

Original Research Article

Antimicrobial stewardship and survey of multidrug-resistant bacteria in selected healthcare facilities in Delta State, Nigeria

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Abstract

Purpose: To evaluate antimicrobial stewardship programs and antimicrobial resistance (AMR) patterns among patients of Eku Baptist Government Hospital and Central Hospital, Warri, Delta State, Nigeria towards improving antibiotic usage and patient outcomes.

Methods: Relevant institutional review boards gave ethical approval. Questionnaires were delivered to 26 healthcare professionals working in Eku Baptist Government Hospital and 36 professionals in Central Hospital, Warri, to determine their knowledge of antimicrobial stewardship programs (ASPs). Demographics, clinical history, antimicrobial use, laboratory results, and treatment outcomes of 306 cases of Eku Baptist Government Hospital and 200 cases of Warri Central Hospital were assessed through a retrospective review of 506 case notes, laboratory reports and pharmacy records of 2021 – 2024.

Results: Both Hospitals reported limited resources (~72 % inadequate) and low ASP awareness (28 - 33 %). There was poor training (24 - 28 %), particularly by nurses in both Hospitals. The use of broad-spectrum antimicrobials such as metronidazole and ceftriaxone was frequently prescribed in both Hospitals, as a result of empirical prescribing, due to the lack of diagnostic ability. Poor practices in infection control and junior workforce (72.6 % had less than 3 years of experience) worsen AMR issues.

Conclusion: There are severe gaps in antimicrobial stewardship in these hospitals. The AMR risks in resource-limited environments require strengthened ASPs that are achieved by resource allocation, standardized protocols, and continuous training.

Keywords: Antimicrobial Resistance (AMR), Stewardship, Broad-spectrum antibiotics, Training, Diagnostics

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INTRODUCTION

Following the identification of bacteria as the causative agents of disease and the invention of

antibiotics as effective treatment methods, the world has realized massive improvements in world health [1]. Antibiotics, which kill or prevent bacterial growth, could be produced by

microorganisms, like fungi (e.g., *Penicillium notatum*, the producer of penicillin) and bacteria (e.g., *Streptomyces* species), or synthesized [2]. Antibiotics are specifically bactericidal agents; antimicrobials include agents that are active against viruses, fungi, protozoans and parasites [3].

Nevertheless, the efficacy of these treatments is currently being seriously threatened by antimicrobial resistance (AMR). The AMR refers to the capacity of microorganisms to resist the impact of antimicrobial agents, making them ineffective [4]. AMR causes treatment failures, protracted illness, escalated medical expenses and death. AMR is estimated to cause up to 10 million deaths every year in the world by 2050 [5]. Although the rate of resistance is alarming, localised testing and collective actions are still poor, especially in low-resource situations where resistance is usually at its worst [6,7].

In Africa, the crisis is made worse by the lax control of access to antimicrobials, such as over-the-counter, counterfeit, or substandard medication, and the widespread use of antibiotics to stimulate livestock growth [8,9]. Water shortage, lack of sanitation, hygiene (WASH) and infection prevention and control (IPC) deficiencies continue to stimulate resistant organism spread [10].

Antimicrobial resistance is a worldwide health threat, making antibiotics ineffective for treating bacterial infections and making clinical processes more complicated. To deal with these challenges, Antimicrobial Stewardship Programmes (ASPs) have become key interventions. ASPs seek to promote the responsible use of antimicrobials, maximize outcomes and reduce the development and transmission of resistance. These initiatives are aimed at choosing the right antibiotic, dose and duration for the infection in question. Local resistance patterns are important tools for good stewardship [11] and clinical guidelines development. However, non-prescription antibiotic use is still rife, varying from 3 % in parts of Europe to almost 100 % in parts of Africa, showing up implementation and regulation lapses [12].

A primary feature of ASPs is the constant monitoring of resistance trends; without data-driven monitoring and feedback, ineffective treatments continue and resistance is allowed to flourish. Anecdotal evidence points to an increase in resistance at Eku Baptist Government Hospital and Central Hospital, Warri, Nigeria, owing to their proximity. These

gaps are addressed in this paper through a scientific and statistical study of resistance patterns using retrospective and questionnaire methods. This study explores three-year trends of resistance in order to critically inform and enable the application of ASP in resource-limited healthcare environments.

METHODS

Ethical clearances were given by the Ethics committee of the Faculty of Basic Medical Science, Delta State University, Abraka (RBC/FBMC/DELSU/25/652), Eku Baptist Government Hospital (EBGH/AD/112/REM//Vol. vii/99) and Central Hospital Warri (CHW/ECC VOL/125) in Ethiope-East and Warri-South Local Government Areas, Delta State, Nigeria, respectively.

Assessment of antimicrobial stewardship program

This was done through standardized questionnaires used by Kallen *et al* [13] to determine the knowledge of healthcare professionals regarding antimicrobial stewardship programmes in their facilities. A total of 62 healthcare workers were utilized, including physicians (n = 18), pharmacists (n = 14), nurses (n = 25), microbiologists (n = 2), infection control specialists (n = 2) and hospital administrators (n = 2). Among this population, 26 of them were Eku Baptist Government Hospital participants and 36 were Central Hospital Warri participants. The questionnaires were given out and collected between May and June, 2025.

Assessment of case notes and laboratory reports

Both Eku Baptist Government Hospital and Central Hospital Warri had retrospective reviews of case notes and laboratory reports. The obtained case notes were acquired in the Medical, Paediatric and Surgical wards, both inpatient and outpatient. The central laboratories of the two hospitals had their Microbiology Unit, where laboratory reports obtained from 2021 to 2024 were examined for:

- Patient demographics: underlying diseases, age, and gender.
- The clinical history and diagnosis.
- Antimicrobial use: type, dose, duration, route and compliance with guidelines.

- Pharmaceutical records, including dosage forms and brand names.
- Laboratory data: kind of material, pathogen isolated, and patterns of antibiotic susceptibility [14,15].
- Post-treatment test.

Data analysis

In the case of Assessment of antimicrobial stewardship programme and Assessment of case note and Laboratory reports, the analysis of data was conducted in SPSS (version 25.0) and presented in the form of Mean $\pm$ standard deviation (SD). Associations, differences in proportions across groups (e.g., physicians, pharmacists, nurses to assess antimicrobial stewardship programme; hospitals, age groups, or genders to assess case notes and Laboratory reports) were assessed by Chi-Square tests. All tests were set at $p < 0.05$ as the level of statistical significance.

RESULTS

Figure 1 reports the demographics among 62 professionals: nurses (40.4 %), physicians (29.0%) and pharmacists (22.6 %) from Eku and Warri hospitals (Figure 1 A). Experience (Figure 1 B) was mostly <3 years (72.6 %) with 37.1 % having < 1 year. Awareness (Figure 1 C) is low (28 – 33 %) and training is even lower (24 – 28 %), especially among nurses, although higher awareness of guidelines was found among pharmacists (60 – 64 %). Figures 1 D and E show that 28 % said they had adequate

resources - a major implementation barrier - but 61 – 64 % said they had infection control policies in place. These resource constraints take their toll, especially on front-line nurses.

Sensitivity testing before prescription

The findings of Figure 2 illustrate the analysis of the microbiology test findings, before antibiotic prescription. As per the outcome, microbiology results are most commonly reviewed by physicians (33.3 %), as they prescribe medication. Similar patterns are observed with pharmacists and nurses (28 - 32 % and 7.1 % respectively), with no review occurring in 11-14 % across groups, which is worrying since this may add to resistance. Better access to microbiological assistance is required, especially for the nurses.

Involvement in antimicrobial prescribing or stewardship activities

Participation in antimicrobial stewardship and documentation requirements on prescriptions are indicated in Tables 1 and 2, respectively. Approximately 71 – 72 % of physicians, pharmacists and nurses participate in the stewardship; physicians and pharmacists enforce guidelines and nurses participate via administration. While involvement is broad, this does not translate to best practises (Table 1). Documentation is most consistent for dose (64 – 68 %), followed by duration (60 – 64 %) and indication (55 – 57 %) and pharmacists having higher adherence due to verification roles. Non-compliance (32 – 44 %) represents accountability loopholes, which require uniform protocols.

Table 1: Involvement in antimicrobial prescribing or stewardship activities

Response	Physicians; N = 18 (%)	Pharmacists N = 14 (%)	Nurses N = 25 (%)
YES	13 (72.2)	10 (71.4)	18 (72.0)
NO	5 (27.8)	4 (28.6)	7 (28.0)

Table 2: Documentation requirements for antimicrobial prescriptions

Documentation component	Response	Physicians; N = 18 (%)	Pharmacists; N = 14 (%)	Nurses; N = 25 (%)
Indication	Yes	10 (55.6)	8 (57.1)	14 (56.0)
	No	8 (44.4)	6 (42.9)	11 (44.0)
Dose	Yes	12 (66.7)	9 (64.3)	17 (68.0)
	No	6 (33.3)	5 (35.7)	8 (32.0)
Duration	Yes	11 (61.1)	9 (64.3)	15 (60.0)
	No	7 (38.9)	5 (35.7)	10 (40.0)

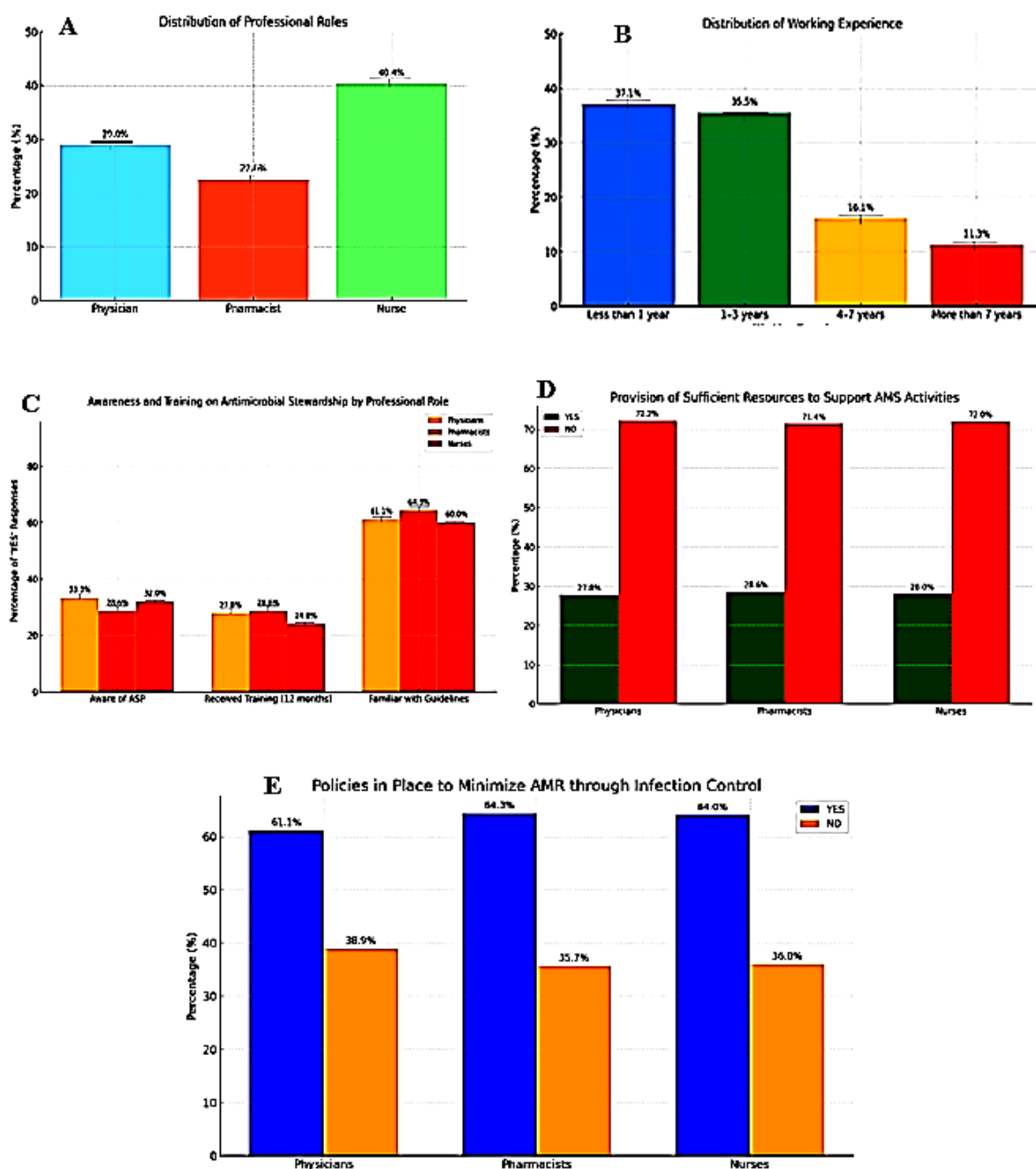


Figure 1A-E: An Assessment of antimicrobial stewardship programmes among healthcare professionals at Eku Baptist and Central Hospital, Warri, Nigeria

Frequency of following hospital's antimicrobial prescribing guidelines

Table 3 and Table 4 assess the frequency of adherence to prescribing guidelines and therapy at 48-72 hours. Reassessment is variable, with nurses being less likely to reassess (48%) than monitoring physicians and pharmacists. This lack of reassessment results in lengthy treatment, suggesting a need for clear protocols (Table 3). The highest guideline adherence is by pharmacists (42.9%) because of enforcement responsibilities. However, 16-17% of physicians and nurses never stick to it, requiring additional training and supervision (Table 4).

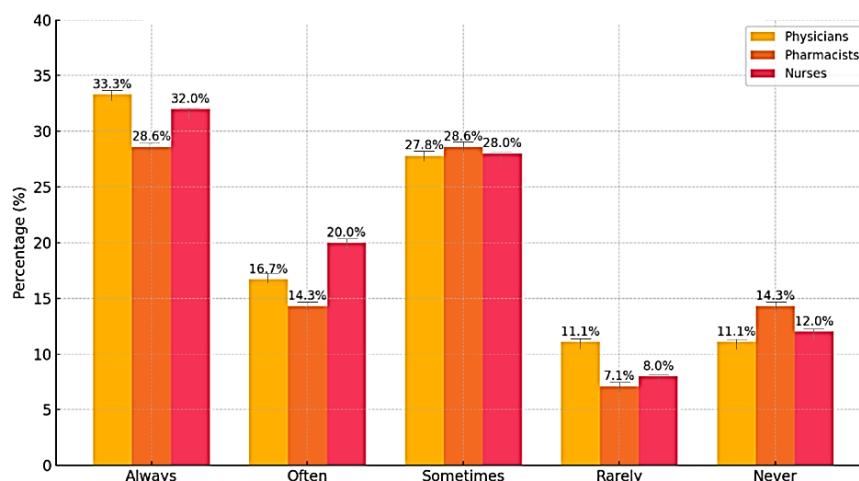


Figure 2: Response option and frequency of reviewing microbiology test before prescribing

Table 3: Reassessment of antimicrobial therapy within 48–72 hours

Response	Physicians; N = 18 (%)	Pharmacists; N = 14 (%)	Nurses; N = 25 (%)
Yes	9 (50.0)	7 (50.0)	12 (48.0)
No	9 (50.0)	7 (50.0)	13 (52.0)

Table 4: Frequency of following hospital's antimicrobial prescribing guidelines

Item	Response options	Physicians; N = 18 (%)	Pharmacists; N = 14 (%)	Nurses; N = 25 (%)
How often do you follow the hospital's antimicrobial prescribing guidelines?	Always	7 (38.9)	6 (42.9)	10 (40.0)
	Often	4 (22.2)	3 (21.4)	6 (24.0)
	Sometimes	4 (22.2)	3 (21.4)	5 (20.0)
	Rarely	0 (0.0)	0 (0.0)	1 (4.0)
	Never	3 (16.7)	2 (14.3)	4 (16.0)

Challenges faced in adhering to antimicrobial stewardship guidelines and infection control practices

Figure 3 and Table 5 point out difficulties in complying with ASP and infection control recommendations. Table 5 identifies patient-related factors (28 – 33 %) as the major barrier, especially for physicians.

Time pressure and a lack of microbiological support are further obstacles to adherence for physicians and nurses. Hand hygiene monitoring is inconsistent (32 – 36 % Always, 16 – 21 % Never), with nurses being more non-compliant. Isolation precautions are not usually followed (60-64% NO), but nurses are more faithful in their adherence. These gaps underscore the need for robust infection control protocols.

Correlation between years of working experience and knowledge of antimicrobial stewardship

Physicians (Figure 4 A): A very weak, non-significant positive linear relationship was found between years of experience and antimicrobial stewardship knowledge (Pearson Product-Moment Correlation, $r = 0.026$, $p = 0.919$). As a result, the null hypothesis is not rejected. Pharmacists (Figure 4 B): There was a moderate, statistically significant, positive correlation ($r = 0.556$, $p = 0.039$). The null hypothesis is rejected and it is observed that more years of working experience are correlated with more knowledge. Nurses (Figure 4 C): Results reveal a moderate, statistical, positive correlation ($r = 0.376$, $p = 0.015$). The null hypothesis is rejected and this confirms that the years of experience is significantly related to the awareness of antimicrobial stewardship.

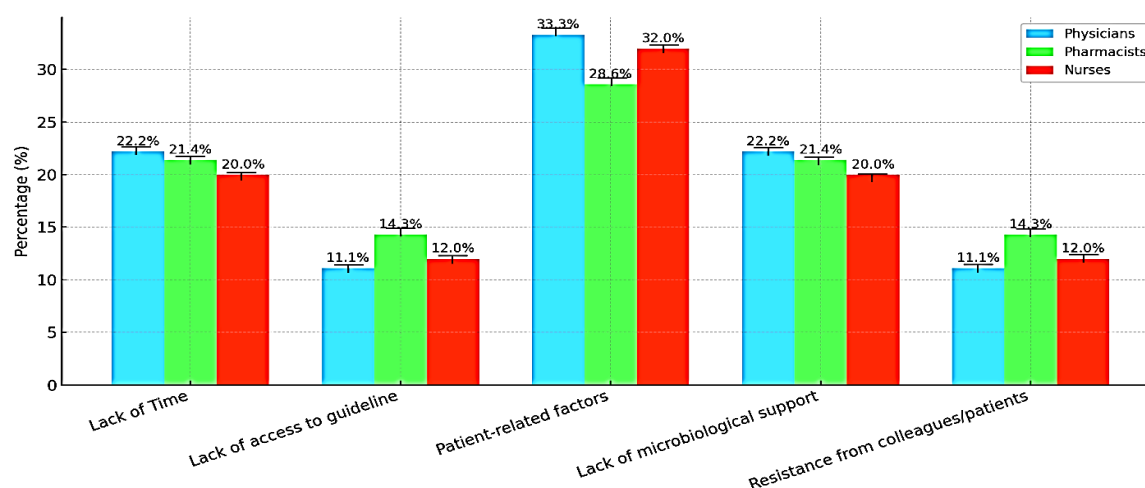


Figure 3: Challenges faced in adhering to antimicrobial stewardship guidelines

Table 5: Infection control practices to minimize antimicrobial resistance

Question	Response options	Physicians; N = 18 (%)	Pharmacists; N = 14 (%)	Nurses; N = 25 (%)
How often are hand hygiene practices monitored in your hospital?	Always	6 (33.3)	5 (35.7)	8 (32.0)
	Often	4 (22.2)	3 (21.4)	5 (20.0)
	Sometimes	2 (11.1)	2 (14.3)	3 (12.0)
	Rarely	2 (11.1)	1 (7.1)	3 (12.0)
	Never	3 (16.7)	3 (21.4)	5 (20.0)
Are isolation precautions strictly implemented for patients with multidrug-resistant organisms (MDROs)?	YES	7 (38.9)	5 (35.7)	10 (40.0)
	NO	11 (61.1)	9 (64.3)	15 (60.0)

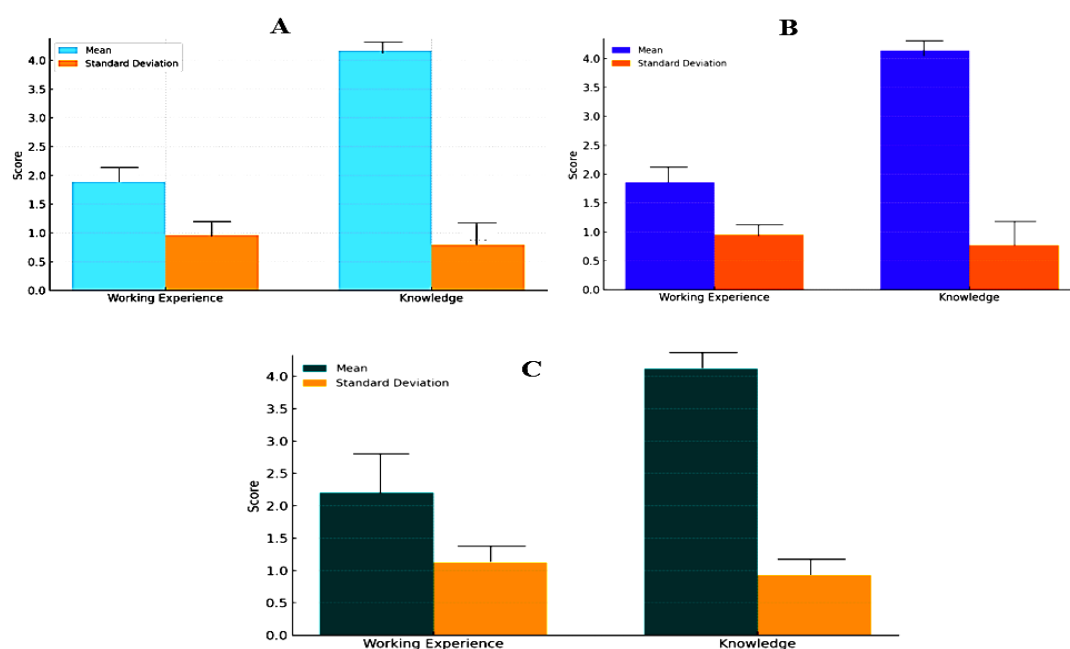


Figure 4: Correlation between years of working experience and knowledge of antimicrobial stewardship, (A) Physicians, (B) Pharmacists, (C) Nurses

Case notes and laboratory reports

Case notes and laboratory results of the patients (age, sex), isolated organism, prescription pattern, tentative and definitive diagnosis, medication (type of drug, number of drugs, dose regime, brand of the drug), sensitivity tests and post treatment tests of the past three years in Eku Baptist Government Hospital and Central Hospital Warri were analysed to obtain the demographics of the patients. The 21 – 40 years age group (37.9 %) and females (62.6 %) predominated, possibly due to higher infection rates or healthcare-seeking behavior.

Antimicrobial use based on pharmacy records

Figure 7 report the most used antimicrobial agent was Metronidazole (341 prescriptions), then there is Ceftriaxone (287 prescriptions) and Ciprofloxacin (143 prescriptions). Amoxicillin and Augmentin were also widely prescribed (give precise figures). The frequency of prescription was relatively low with gentamicin and Ampiclox (provide counts). In general, the data suggest that some broad-spectrum agents are used more than others.

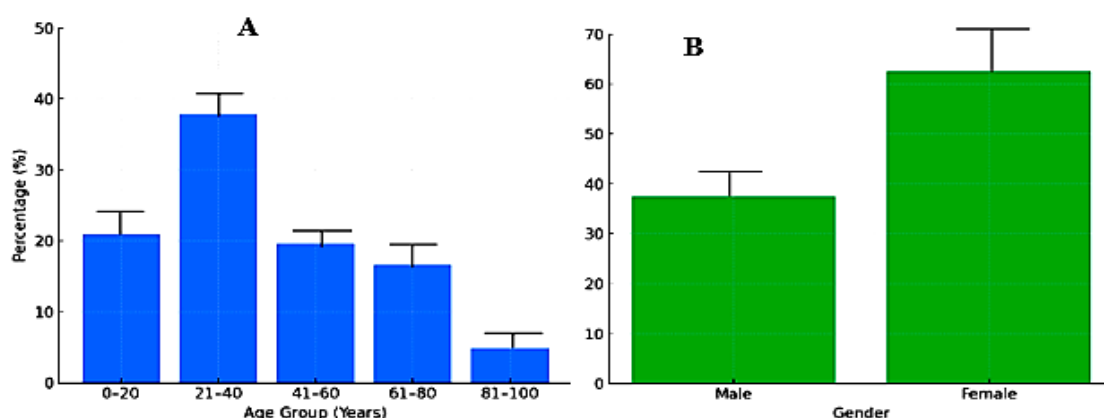


Figure 5A-B: Retrospective demographic and clinical analysis of patient case notes: A three-year review at Eku Baptist and Central Hospital, Warri, Nigeria

Common clinical diagnoses were identified

Diagnosis Trends

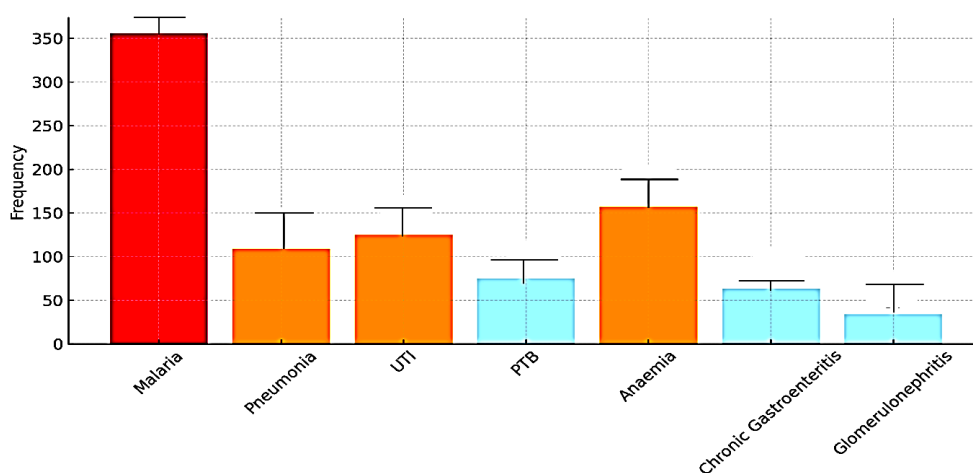


Figure 6: Diagnosis and frequency count

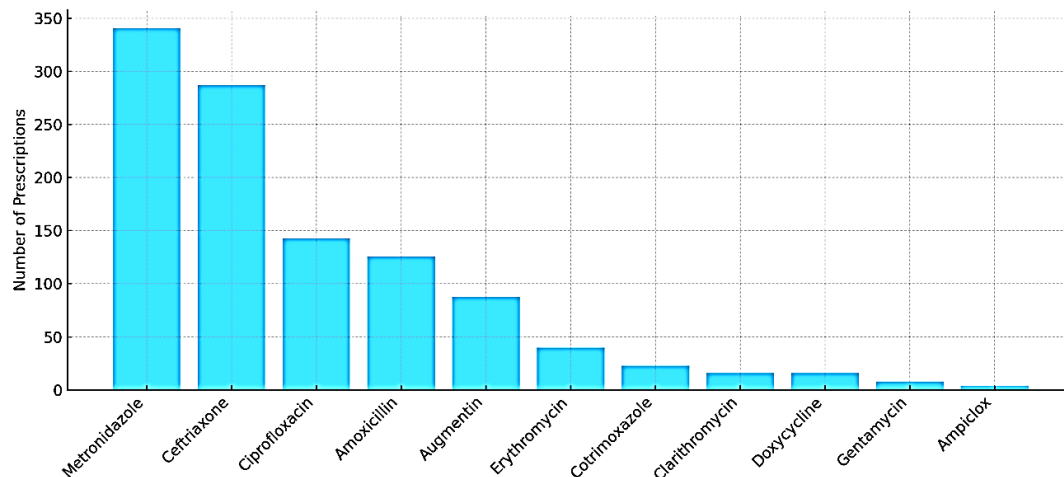


Figure 7: Showing the number of Antibiotic Prescription Patterns at Eku and Warri Hospitals

Antibiotic prescription pattern

To visualize the antimicrobial usage patterns, Figure 7 illustrates the distribution of antimicrobial prescriptions across the study period.

DISCUSSION

Antimicrobial resistance (AMR) is a global health crisis. It is estimated that 1.27 million deaths were caused by resistant bacterial infections, and approximately 4.95 million were caused by resistant infections worldwide [5]. The burden is disproportionately impacting sub-Saharan Africa, as well as Nigeria, where multidrug-resistant (MDR) pathogens, such as *Escherichia coli* (*E. coli*) and *Klebsiella pneumoniae* (*K. pneumoniae*), are common, although there is limited data in Delta state [15].

The results of the study show that there are considerable gaps in the implementation of Antimicrobial Stewardship Programmes, which is correlated with the situation in the region in Nigeria and other low- and middle-income countries (LMICs) [16]. Only one out of four healthcare professionals (physicians, pharmacists, and nurses) indicated that they had enough resources to facilitate the activities of Antimicrobial Stewardship Programmes, and 61 - 64 % of them admitted to having infection control policies. This indicates a primitive stewardship model, which is more of infection control instead of wholesome antibiotic optimization measures. The scarcity of resources (72 % reported inadequacy) is similar to that reported in a study in Nigeria in 2020, which reported that 25 % of tertiary hospitals had formalized an Antimicrobial Stewardship Programme because of

underfunding and infrastructure. These challenges may be worsened by the prevalence of nurses (40.4 %) and a junior workforce (72.6 %, less than three years), as inexperience may negatively influence compliance with stewardship protocols and is consistent with Barlam *et al* [17], who highlight the importance of having experienced leadership in the Antimicrobial Stewardship Programmes.

The knowledge of the Antimicrobial Stewardship Programmes in the current study is quite low (28 - 33), as well as the rates of training (24 - 28), most specifically among nurses. This is in line with Cox *et al* [16], who indicated that poor training in LMICs is one of the factors that lead to poor prescribing of antibiotics. Guidelines were a bit better known by pharmacists (64.3 %), probably because of the medication management, but the low awareness in general highlights the urgency of specific education. The 33.3 % of physicians who always review the microbiology result before prescription is a positive but not adequate rate since 11 - 14 % of groups never review the result, which is associated with higher risks of AMR [18]. The large percentage of stewardship activities (71 - 72 % involvement) is an indicator of engagement but not adherence to evidence-based practices, as indicated by inconsistent documentation (32 - 44 % non-compliance) and reassessment (48 - 50 % compliance) of antimicrobial therapy within 48 - 72 hours.

The main compliance barriers were patient-related (28 - 33) and non-microbiological reasons (20 - 22), similar to global evidence that clinical pressures and diagnostic constraints contribute to empirical prescribing [19]. Poor infection

control was indicated by low hand hygiene observation and MDR isolation rates (32 – 36 % and 60 – 64 % non-isolation, respectively), which is a common AMR driver in LMICs [20]. Strengthening ASPs at Eku and Warri requires resources, uniform protocols and specific training, especially among the huge nursing workforce. Analysis of 506 patients (2021 - 2024) showed a demographic characterized by the 21 - 40 years old age group (37.9 %) and females (62.6 %), which probably reflects an increased healthcare-seeking for UTIs and reproductive infections [21]. Primary diagnoses were malaria (356), UTIs (125), pneumonia (109) and tuberculosis (75). Restricted diagnostic capabilities - as indicated by reliance on FBC and MP tests - are another driver of empirical prescribing and contribute to AMR [20].

Prescription patterns revealed substantial broad-spectrum use, particularly of metronidazole (341), ceftriaxone (287) and ciprofloxacin (143), but gentamicin and Ampiclox were rarely used. This is similar to Lagos-based findings of Watch group overuse and increasing resistance in *E. coli* and *K. pneumoniae* [22]. Such diagnostic uncertainty is the driving force behind empirical prescribing and low microbiology review rates (11 – 14 % never reviewed) indicate limited culture-guided therapy and increased MDR risks.

The results do not contain any post-treatment information, limiting data on treatment outcomes; however, the large number of prescriptions and preference for broad-spectrum antibiotics imply treatment failures might occur, as noted in one study done in 2024 that found that the presence of *blaCTX-M* genes made cephalosporins resistant [23]. These results underscore the need for better diagnostic infrastructure, periodic sensitivity testing and prescription auditing to fulfil the requirements of WHO AWaRe and reduce pressure for resistance [24].

This study adds greatly to the knowledge of antimicrobial resistance (AMR) and antimicrobial stewardship program (ASP) in resource-constrained facilities, especially Eku Baptist Government Hospital and Central Hospital, Warri. By combining retrospective analysis of case notes with prospective professional assessments, the study addresses important gaps in the localized data, and it provides the following outcomes:

- i. **Localized Evidence on Stewardship Practices:** The study assesses the application of ASP between physicians, pharmacists, and nurses with low awareness (28 – 33 %), little to no training (24 – 28 %), and lack of

resources (28 %). As one of the first studies in the Delta State to quantify professional awareness, it implies the need for educational interventions and allocation of resources, especially for nurses (40.4 % of participants) who are on the frontlines.

- ii. **Analysis of Antimicrobial Use Patterns:** The use of broad-spectrum antibiotics is documented in the study in the form of Metronidazole (341) and Ceftriaxone (287) for malaria, pneumonia and UTIs. This addresses the paucity of literature on Nigerian tertiary prescription patterns and illustrates a reliance on empirical prescribing which is due to lack of diagnostic capacity and the need for better microbiological services.
- iii. **Demographic Insights into Infection Burden:** Analysis of 506 patients suggests that they are 21 - 40 years old (37.9 %) and females (62.6 %) in the majority. Characterizing this population gives a basis for the design of specific public health interventions to target high-risk groups and patient characteristics that favor antibiotic use.
- iv. **Identification of Barriers to Effective Stewardship:** Patient-related aspects (28 – 33 %), time scarcity (20 – 22 %) and insufficient microbiological support (20 – 22 %) are identified as major issues impeding ASP compliance. These results provide context-specific information for the international AMR discussion on obstacles in low-resource environments, which justify localised measures such as improved access to diagnoses.
- v. **Foundation for Policy and Practice Improvements:** With the combination of retrospective and prospective assessments, the study provides a framework of the celebrities of managing AMR for resource restricted the foundation. The results support improved diagnostic facilities and frequent audits to reduce the risk of AMR, which serves as a model to healthcare facilities in Nigeria and Africa to optimize the use of antimicrobials.

Implications for antimicrobial stewardship

The data shows widespread use of empirical prescribing in the absence of documented, conclusive diagnoses in most of the situations. The abundance of prescriptions and the prevalence of broad-spectrum antibiotics indicate the necessity to strengthen antimicrobial stewardship programs, develop better diagnostic

structures, carry out periodic auditing of prescriptions, as well as regular sensitivity testing to minimize AMR risk.

Limitations

Lack of detailed sensitivity and post-treatment outcome data restricts AMR prevalence assessment.

CONCLUSION

The study indicates severe deficiencies in the antimicrobial stewardship programmes (ASP) at Eku Baptist Government Hospital and Central Hospital, Warri, such as insufficient resources (72 % inadequate), insufficient awareness of ASP (28 - 33 %), and insufficient training (24 - 28 %), especially among the nurses (40.4 % of the participants). This is aggravated by a junior workforce (72.6 % less than 3 years of experience) and patchy infection control (e.g., 60-64 % no isolation of MDR organisms). The prescription patterns prefer the use of broad-spectrum antibiotics (e.g., metronidazole, ceftriaxone), which are guided by the use of empirical prescribing and weak sensitivity testing (11 - 14 % never review results). The patient population is largely comprised of women (62.6) with a median age of 37.9, indicating high infection rates and healthcare-seeking behaviour, with malaria, UTIs, and pneumonia being the most common diagnoses. The results suggest that improved ASPs, diagnostics, and infection control are required to fight antimicrobial resistance in Delta State.

DECLARATIONS

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Ethical approval

Ethical approval was sought at the Faculty of Basic Medical Science, Delta State University, Abraka (RBC/FBMC/DELSU/25/652), Eku Baptist Hospital (EBGH/AD/112/REM/Vol. vii/99) and Central Hospital Warri (CHW/ECC VOL/125).

Use of Artificial Intelligence

According to the authors, no research reporting instruments were utilised in this research article.

Use of the research reporting tool

The authors declare that no research reporting tools were employed in this research article.

Availability of data and materials

All datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Conflict of interest

No conflict of interest is associated with this work.

Authors Contributions

All authors contributed to this study and the writing of the manuscript. Conceptualization of the study was done by OGI, MOO, and EU. First and final drafts of the manuscript were done by OGI, MOO, COA, data collection and data analysis were done by OGI, MAK and FBF, and proofreading of the manuscript was done by MOO and EU.

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