. Unnecessary antibiotic prescriptions lead to adverse drug reactions and the development of opportunistic infections [16], while inappropriate antibiotic selection increases the risk of antimicrobial resistance [17], a growing global health threat. While initial empirical broad-spectrum antibiotic therapy may be necessary to prevent mortality, it is advocated that there should be a commitment to de-escalation and antibiotic stewardship.[18]

Ceftriaxone emerged as the most frequently prescribed antibiotic, underlining its continued role as a cornerstone in empirical therapy for critically ill patients. Ceftriaxone is a third-generation parenteral cephalosporin that works by disrupting

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bacterial cell wall synthesis. It has good activity against Gram-positive and Gram-negative aerobic bacteria, but minimal activity against anaerobic bacteria. It is effective in urinary tract, lower respiratory tract, skin, soft tissue, bone, and joint infections.[19] It was also the most frequently prescribed first-line antibiotic in a study in Qatar.[20] This preference likely reflects its broad-spectrum activity, favorable pharmacokinetics, and clinician familiarity, especially in settings where community-acquired infections or common hospital pathogens are prevalent. However, a study in Ethiopia found a pooled inappropriate ceftriaxone utilization rate of 55.24%. The predictors of inappropriate utilization are empirical therapy, multiple medication co-prescription, emergency and surgical ward, prophylactic use, and longer hospital stay.[21] Therefore, the finding of a 100% empirical rate of antibiotic prescription in this study cannot be encouraged.

The frequent combination of ceftriaxone with metronidazole in this study is probably motivated by a desire to cover both aerobic and anaerobic pathogens. Ceftriaxone has good coverage for aerobic gram-positive and gram-negative bacteria, but limited coverage against anaerobic bacteria, which are adequately covered by metronidazole.[22] This approach allows a wider antibiotic coverage when the specific organism is not known or multiple bacterial agents are suspected, which is consistent with current guidelines. These medications are available and relatively affordable, making them a popular choice.

Second-line antibiotics are used when there has been a poor response to first-line antibiotics and the patient's clinical condition has deteriorated. They provide an opportunity to escalate therapy in the search for a better clinical response. This study identified meropenem and levofloxacin as the most frequently prescribed second-line antibiotics. Meropenem is a carbapenem with broad-spectrum activity usually reserved for suspected or confirmed multidrug-resistant infections. Its use as a second-line antibiotic is consistent with stewardship efforts to limit carbapenem use to cases where necessary. Levofloxacin's use as a second-line agent may relate to its broad spectrum and good tissue penetration, especially for respiratory and urinary tract infections, which are common in ICU settings.

These prescribing trends raise important considerations about antimicrobial resistance (AMR). The heavy reliance on ceftriaxone, a cephalosporin, as a first-line agent and the subsequent use of meropenem, a carbapenem, as second-line therapy may reflect increasing resistance to cephalosporins. In a study in Sudan, East Africa, an overall ceftriaxone resistance rate of 70.7% was found, with Gram-negative organisms showing a higher rate (74.2%) than Gram-positive organisms (44.4%).[23] There is therefore a need for continuous surveillance of local antibiograms and resistance mechanisms to guide empirical therapy and avoid the overuse of broad-spectrum antibiotics that drive resistance. Resistance to ceftriaxone, which may not have been present previously, may develop over time, necessitating a change in first-line antibiotic choice.

The findings from this study indicate that the overall duration of antibiotic use, the number of antibiotics prescribed, and the regularity of antibiotic administration did not differ significantly between patients who survived to ICU discharge and those who did not. Antibiotic administration was regular in the majority of patients; therefore, irregular administration may not significantly affect survival. The number of antibiotics prescribed may not have shown a significant association with survival in this study because of the diversity of cases managed in the intensive care unit. The impact of antibiotic therapy duration on ICU outcomes is complex. Early onset of antibiotic treatment is beneficial in sepsis [24], but prolonged antibiotic administration results in negative out-

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comes such as increased costs, increased adverse drug effects, and antibiotic resistance.[25] The lack of difference in duration of antibiotic administration and regimen between survivors and non-survivors also suggests that other factors, such as timely diagnosis, severity of illness, organ dysfunction, and availability of supportive care measures, might be more important in determining ICU mortality. These results underscore the complexity of antibiotic prescribing in the ICU, where patient outcomes are influenced by factors beyond antibiotic duration or dosing patterns.

However, patients receiving prophylactic antibiotics had a statistically higher survival rate than those receiving antibiotics therapeutically. This finding may reflect that patients receiving prophylactic antibiotics were generally at lower risk of severe infections or complications, or that prophylactic strategies effectively prevented infections that could have otherwise worsened patient outcomes. Early preventive measures with antibiotics could confer a survival advantage by reducing infection-related complications before they arise. However, this must be balanced with the risks of antibiotic overuse and the potential for the development of antimicrobial resistance. Conversely, therapeutic antibiotic use typically indicates the presence of an active infection, which inherently carries a higher risk of morbidity and mortality.

Limitations

Limitations of this study include its observational nature and the potential variability in microbiological testing that is available across different ICUs, which may affect generalizability.

Conclusion

This study highlights ceftriaxone's primacy in empirical ICU antibiotic therapy, the strategic use of metronidazole for anaerobic coverage, and the reserved role of meropenem and levofloxacin as critical second-line agents. While the quantity and administration patterns of antibiotics may not differ between survivors and non-survivors in the ICU, the indication for use, prophylactic versus therapeutic, is a significant factor associated with patient outcomes. Optimizing antibiotic prescribing strategies with a focus on prevention could improve survival rates, but further studies are needed to clarify the mechanisms and develop evidence-based guidelines. These insights advocate for ongoing antimicrobial stewardship interventions to balance effective infection management with minimizing resistance development in the ICU environment.

Recommendations

Future research should explore barriers to microbiological testing and evaluate interventions that enhance diagnostic stewardship alongside antibiotic prescribing practices.

Abbreviations

ICU: Intensive Care Unit

HIV: Human Immunodeficiency Virus

AIDS: Acquired Immune Deficiency Syndrome

AMR: Antimicrobial Resistance

Author Contributions

Dr. Ige Olufemi: Contributed to the study concept and design, acquisition, analysis, and interpretation of data, drafting the article for important intellectual content, and final approval of the version to be published.

Dr. Ojo Olawale: Contributed to study design, acquisition, analysis, and interpretation of data, critically revised the article for important intellectual content, and final approval of the version to be published.

Dr. Adewumi Oluwaseyi: Contributed to study design, acquisition, analysis, and interpretation of data, critically revised the article for important intellectual content, and final approval of the version to be published.

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Dr. Agah Overcomer: Contributed to study design, acquisition, analysis, and interpretation of data, critically revised the article for important intellectual content, and final approval of the version to be published.

All authors agree to be accountable for the accuracy and integrity of all aspects of the work.

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Competing interests

The authors have no conflict of interest to declare.

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