



ANTIMICROBIAL RESISTANCE CARRIAGE AMONG EMERGENCY AND IN-HOSPITAL PATIENTS IN BENIN CITY, NIGERIA

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ABSTRACT

Antimicrobial resistance (AMR) is an escalating threat in sub-Saharan Africa, where hospital-based paediatric data remain limited. This study assessed the prevalence, distribution, and resistance patterns of microorganisms among children receiving care at a tertiary hospital in Benin City, Nigeria. This was a hospital-based cross-sectional analysis of paediatric patients with linked clinical and microbiological data at the University of Benin Teaching Hospital. Nasal and rectal swabs were collected from all study participants and processed microbiologically within 2 hrs of collection. The following organisms and phenotypes were recovered following standard microbiological techniques: methicillin-resistant *Staphylococcus aureus* (MRSA), extended spectrum beta-lactamase- (ESBL), carbapenemase-producing *Escherichia coli* and *Klebsiella pneumoniae*. Antimicrobial susceptibility testing was performed and interpreted according to Clinical and Laboratory Standards Institute criteria. The primary outcome was any AMR phenotype at the patient level. Among 44 recruited patients, AMR was detected in 12 (27.3%; 95% CI, 15.0–42.8). A total of 70 isolates were identified, dominated by *S. aureus* (50.0%) and Enterobacterales (25.7%). MRSA accounted for 20.0% of *S. aureus* isolates. Among Enterobacterales, 38.9% were ESBL-producing, and 5.6% were identified as carbapenemase-producing. Antibiotic-specific resistance was highest for trimethoprim-sulfamethoxazole (100%), nitrofurantoin (63.6%), and ciprofloxacin (54.5%), whereas phenotypic carbapenem resistance was low. AMR was strongly associated with emergency presentation (100.0% vs. 6.5% in non-emergency settings; $p < 0.001$). In conclusion, more than one-quarter of paediatric patients in this tertiary setting had clinically significant AMR, characterised by MRSA and high ESBL prevalence among Enterobacterales. Resistance was concentrated in high-acuity hospital pathways, underscoring the need for strengthened antimicrobial stewardship, targeted infection prevention, and enhanced laboratory surveillance in tertiary paediatric care in Nigeria.

Keywords: Antimicrobial resistance, Paediatric population, Methicillin-resistant *Staphylococcus aureus*, Extended-spectrum beta-lactamase, Carbapenemase-producing Enterobacterales, Nigeria

INTRODUCTION

Antimicrobial resistance (AMR) has emerged as one of the most pressing global health threats of the twenty-first century. The World Health Organization (WHO) recognises AMR as a major challenge to the prevention and treatment of an ever-increasing range of infections caused by bacteria, parasites, viruses, and fungi (World Health Organization, 2022). Without effective antimicrobial agents, routine medical procedures, management of common infections, and emergency care are compromised. The O'Neill Review projected that, if unchecked, AMR could cause 10 million deaths annually by 2050, disproportionately affecting low- and middle-income countries (O'Neil, 2016). Sub-Saharan Africa bears a substantial share of this burden, driven by high infectious disease prevalence, limited laboratory capacity, antibiotic misuse, and inadequate surveillance systems (Laxminarayan *et al.*, 2013). Despite increasing global attention, AMR data from many African settings remain fragmented, particularly in paediatric hospital populations. This gap is critical, as children in low-resource settings are frequently exposed to antimicrobials due to high burdens of respiratory, gastrointestinal, and bloodstream infections. Notably, hospitalised children represent a high-risk group for AMR acquisition and detection. Inpatient settings, particularly tertiary referral hospitals, concentrate severe infections and prior antimicrobial exposure, both of which are established drivers of AMR (Centers for Disease Control and Prevention, 2019). Emergency departments further concentrate critically ill patients who often receive empirical

broad-spectrum antibiotics before microbiological confirmation, potentially selecting for resistant microorganisms. In many African tertiary hospitals, microbiological testing is limited to more severe cases, introducing an epidemiological pattern in which resistance is detected more frequently among emergency and hospitalised patients (Umeokonkwo *et al.*, 2023). This is consistent with global evidence indicating higher AMR rates among hospital-associated infections than among community-acquired infections (World Health Organization, 2022).

Staphylococcus aureus (*S. aureus*) is a leading cause of skin and soft tissue infections, pneumonia, and bloodstream infections worldwide. Methicillin-resistant *S. aureus* (MRSA) has been recognised as a major cause of hospital-associated infections since the late twentieth century (Centers for Disease Control and Prevention, 2019). Although MRSA prevalence varies geographically, many hospital-based studies in sub-Saharan Africa report increasing rates of methicillin resistance among *S. aureus* isolates (World Health Organization, 2022). Similarly, Gram-negative organisms, particularly *Escherichia coli* (*E. coli*) and *Klebsiella* species, are among the most common causes of paediatric urinary tract infections, sepsis, and gastrointestinal infections. Extended-spectrum beta-lactamase (ESBL) production in Enterobacterales confers resistance to third-generation cephalosporins, which are widely used as first-line therapies in hospital settings (Paterson & Bonomo, 2005). ESBL-producing organisms are increasingly reported across African healthcare facilities (World Health Organization, 2022). More

concerning is the emergence of carbapenemase-producing organisms. Carbapenems are often considered last-line agents for severe Gram-negative infections. The detection of carbapenemase-producing Enterobacterales (CPE) in hospital settings signals potential treatment limitations and increased mortality risk (Centers for Disease Control and Prevention, 2019). Multidrug resistance (MDR), commonly defined as non-susceptibility to at least one agent in three or more antimicrobial classes, reflects the cumulative action of resistance mechanisms and substantially narrows therapeutic options (Magiorakos *et al.*, 2012). While MDR prevalence varies by organism and region, its presence in hospitalised paediatric populations is particularly concerning due to limited antibiotic alternatives for children.

Nigeria, like many other African countries, faces unique challenges in AMR control, including unrestricted access to over-the-counter antibiotics, inconsistent implementation of antimicrobial stewardship, and variable laboratory infrastructure (Williams *et al.*, 2018). The country's national AMR surveillance systems are still evolving, and hospital-based data remain critical for informing local stewardship strategies and empirical treatment guidelines. The University of Benin Teaching Hospital (UBTH), Benin City, Edo State, represents an important tertiary referral hub in southern Nigeria. However, published data on the distribution of microorganisms and resistance phenotypes in paediatric hospital populations in this region remain limited. Generating local epidemiological data on carriage of MDR phenotypes is essential for guiding context-specific antimicrobial stewardship interventions and aligning with the WHO Global Antimicrobial Resistance Surveillance System (GLASS) framework (World Health Organization, 2022). Given the global escalation of AMR, the recognised vulnerability of hospitalised paediatric populations, and the limited local data from southern Nigeria, this study aimed to characterise the carriage of MDR among paediatric patients, the distribution of isolated bacteria in this setting; microorganism-specific resistance patterns, including MRSA among *S. aureus* and ESBL/carbapenemase production among Enterobacterales; and antibiotic-specific resistance prevalence with explicit denominators. By aligning epidemiological findings with clinical contexts, particularly emergency presentations and hospital-based care, this study provides evidence relevant to antimicrobial stewardship policy, empirical therapy protocols, and infection prevention strategies within tertiary-care settings in Nigeria.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based cross-sectional study was conducted at UBTH, a 910-bed tertiary referral centre in Benin City, Edo State, Nigeria. The hospital serves Edo State and neighbouring regions, providing both emergency and routine in-hospital paediatric care. The study formed part of a broader AMR surveillance initiative, with the analysed data focusing on paediatric patients for whom linked clinical and laboratory data were available.

Study Population and Eligibility

Children aged <18 years who were admitted to or presented to UBTH during the study period were eligible for inclusion. Participants were enrolled following caregiver consent, and clinical samples were obtained as part of routine hospital care.

Data Sources

Two primary datasets were used: a clinical dataset containing sociodemographic and hospital-related variables, and a

microbiological dataset containing microorganism identification and antimicrobial susceptibility results. Records were merged using unique patient identifiers. When multiple isolates were recorded for a single patient, resistance phenotypes were aggregated using a maximum-value approach: if any isolate demonstrated resistance, the patient was classified as resistant for that phenotype. Microorganism names were standardised to correct inconsistencies in spelling and formatting prior to analysis.

Clinical Specimens and Microbiological Procedures

Nasal and rectal swabs were collected as part of routine diagnostic evaluation in children who met the study inclusion criteria. Specimens were processed at the UBTH Medical Microbiology Laboratory. Nasal swabs were cultured on Blood agar, MacConkey agar, and mannitol salt agar and incubated at 37 °C for 18-24 hrs. Rectal swabs were cultured on MacConkey agar and incubated at 37°C for 18-24 hrs. Bacterial identification was performed using standard microbiological techniques, including colony morphology, Gram staining, and biochemical characterisation. Biochemical characterisation for staphylococci was carried out using conventional tests, namely mannitol fermentation, catalase and coagulase (slide and/or tube test) (Cheesbrough, 2006), after verifying that they were Gram-positive cocci in clusters. The identities of *E. coli* and *K. pneumoniae* were determined using API20E kits after confirming they were Gram-negative rods.

Antimicrobial Susceptibility Testing

Antimicrobial susceptibility testing (AST) was conducted and interpreted in accordance with Clinical and Laboratory Standards Institute (CLSI) guidelines (Clinical & Laboratory Standards Institute, 2023). Antibiotic discs used included Meropenem (10 µg), Imipenem (10 µg), Ertapenem (10 µg), Ceftazidime (30 µg), Ceftriaxone (30 µg), Cefuroxime (30 µg), Piperacillin-tazobactam (100-10 µg) Levofloxacin (5 µg), Amoxicillin-clavulanate (30 µg), Gentamicin (10 µg) Amikacin (30 µg), ciprofloxacin (5 µg), nitrofurantoin (300 µg), Cefoxitin (30 µg), and Trimethoprim-sulfamethoxazole (1.25-23.75 µg) Zone diameters were categorised as susceptible, intermediate, or resistant using CLSI breakpoints. Quality control procedures were implemented for each testing batch using the appropriate reference strain (*E. coli* ATCC 25922).

Detection of Methicillin-resistance

All *S. aureus* recovered were screened for methicillin-resistance by seeding the organism on Mueller-Hinton agar (MHA) plates following CLSI guidelines and placing 30µg cefoxitin disc at the centre of the plate (Oxoid, U.K). MHA were read after incubation at 35°C for 18 hrs. by observing for the zone of inhibition around the cefoxitin disc. A zone diameter ≤ 21mm for the cefoxitin disc was deemed resistant.

Determination of Extended-spectrum β-Lactamase (ESBL) Producing Bacteria

All *E. coli* and *K. pneumoniae* isolates were screened for ESBL production using the double-disc synergy technique as described by Kaur *et al.* (2013). The discs namely ceftazidime (30µg), cefotaxime (30µg), cefepime (30µg) and amoxicillin-clavulanate (AMC) (30µg) (Oxoid, U.K) were used for the test. Briefly, the test organism was seeded on the MHA plate as earlier described for AST. The ceftazidime and cefotaxime discs were placed 15mm from the AMC disc at the centre of the plate, while the cefepime was placed 20mm from the AMC disc. The plate was thereafter incubated at 37°C

overnight. Any isolate showing expansion towards either cephalosporin placed adjacent to amoxicillin-clavulanate was deemed ESBL-producing when compared with the negative control strain (*Escherichia coli* ATCC 25922), which did not show any synergism.

Detection of Carbapenemase-Producing Organisms (Simplified Carbapenemase Inactivation Method)

All Gram-negative bacterial isolates were screened for carbapenemase activity. A modification of the simplified carbapenemase inactivation method (sCIM) described by Jing *et al* (2018) was used. Briefly, a 0.5 McFarland standard suspension of the indicator strain (*E. coli* ATCC 25922) was swabbed in three directions on a Mueller-Hinton agar (MHA) plate and allowed to dry for 3-10 minutes. One to three colonies of the test bacillus, which had grown on blood agar, were thereafter smeared on one side of 10µg imipenem discs (from Oxoid, UK). The side of the antibiotic discs smeared with the test organism was immediately put on the already seeded Mueller-Hinton plate and incubated at 35°C for 16-18 hrs. Another imipenem disk (not smeared with the organism) was placed on the MHA plate as a control. For the interpretation of the test, discs with a zone diameter ≤ 22 mm indicate that the isolate is carbapenemase-producing (positive); a zone of inhibition ≥ 26 mm indicates the absence of carbapenemase activity (negative); a zone of inhibition of 23–25 mm indicates a carbapenemase indeterminate isolate (Jing *et al.*, 2018).

Data Management and Statistical Analysis

Sociodemographic and clinical variables included age, sex, patient category (in-hospital vs community), clinical location (emergency vs non-emergency), and residence (urban, semi-

urban, rural). Age was analysed both as a continuous variable and as a binary variable (<5 years and 5–17 years). Microorganism distribution was analysed at the isolate level, while resistance outcomes were examined at both isolate and patient levels. Data were analysed using STATA version 16. Continuous variables were summarised using means and standard deviations or medians and interquartile ranges, as appropriate. Binary and categorical variables were presented as frequencies and percentages. AMR prevalence was calculated with exact binomial 95% confidence intervals. Statistical significance was defined as a two-sided p-value <0.05.

Ethical Considerations

Ethical approval was obtained from the University of Benin Teaching Hospital Health Research Ethics Committee (reference number: ADM/E 22/A/VOL. VII/14831247). Written informed consent was obtained from caregivers prior to enrolment. All data were anonymised prior to analysis to ensure confidentiality.

RESULTS AND DISCUSSION

Study Population and Distribution of Antimicrobial Resistance

A total of 44 recruited patients with aligned clinical and laboratory data were included in this study (Table 1). The median age was 8.0 years (IQR 1.6–13.1). The cohort was predominantly paediatric, with 59.1% aged 5–17 years and 40.9% under 5 years. Males comprised 61.4% of the study participants. Most participants were in-hospital cases (93.2%), and 22.7% were sampled from emergency settings. Urban residence predominated (75.0%), followed by semi-urban (22.7%) and rural (2.3%).

Table 1: Sociodemographic and Clinical Characteristics of Participants, Overall and by AMR phenotype Status (N = 44)

Characteristic	Overall (N=44)	AMR phenotype present (n=12)	AMR phenotype absent (n=32)	p-value
Age (years), median (IQR)	8.0 (1.6–13.1)			
Age group, year				
<5	18 (40.9%)	4 (33.3%)	14 (43.8%)	0.733
5–17	26 (59.1%)	8 (66.7%)	18 (56.2%)	
Sex				
Male	27 (61.4%)	9 (75.0%)	18 (56.2%)	0.438
Female	15 (34.1%)	3 (25.0%)	12 (37.5%)	
Missing	2 (4.5%)	0 (0.0%)	2 (6.2%)	
Patient category				
In-hospital	41 (93.2%)	12 (100.0%)	29 (90.6%)	0.551
Community	3 (6.8%)	0 (0.0%)	3 (9.4%)	
Recruitment location				
Non-emergency	31 (70.5%)	2 (16.7%)	29 (90.6%)	<0.001
Emergency	10 (22.7%)	10 (83.3%)	0 (0.0%)	
Residence				
Urban	33 (75.0%)	11 (91.7%)	22 (68.8%)	0.288
Semi-urban	10 (22.7%)	1 (8.3%)	9 (28.1%)	
Rural	1 (2.3%)	0 (0.0%)	1 (3.1%)	
Number of samples per patient				
1	27 (61.4%)	2 (16.7%)	25 (78.1%)	<0.001
≥2	17 (38.6%)	10 (83.3%)	7 (21.9%)	

Distribution of Bacterial Isolates

Across all laboratory entries, 70 isolates were documented (Table 2). Gram-positive organisms predominated, with *S. aureus* accounting for half of all isolates (50.0%), followed by coagulase-negative staphylococci (22.9%). Among Gram-

negative organisms, *E. coli* represented 21.4% of isolates, while *Klebsiella pneumoniae* comprised 4.3%. This distribution reflects a microbiological profile dominated by staphylococcal species, with a substantial representation of Enterobacterales.

Table 2: Frequency Distribution of Identified Microorganisms (n = 70)

Clinical specimen	Microorganism	n (%)
Nasal swab	<i>S. aureus</i>	35 (50.0%)
	Coagulase-negative staphylococci	16 (22.9%)
Rectal swab	<i>E. coli</i>	15 (21.4%)
	<i>K. pneumoniae</i>	3 (4.3%)

Antimicrobial Resistance Phenotype Prevalence

From a conceptual perspective, the outcome variable was defined by the presence of any of the following AMR phenotypes: MRSA, ESBL-production, or carbapenemase production. The prevalence of the aforementioned phenotypes

were 20%, 38.9% and 5.6%, respectively. Antimicrobial resistance was therefore identified in 12 of 44 patients (27.3%). (Table 3). Approximately three-quarters of patients (72.7%) had no documented resistance under the composite definition.

Table 3: Overall Carriage of Antimicrobial Resistance (N = 44)

AMR outcome	n	Prevalence [% (95% CI)]
Any AMR detected	12	27.3% (15.0–42.8)
No AMR detected	32	72.7% (57.2–85.0)

AMR was not significantly associated with age group, sex, patient category, or residence (Table 4). However, AMR was strongly associated with emergency clinical location (100.0% vs 6.5% in non-emergency; $p < 0.001$). Urban residence had a higher point prevalence (33.3%) than semi-urban (10.0%) and rural settings, although this difference was not statistically

significant. The consolidated analysis indicates that AMR detection in this cohort is primarily among emergency-presenting, hospital-based patients, suggesting that clinical acuity and healthcare exposure may be major determinants of resistance in the study setting.

Table 4: Antimicrobial Resistance Phenotype Prevalence by Sociodemographic and Clinical Characteristics (N = 44)

Variable	N	AMR cases (n)	AMR prevalence (%)	p-value
Age group				
<5	18	4	22.2%	0.733
5–17	26	8	30.8%	
Sex				
Male	27	9	33.3%	0.438
Female	15	3	20.0%	
Missing	2	0	0.0%	
Patient category				
In-hospital	41	12	29.3%	0.551
Community	3	0	0.0%	
Recruitment location				
Non-emergency	31	2	6.5%	<0.001
Emergency	10	10	100.0%	
Missing	3	0	0.0%	
Residence				
Urban	33	11	33.3%	0.288
Semi-urban	10	1	10.0%	
Rural	1	0	0.0%	

Microorganism-specific Resistance Patterns

Among *S. aureus* isolates, 20.0% (7/35) were MRSA, indicating a notable burden of clinically significant staphylococcal resistance. Within Enterobacterales (*E. coli* and *K. pneumoniae*), 38.9% (7/18) of isolates were identified

as ESBL-producing, and one *E. coli* isolate identified as carbapenemase-producing: 5.6% (1/18). These findings suggest a substantial prevalence of advanced beta-lactam resistance mechanisms among Gram-negative isolates.

Table 5: Organism-Specific Resistance Profiles

Organism/Group	Resistance Phenotype	n/N	Percent
<i>S. aureus</i>	MRSA	7/35	20.0%
Enterobacterales (<i>E. coli</i> + <i>K. pneumoniae</i>)	ESBL-Producing	7/18	38.9%
Enterobacterales (<i>E. coli</i> + <i>K. pneumoniae</i>)	Carbapenemase-Producing	1/18	5.6%

Antibiotic-specific Resistance Prevalence

Antibiotic susceptibility testing data were available for 11 isolates in the Enterobacterales panel (Figure 1). Resistance was highest for trimethoprim–sulfamethoxazole (100%), followed by nitrofurantoin (63.6%) and ciprofloxacin (54.5%). Resistance to third-generation cephalosporins ranged between 18.2% and 27.3%. Carbapenem resistance

based on antibiotic testing was low ($\leq 9.1\%$), and aminoglycoside resistance was uncommon. These results indicate high resistance to commonly used oral agents and fluoroquinolones, with comparatively preserved phenotypic susceptibility to carbapenems despite elevated carbapenemase identifications.

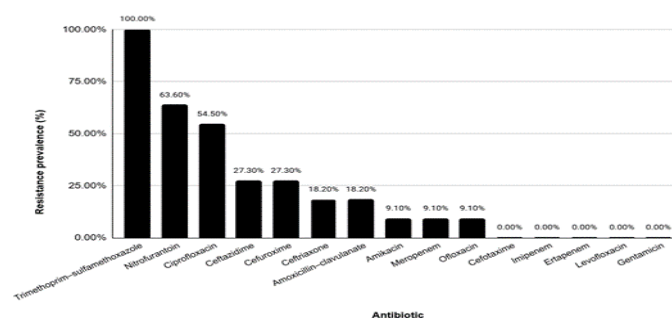


Figure 1: Antibiotic Susceptibility Testing Pattern

Discussion

Summary of Key Findings

In this hospital-based paediatric cohort from Benin City, slightly over one-quarter of participants met the composite definition for AMR. The microbiology was dominated by *S. aureus* and Enterobacterales (*E. coli* and *K. pneumoniae*), with clinically important resistance phenotypes detected in both groups. Approximately one in five *S. aureus* isolates were methicillin-resistant (MRSA), while ESBL and carbapenemase phenotypes were common among Enterobacterales isolates. At the antibiotic level, resistance was concentrated in widely used oral and empiric agents, particularly trimethoprim-sulfamethoxazole and fluoroquinolones, while phenotypic carbapenem resistance remained comparatively low in the subset tested. The single most striking epidemiologic correlate was clinical location: AMR was concentrated among emergency presentations.

Interpretation in the Context of Existing Evidence

The magnitude of AMR observed here is consistent with the wider pattern reported across sub-Saharan Africa: most available paediatric resistance data come from urban tertiary hospitals, and these settings tend to report high non-susceptibility to commonly used empiric regimens (Williams *et al.*, 2018). A systematic review highlighted two converging drivers of AMR that remain relevant in Nigeria: high infectious disease burden and antimicrobial consumption in children, and limited diagnostic capacity leading to syndromic, empiric prescribing—conditions that amplify selection pressure and delay de-escalation (Williams *et al.*, 2018). These pressures are also reflected in Nigerian hospital audits, showing very high inpatient antimicrobial use and low levels of targeted therapy (Umeokonkwo *et al.*, 2023). Nonetheless, the AMR estimates in the present study should be interpreted as hospital-care-weighted rather than community-representative. In Nigeria, surveillance remains uneven and is often limited to tertiary facilities, so prevalence estimates vary widely by case, specimen type (infection vs colonisation), and the population selected for culture (Nigeria Centre for Disease Control, 2017). This study's cohort is predominantly in-hospital and paediatric, which, in the Nigerian context, typically implies a higher pre-test probability of resistance than community cohorts (Umeokonkwo *et al.*, 2023).

The MRSA proportion among *S. aureus* isolates (~20%) sits within the range reported in West Africa and is biologically plausible for a tertiary hospital interface. In Kano, among children living with HIV (a high-risk group), both substantial *S. aureus* carriage and severe-disease MRSA signals were reported, including reports of oxacillin resistance among bloodstream isolates (Sadauki *et al.*, 2022). While that population differs from ours, it illustrates a broader Nigerian reality: MRSA epidemiology is heterogeneous, with higher

rates typically observed in high-risk clinical groups and healthcare-associated contexts, and lower rates in general community sampling (Sadauki *et al.*, 2022). The present results therefore strengthen the argument that MRSA is not a marginal phenotype in paediatric care pathways and should remain embedded in local empiric-treatment and infection prevention and control (IPC) planning. The proportion of ESBLs among Enterobacterales aligns closely with contemporary Nigerian evidence, indicating that ESBL-producing microorganisms are common in healthcare-associated and admission-carriage settings. For example, among children admitted to a teaching hospital in Lagos, carriage of ESBL-producing Enterobacterales at admission was 25.3%, and acquisition occurred during hospitalisation, emphasising the combined roles of importation and in-hospital transmission (Jewoola *et al.*, 2020). At the national level, a systematic review reported a pooled ESBL prevalence among *Klebsiella pneumoniae* isolates of approximately 40%, reinforcing that high ESBL prevalence is now a structural feature of Nigerian clinical microbiology rather than an outlier phenomenon (Ezeh *et al.*, 2024). Findings in the present study are directionally consistent with these data, although the denominators differ (patient-level carriage vs isolate-level phenotypes). However, the proportion of carbapenemase requires a more nuanced interpretation. Nigeria is increasingly reporting carbapenem-resistant or carbapenemase-associated Enterobacterales, but prevalence estimates depend heavily on the population sampled and whether the endpoint is rectal carriage, clinical infection isolates, or laboratory phenotypes (Adekanmbi *et al.*, 2024). In Ibadan, rectal carriage of carbapenem-resistant Enterobacterales was substantial across healthcare levels, with the highest prevalence in tertiary care (Adekanmbi *et al.*, 2024). Against this background, the proportion of carbapenemase phenotypes in a tertiary paediatric pathway is epidemiologically credible; however, the apparent discordance between frequent carbapenemase flags and relatively low phenotypic carbapenem resistance in the antibiotic panel tested in the present study should be treated as a priority analytic and laboratory-quality question rather than overinterpreted as a biological paradox. Observed discordance may reflect several overlapping factors: small denominators in susceptibility testing; misalignment between screening algorithms and confirmatory panels; variability in organisms and resistance mechanisms reported as “carbapenemase”; and early emergence of carbapenemase genes with inconsistent phenotypic expression under specific laboratory conditions (Nordmann *et al.*, 2011). This is precisely why Nigeria's emerging CRE/CP-E surveillance literature emphasises standardised screening pathways and confirmatory testing as prerequisites for reliable trend interpretation (Adekanmbi *et al.*, 2024).

The strong association between AMR and emergency presentation should be interpreted as a composite marker of illness severity, prior antibiotic exposure, and intensity of diagnostic work-up, rather than a causal effect of “being in emergency” per se. Similar selection dynamics are well recognised in AMR surveillance: sicker patients are more likely to be cultured, more likely to have received antibiotics pre-admission, and more likely to have complicated infections that are AMR (Williams *et al.*, 2018). The parallel finding that patients with multiple specimens were more frequently classified as AMR-positive supports this interpretation, as repeated sampling is typically triggered by clinical deterioration, treatment failure, or high suspicion of invasive infection. Therefore, the emergency association is best interpreted as an epidemiologic “signal” that the resistant burden is concentrated in high-acuity pathways, where empiric choices have the greatest impact, rather than as an inference about location-based transmission alone.

The observed resistance profile (very high resistance to trimethoprim–sulfamethoxazole and substantial resistance to fluoroquinolones) aligns with a long-standing Nigerian pattern in which commonly available, frequently used antibiotic agents exhibit the greatest erosion of effectiveness (Williams *et al.*, 2018). The national situation analysis documents high resistance to inexpensive, widely accessible antibiotics in multiple regions, including paediatric populations, and highlights pervasive pressures from unregulated antimicrobial access and empiric use (Nigeria Centre for Disease Control, 2017). These patterns are also consistent with broader evidence from the African region indicating high resistance to frequently prescribed antibiotics and the need for facility-level antibiograms to avoid “default empiricism” (Gahimbare *et al.*, 2024; Williams *et al.*, 2018). From a clinical standpoint, the implication is not merely that “resistance is high,” but that step-down options become constrained, leading to prolonged parenteral therapy, longer admissions, higher costs, and increased nosocomial exposure, especially in paediatric settings.

Strengths and Limitations

This study links patient-level characteristics to the distribution of microorganisms and resistance phenotypes in a tertiary care setting in Nigeria, where paediatric AMR data remain comparatively sparse in the South-South zone. The analysis standardised the nomenclature of microorganisms, reported explicit denominators for antibiotic susceptibility where available, and produced both patient-level and isolate-level summaries to support stewardship decision-making. The focus on MRSA and Enterobacterales aligns with WHO priority pathogen concerns and the dominant causes of severe paediatric bacterial illness in African tertiary settings (Williams *et al.*, 2018). However, this study has some limitations worth noting. The sample size is modest, and the cohort is not community representative, limiting generalisability and statistical power for multivariable inference. Resistance phenotypes for ESBL and carbapenemase relied partly on routine laboratory proportions rather than molecular confirmation, and antibiotic susceptibility testing denominators were small for some antibiotics, making prevalence estimates sensitive to minor changes in counts.

Implications of Findings for Policy, Practice, and Research

Per policy, the findings support prioritising facility-level antimicrobial stewardship in the study hospital and similar tertiary centres, with emphasis on paediatric pathways. The combination of MRSA and a high ESBL burden warrants

review of empiric guidelines, particularly in emergency and high-acuity units, and the routine dissemination of local antibiograms. The evidence also reinforces the need to operationalise surveillance in alignment with Nigeria’s national AMR agenda and to strengthen IPC at high-risk paediatric entry points (Nigeria Centre for Disease Control, 2017). Clinically, high resistance to trimethoprim–sulfamethoxazole and notable fluoroquinolone resistance pose challenges for empiric and step-down strategies. Where feasible, routine culture and susceptibility testing should be strengthened for severe presentations and non-responders, with early de-escalation guided by results. Given the proportion of ESBLs, third-generation cephalosporins may be unreliable for some Enterobacterales infections without confirmatory testing; conversely, the apparently preserved phenotypic carbapenem susceptibility in the tested subset suggests that carbapenems should remain protected and used strategically, alongside confirmatory testing and stewardship oversight. In terms of research, the results justify a larger, prospective paediatric cohort in Edo State with (1) standardised ESBL and carbapenemase confirmatory testing, (2) explicit differentiation between infection isolates and colonisation screening, and (3) systematic capture of prior antibiotic exposure and device use—variables shown to matter in Nigerian paediatric ESBL carriage work (Jewoola *et al.*, 2020). Molecular characterisation (where feasible) would clarify whether carbapenemase proportions reflect the presence of specific gene families circulating locally and would strengthen outbreak detection and IPC targeting. In parallel, evaluating prescribing practices in the paediatrics department of the study hospital would help link resistance patterns to modifiable antimicrobial use behaviours (Umeokonkwo *et al.*, 2023).

CONCLUSION

This study indicates a clinically important AMR burden in a tertiary paediatric cohort in Benin City, with resistance concentrated in high-acuity (emergency) pathways and driven by MRSA and advanced beta-lactam resistance among Enterobacterales. The results support the immediate strengthening of paediatric antimicrobial stewardship, emergency-unit IPC, diagnostic testing capacity, and routine facility antibiogram production and use for empiric guideline updates. Future work should scale sample size, standardise confirmatory phenotyping, and incorporate molecular characterisation to better define transmission dynamics and to protect last-line therapies.

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