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The Prevalence and Risk Factors of Carbapenem-Resistant *Acinetobacter* Species in Catheterized and Non-Catheterized Patients in A Tertiary Hospital at Nnewi, Anambra State, Nigeria

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Abstract **Original Research Article**

A study was conducted to determine the prevalence and risk factors of carbapenem-resistant *Acinetobacter spp*. among catheterized and non-catheterized patients at Nnamdi Azikiwe University Teaching Hospital, Nnewi, and Anambra State, Nigeria. The cross-sectional study was carried out from May to July 2025 and included 200 hospitalized participants: 82 catheterized and 118 non-catheterized patients. Questionnaire data were collected through oral interviews, and urine specimens were collected in sterile containers. Conventional culture methods were used, and antimicrobial susceptibility testing was performed using the Kirby–Bauer disc-diffusion method. The report recorded the highest prevalence of significant bacterial growth among participants aged 56–65 years (38.2%); the age group 36–45 years had the lowest reported prevalence (15.8%). Doripenem showed the highest reported resistance (95.5%), while ertapenem had the lowest reported resistance (51.3%). The reported highest multidrug-resistance pattern involved doripenem and meropenem (86.8%). Statistical associations were reported between positive isolates and age groups 36–45 and 46–55 years, occupation, and catheterization status. No statistically significant associations were reported for symptoms or medical history. The study concluded that carbapenem-resistant *Acinetobacter spp*. represented a concern for hospital infection prevention and antimicrobial treatment. The findings support attention to hygiene, infection-control practices, and antimicrobial susceptibility testing.

Keywords: *Acinetobacter spp*.; carbapenem resistance; catheterization; antimicrobial susceptibility; urinary isolates; Nigeria.

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1. Introduction

Antimicrobial resistance is an important concern in hospital settings, particularly where resistant organisms can affect patients with severe illness or compromised health. The source project describes *Acinetobacter spp.*, especially *Acinetobacter baumannii*, as an emerging nosocomial pathogen and notes its capacity to acquire resistance determinants (Perez *et al.*,

2007; Roca *et al.*, 2012). It also identifies the use of urinary catheters, prolonged antibiotic therapy, and surgery among factors associated with acquisition of *Acinetobacter* infections (Cisneros *et al.*, 2005).

Acinetobacter spp. are described in the source as aerobic, Gram-negative coccobacilli that are catalase-positive, oxidase-negative, non-motile, non-fastidious, and non-glucose-fermenting (Goossens *et al.*, 2005; Sofia *et al.*, 2004). The project discusses pneumonia, meningitis, and urinary tract infections among infections associated with these organisms and highlights the challenges posed by antimicrobial resistance in hospitalized patients (Leung *et al.*, 2006).

The project was undertaken in response to concern about carbapenem-resistant *Acinetobacter spp.* in hospital environments. It focused on catheterized and non-catheterized patients at Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, with the aim of contributing local information on the occurrence of the organism and possible associated factors (Ochiabuto *et al.*, 2017).

The research project was undertaken in response to concern about carbapenem-resistant *Acinetobacter spp*. in hospital environments. It focused on catheterized and non-catheterized patients at Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, with the aim of contributing local information on the occurrence of the organism and possible associated factors. A study in 2017 investigated the carriage of *Acinetobacter spp*. on the hands and nostrils of hospital staff at Nnamdi Azikiwe University Teaching Hospital and assessed the antimicrobial susceptibility patterns of the isolates (Ochiabuto *et al*., 2017).

1.1 Aim and Objectives

- The aim was to determine the prevalence and risk factors for carbapenem-resistant *Acinetobacter spp.* among catheterized and non-catheterized patients in a tertiary hospital at Nnewi, Anambra State.
- To isolate and identify *Acinetobacter spp.* from catheterized and non-catheterized patients in relation to age range.
- To determine the frequency of carbapenem-resistant *Acinetobacter spp.* among the isolates obtained.
- To determine prevalence in relation to symptoms, medical history, and history of past diseases.
- To identify factors associated with carbapenem resistance in *Acinetobacter spp.*

2. Literature Review

2.1 Overview and Clinical Importance of Acinetobacter spp.

Acinetobacter species are Gram-negative, non-fermenting coccobacilli that are widely distributed in the environment and can persist in healthcare settings (Doughari *et al.*, 2011). Although several species may be recovered from clinical specimens, *Acinetobacter baumannii* is especially important because of its association with healthcare-associated infections and its capacity to survive under hospital conditions (Antunes *et al.*, 2011; González-Villoria & Valverde-Garduño, 2016). Reviews describe *Acinetobacter* as an increasingly consequential opportunistic pathogen, particularly among critically ill patients and those exposed to invasive procedures (Clark *et al.*, 2016; Lim *et al.*, 2016; Peleg *et al.*, 2008; Visca *et al.*, 2011). Furthermore, studies have noted that community-acquired presentations can occasionally occur alongside nosocomial outbreaks (Falagas & Rafailidis, 2007).

2.2 Carbapenem Resistance and its Clinical Implications

Carbapenems are broad-spectrum antimicrobial agents often relied upon for serious infections caused by resistant Gram-negative bacteria. The emergence of carbapenem-resistant *Acinetobacter baumannii* is therefore concerning because it can narrow treatment choices and complicate the management of hospital-acquired

infections (Farrell *et al.*, 2012; Van Looveren & Goossens, 2004). Studies and reviews have documented the international spread of carbapenem-resistant lineages, such as global clone 2, and the increasing difficulty of treating multidrug-resistant *Acinetobacter* infections (Higgins *et al.*, 2010; Kim *et al.*, 2013; Maragakis & Perl, 2008; Meriç *et al.*, 2008; Doi *et al.*, 2015). The World Health Organization placed carbapenem-resistant *Acinetobacter baumannii* among its critical-priority pathogens in its 2017 priority list, emphasizing the need for surveillance, infection prevention, and development of effective treatment options (Hsu *et al.*, 2017; World Health Organization, 2017).

2.3 Mechanisms Contributing to Antimicrobial Resistance

Resistance in *Acinetobacter* may arise through several mechanisms, including production of β-lactamases, changes in outer-membrane permeability, efflux-pump activity, and alterations in antimicrobial targets mediated by penicillin-binding proteins and genetic elements (D'Elia *et al.*, 2009; Esterly *et al.*, 2011; Russo, 2009; Russo, 2010; Trebosc *et al.*, 2016). These mechanisms may coexist, allowing organisms to resist multiple antimicrobial classes (Lee *et al.*, 2007). The literature also highlights the organism's capacity to acquire resistance determinants and to spread successfully in healthcare environments (Gordon & Wareham, 2010; Vila *et al.*, 2007; Doi *et al.*, 2015). Because resistance profiles can vary between hospitals and over time, local antimicrobial susceptibility testing is important when selecting therapy and interpreting empirical treatment options.

2.4 Healthcare-Associated Transmission and Catheterization

Healthcare-associated *Acinetobacter* infections are influenced by patient vulnerability, contact with contaminated equipment or surfaces, antimicrobial exposure, and the intensity of care required (Bartley *et al.*, 2010). Hospital surfaces and shared equipment can contribute to transmission when cleaning and disinfection practices are inadequate (Weber *et al.*, 2010). Urinary catheterization is an important clinical exposure because an indwelling device can provide a route for microbial entry and may increase the opportunity for biofilm formation. The risk of catheter-associated infection is affected by the indication for catheter use, duration of catheterization, insertion technique, and ongoing catheter care. Guidance on urinary catheter care therefore emphasizes appropriate indications, aseptic insertion, maintenance of a closed drainage system, and removal as soon as the device is no longer needed (Department of Health, 2003; Gilbert, 2006). Catheterization should be considered alongside other patient and healthcare factors rather than assumed to be the sole cause of infection or resistance.

2.5 Evidence from African and Nigerian Hospital Settings

Reports from African hospitals have documented *Acinetobacter* isolates with resistance to commonly used antibiotics, reinforcing the value of local surveillance (Anthony *et al.*, 2016; Idzenga *et al.*, 2006). Studies from Nigerian tertiary-care settings have examined the occurrence and antimicrobial susceptibility of *Acinetobacter species*, including reports of multidrug-resistant isolates in hospital intensive-care environments (Iregbu *et al.*, 2002; Nwadike *et al.*, 2014; Odewale *et al.*, 2016). Research in the region is important because antimicrobial use, infection-prevention resources, case mix, and laboratory capacity differ between settings. Findings from one hospital cannot automatically be generalized to another; facility-specific data are needed to guide prevention priorities and support appropriate antibiotic stewardship.

2.6 Risk Factors and Rationale for the Present Study

Prior literature identifies a range of factors associated with resistant *Acinetobacter* infection or colonization, including prolonged hospitalization, critical illness, invasive devices, previous antimicrobial exposure, and contact with healthcare environments where resistant organisms circulate (Cisneros *et al.*, 2005; Jung *et al.*, 2010; Maragakis & Perl, 2008; Park *et al.*,

2013; Simor *et al.*, 2002; Villa *et al.*, 2014). However, the importance of individual factors can vary by population and setting. The present study examined urine specimens and selected demographic, clinical, and catheterization variables among hospitalized patients at Nnamdi Azikiwe University Teaching Hospital, Nnewi. By comparing catheterized and non-catheterized participants and documenting reported susceptibility patterns, the project sought to contribute local evidence on *Acinetobacter* and carbapenem resistance.

2.7 Summary of the Literature Gap

The reviewed literature establishes *Acinetobacter spp.* as important healthcare-associated organisms and identifies carbapenem resistance as a serious therapeutic and infection-control concern. It also supports attention to catheter practices, antimicrobial exposure, environmental hygiene, and hospital-specific surveillance. Nevertheless, local data comparing catheterized and non-catheterized patients remain useful because prevalence and susceptibility patterns are not uniform across institutions. This study addresses that local evidence need in a tertiary hospital in Nnewi, Anambra State, Nigeria.

3. Materials and Methods

3.1 Study Design and Setting

This was a cross-sectional study conducted at Nnamdi Azikiwe University Teaching Hospital, Nnewi, Anambra State, Nigeria, over three months, from May to July 2025. The source project describes the Nnewi branch as the study site because of its larger study population and the availability of cases relevant to the research.

3.2 Study Population and Sample Size

The study population comprised hospitalized male and female patients aged 18–65 years, including catheterized and non-catheterized patients with different ailments. A total of 200 participants were included: 82 catheterized patients and 118 non-catheterized patients. The source states that the sample size was calculated using the formula $n = Z^2P(1-P)/d^2$, with a prevalence estimate of 79%, a 95% confidence coefficient of 1.96, and a precision level of 0.05 (Naing *et al.*, 2006).

3.3 Eligibility Criteria

Inclusion criteria were age 18–65 years, hospitalization at the study hospital, catheterized or non-catheterized status, and willingness to participate. Patients younger than 18 years, individuals outside the hospital, and unwilling patients were excluded.

3.4 Ethical Considerations and Consent

Ethical approval was obtained from the ethics committee of the Faculty of Health Sciences and Technology, Nnamdi Azikiwe University, Nnewi Campus, and Nnamdi Azikiwe University Teaching Hospital before the study commenced. Informed consent was sought and obtained at the study site following institutional guidelines (Indiana Healthcare-Associated Infection Initiative, 2017).

3.5 Data Collection and Specimen Collection

Participant information was collected through an oral interview using a structured questionnaire in English, adapted from standardized hospital-acquired infection surveillance formats (Census of District Health Boards, 2002). The questionnaire covered relevant symptoms and medical history. Clean-catch early-morning urine samples were collected from non-catheterized participants into sterile containers following standardized pre-analytical protocols (UK Biobank, 2011). For catheterized participants, urine was collected aseptically from the catheter sampling port after cleaning the port area with 70% alcohol and using a sterile syringe. Samples were labelled with collection dates and identification numbers and transported to the laboratory for analysis.

3.6 Laboratory Procedures

Urine specimens were processed for microscopy, chemistry, and culture in accordance with standard clinical microbiology protocols (Morello *et al.*, 2002; Coyle, 2005). For culture, a conventional surface-streaking technique on *Acinetobacter* selective medium (CHROMagar, USA) supplemented with selective antibiotics was performed, followed by incubation at 37°C for 24–72 hours. Colony counts were performed using a colony counter. A bacterial count of 10^5 CFU/mL was treated as significant growth, and results were recorded as significant or non-significant growth.

Urine chemistry was assessed using Combi-9 strips (Partec, Germany), with results interpreted against a standard chart. Antimicrobial susceptibility testing was reported as being performed using the Kirby–Bauer disc-diffusion method, strictly adhering to established international guidelines (Clinical and Laboratory Standards Institute, 2017; British Society for Antimicrobial Chemotherapy, 2013). This involved preparation of a bacterial suspension adjusted to McFarland's standard, agar inoculation, application of antimicrobial discs, aerobic incubation at 37°C for 24 hours, and measurement of inhibition zones. Susceptibility results were categorized as sensitive, intermediate, or resistant.

3.7 Data Analysis

Data were analysed using SPSS version 23. Simple prevalence calculations and chi-square analysis were used to assess associations. Statistical significance was set at $p < 0.05$, with the report also referring to a 95% confidence interval.

4. Results

A total of 200 hospitalized participants were included, comprising 82 catheterized patients and 118 non-catheterized patients. The following results were reported.

4.1 Bacterial Growth and Age

The report states that the 56–65-year age group had the highest reported prevalence percentage (38.2%), with significant growth reported as 20.0% among catheterized patients and 18.2% among non-catheterized patients. The 36–45-year age group had the lowest reported prevalence percentage (15.8%), with significant growth reported as 9.1% among catheterized patients and 6.7% among non-catheterized patients. The source reports statistically significant associations for the 36–45 and 46–55-year age groups ($p = 0.01$; $p < 0.05$), while the 18–35 and 56–65-year groups were reported as not statistically significant.

4.2 Antimicrobial Susceptibility Findings

Finding Reported in the Source	Reported Percentage	Details Reported
Highest resistance to a carbapenem	Doripenem: 95.5%	43.4% catheterized; 52.1% non-catheterized
Highest reported multidrug-resistance pattern	Doripenem + meropenem: 86.8%	34.7% catheterized; 52.1% non-catheterized
Lowest resistance among the listed carbapenems	Ertapenem: 51.3%	4.3% catheterized; 47.0% non-catheterized
Most sensitive drug as stated in the abstract	Imipenem: 4.3% resistance	0.0% catheterized; 4.3% non-catheterized

The abstract identifies doripenem as the drug with the highest reported resistance and imipenem as the most sensitive, with a reported resistance percentage of 4.3%. The results

section reports ertapenem as having the lowest resistance percentage (51.3%).

4.3 Medical History and Symptoms

The report states that there were no statistically significant associations between positive isolates and the medical-history variables assessed ($p > 0.05$). These variables included history of past diseases, symptoms associated with *Acinetobacter* urinary tract infection, antibiotic and herbal intake, and urinary tract infection before admission.

4.4 Occupation and Catheterization Status

Occupation was reported as statistically associated with the study outcome ($p = 0.00$ as written in the source; $p < 0.05$). Self-employed participants had the highest reported percentage (53.0%), comprising 29.0% among catheterized and 24.0% among non-catheterized participants. Participants described as non-employed had the lowest reported percentage (11.0%), comprising 5.0% among catheterized and 6.0% among non-catheterized participants.

The source reports that non-catheterized patients accounted for 59.0% and catheterized patients for 41.0% of the catheterization profile. It also reports a statistically significant association between catheterization status and bacterial-count status ($p = 0.00$ as written in the source; $p < 0.05$). Significant growth was reported as 46.2% among catheterized patients and 53.8% among non-catheterized patients. For non-significant growth, the report gives 72.7% for catheterized and 27.3% for non-catheterized patients.

5. Discussion

This study examined the occurrence of carbapenem-resistant *Acinetobacter spp.* in urine samples from catheterized and non-catheterized hospitalized patients at a tertiary hospital in Nnewi. The project's results describe differences in bacterial growth by age group and catheterization status, and report associations involving selected age groups, occupation, and catheterization status. The project did not report statistically significant associations for the medical-history and symptom variables assessed.

There was a very high resistance to doripenem and a high resistance pattern involving doripenem and meropenem antibiotic drugs. This is a concern because resistance can restrict treatment options for infections associated with *Acinetobacter spp.* The project emphasizes the importance of antimicrobial susceptibility testing before treatment and of infection-prevention practices in hospital settings.

The project identified catheterization, prolonged antibiotic therapy, and surgery as risk factors discussed in the literature review. In the study, the reported association between catheterization status and bacterial-count status supports the need to pay attention to catheter handling and specimen collection practices. However, because the design was cross-sectional, the reported associations should not be interpreted as proof that catheterization caused the observed findings.

6. Conclusion

Carbapenem-resistant *Acinetobacter spp.* are an important concern in hospital settings, particularly among hospitalized patients who may be vulnerable to infection. The study reported resistance to the tested carbapenems and associations between the study outcome and selected demographic and catheterization variables. The project recommends appropriate hygiene, infection-control measures, and further attention to antimicrobial susceptibility.

7. Recommendations

- Strengthen hygiene and infection-prevention practices in hospital wards and during catheter care.
- Use antimicrobial susceptibility testing to inform antibiotic selection where clinically indicated.

- Ensure appropriate sterilization and disinfection of instruments and medical equipment.
- Promote surveillance of *Acinetobacter spp.* and antimicrobial resistance in hospital settings.

Declarations

Ethics approval and consent to participate: Ethical approval was obtained from the ethics committee of the Faculty of Health Sciences and Technology, Nnamdi Azikiwe University, Nnewi Campus, and Nnamdi Azikiwe University Teaching Hospital. Informed consent was obtained at the study site.

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Conflicts of interest: There were no conflicts of interest in the course of the research study.

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