Original Research Article
Nigerian Journal of Biotechnology and Life Sciences
ISSN: 2814-0281
Vol. 3 No 2a (2026) p. 208 - 217
http://www.njbls.fud.edu.ng/

# Determinants of Nosocomial Infections Among Hospitalized Patients in Kano, Nigeria: A Logistic Regression Analysis of Prevalence and Risk Factors

**Murjanatu Mas'ud[1], Binta Muhammad Aminu[1], Aisha Ibrahim Aminu[1], Fatima Mas'ud[2]**

[1] Department of Microbiology, Faculty of Life Sciences, Bayero University Kano, Kano, P.M.B. 3011, Nigeria
[2] Department of Human Anatomy, Faculty of Basic Medical Sciences, Bayero University Kano, Kano, P.M.B. 3011, Nigeria
*Corresponding Author email: murjanatumasud98@yahoo.com
https://doi.org/10.67601/njbls.v3i2a.36

## Article info

**Date received**
08/07/2026
**Date accepted**
24/08/2026
**Available online**
11/09/2026

## Keywords

Nosocomial Infections (NIs), Nigeria, Risk factors, bacterial infections, Prevalence, Infection Control

## Abstract

Nosocomial Infections (NIs) is a major threat to patients' well-being leading to morbidity and mortality in low-income regions, but updated data from sub-Saharan Africa remain limited. This study was conducted to assess the prevalence, microbial profile, and risk factors of nosocomial infections at Murtala Muhammad Specialist Hospital, Kano, Nigeria. A cross-sectional hospital-based study involving 346 hospitalized patients from surgical, orthopaedic, and eclampsia wards. Urine, wound swabs and blood samples were collected and processed using standard microbiological techniques. Positive isolates were subjected to biochemical tests based on Bergey's Manual of Determinative Bacteriology. A questionnaire was administered to the patients to obtain their demographic information and risk factors associated with NIs. Logistic regression was employed to analyse the risk factors. Overall infection prevalence was 39.9% (138 out of 346), with Gram-positive bacteria (75.4%) mainly *Staphylococcus aureus* and *Streptococcus spp*. *Proteus*, *Pseudomonas aeruginosa, Klebsiella pneumoniae* and *E. coli* represented Gram-negatives isolates. Urine has the highest bacterial burden of 55.1%, with *Streptococcus* species with Streptococcus species being the most common isolate 40 (29.0) 38 especially in urine sample 38 (27.5). Male orthopaedic ward has the highest bacterial burden of 54.7% with *Proteus* being one of the predominating organisms isolated from wound swab. Major risk factors included the ward of admission (Female Surgical ward: $OR = 114.0$, $p < 0.001$) and age above 50 years ($OR = 2.63$). Low education ($OR = 12.28$) was also identified as a significant factor. The study reports a high occurrence of NIs at MMSH, the distribution of which driven by structural, clinical, and behavioural factors. Infection Prevention and Control (IPC) programs and patient education are crucial to reduce infection risk especially in high-risk wards.

## Introduction

Nosocomial Infections (NIs) have reached crisis levels in Nigerian hospitals, creating what the World Health Organization (2022) describes as a perfect storm of antimicrobial resistance, inadequate infrastructure, and overburdened healthcare workers. Recent surveillance data from the Nigeria Centre for Disease Control (2023) reveals that 14.3% of hospitalized patients acquire infections during their stay, with surgical site infections accounting for 31% of cases, bloodstream infections 22%, and catheter-associated urinary tract infections 19%. These figures substantially exceed the 7-10% prevalence documented in high-income countries (WHO, 2022), highlighting the disproportionate burden faced by Nigeria's healthcare system. The economic consequences are equally devastating, with NIs increasing hospitalization costs by 300-500% and prolonging hospital stays by 9-14 days according to Nigeria's National Action Plan on Antimicrobial Resistance (Federal Ministry of Health, Nigeria, 2021). This financial strain cripples already underfunded hospitals while pushing patients into medical poverty.

The etiology of NIs is complex and multifactorial, often originating from the introduction of pathogenic microorganisms into healthcare settings (Haque et al., 2018). These pathogens can be either endogenous, arising from the patient's normal flora, or exogenous, transmitted through other patients, healthcare workers, or contaminated medical devices (Alkali et al., 2019). While a variety of infectious agents including bacteria, viruses, fungi, and parasites can cause NIs, bacterial infections are the most predominant. These microorganisms may either colonize or cause infections, depending on the host's susceptibility (Gillespie & Bamford, 2012).

Among the most significant bacterial pathogens, *Staphylococcus aureus* (often endogenous, carried nasally) and *Enterococci* (opportunistic gut commensals) both persist on surfaces and transmit through direct or environmental contact, with *Enterococci* responsible for 20-30% of device-related infections (Gillespie & Bamford, 2012).

*Escherichia coli* and *Klebsiella pneumoniae* are spread through person-to-person contact, inadequate hygiene, or contaminated medical devices, frequently causing infections when they translocate from their normal niches, with *E. coli* being a leading cause of UTIs and bloodstream infections (Clinical and Laboratory Standards Institute, 2020). *Pseudomonas aeruginosa* and Clostridioides difficile require stringent disinfection due to their pronounced environmental persistence in healthcare settings (reservoirs including sinks and equipment), with C. difficile being particularly notable for its spore-mediated transmission causing antibiotic-associated *diarrhea* (Gillespie & Bamford, 2012).

In Nigeria, the antimicrobial resistance crisis has dramatically worsened HAI challenges over the past decade. Recent study on antimicrobial resistance demonstrates that 68% of Gram-negative pathogens in Nigerian hospitals now produce extended-spectrum β-lactamases (ESBLs), rendering most β-lactam antibiotics ineffective (Oluwasemowo et al., 2023). Even more alarming is the 400% increase in carbapenem-resistant Enterobacteriaceae between 2018-2023 documented in the NCDC's latest surveillance report (Nigeria Centre for Disease Control, 2023). These resistance patterns mirror trends observed across West Africa, particularly in Ghana where research published in Antimicrobial Resistance & Infection Control found similar ESBL rates among *Klebsiella pneumoniae and Escherichia coli* isolates (Labi et al., 2020).

However, Nigeria's crisis appears more advanced, with methicillin-resistant *Staphylococcus aureus* (MRSA) now detected in 44% of surgical ward infections compared to Ghana's 28% according to a multicenter study by Ogunleye et al. (2022). Northern Nigeria faces particularly severe challenges that remain understudied in the medical literature. Nwankwo et al. (2012) and Alkali et al. (2019) revealed critical shortages of infection prevention supplies - only few hospitals have consistent access to alcohol-based hand rub, and just 8% maintained proper sterilization equipment. These systemic failures create ideal conditions for NI transmission, compounded by cultural practices such as extensive patient visitation that increase microbial traffic in wards. In the region's climate, Harmattan dust storms from November to February has been associated with seasonal spikes in surgical site infections according to unpublished data from Murtala Muhammad Specialist Hospital. These unique epidemiological factors necessitate region-specific research to guide interventions. Therefore, this study was conducted to survey the prevalence, microbial profile, and risk factors associated with nosocomial infections among patients admitted to selected wards at Murtala Muhammad Specialist Hospital, Kano, Nigeria.

## Materials and methods

### Study Population

A survey of nosocomial pathogens was conducted in five selected wards at Murtala Muhammad Specialist Hospital, Kano, Nigeria. The selected wards were the Male Surgical ward, Female Surgical Ward, the Male Orthopaedic ward, Female Orthopaedic ward, and Eclampsia Ward under the Gynaecology Ward. This hospital was selected due to its high patient intake and frequent cases of nosocomial infections.

### Data and Sample Collection

A total of 346 samples were collected from the eligible patients following standardized protocols. Urine, blood, and swab samples were collected from consenting patients using aseptic technique to minimize contamination. Each sample was accurately labelled, securely stored in suitable containers, and promptly transported to the laboratory for comprehensive analysis and evaluation. Medical history and socio-demographic data were obtained using a structured questionnaire, along with information from caregivers and case file reviews to assess patient risk factors for the development of nosocomial infections.

### Sample Size Determination

The sample size was calculated using the formula by Lwanga and Lemeshow (1991):

$$n = \frac{Z^2 p(1-p)}{d^2}$$

where n is the sample size, Z is the Z-score corresponding to $Z^2$= (1.96) for a 95% confidence level, P = 34.3% = 0.343 the estimated prevalence, q = 1- p = 1- 0.343 = 0.657, $d^2$ = 5% = $(0.05)^2$, the margin of error or precision

$$\mathrm{n} = \frac{(1.96)^2 \times 0.343 \times 0.657}{(0.05)^2} = 346$$

### Bacterial Isolation

In vitro characterization of bacteria was carried out using standard culture and biochemical tests. Each specimen was streaked onto differential and selective culture media (Oxoid, Ltd, UK) including CLED, Chocolate, Mannitol Salt Agar and MacConkey agar for investigation of bacteria.

### Biochemical Tests

The isolates were identified using Gram staining and biochemical tests based on Bergey's manual of determinative bacteriology (Holt et al, 1994). The biochemical tests were carried on the bases of their Gram reaction, standard biochemical reaction include; catalase, coagulase, citrate, oxidase, TSI test, urease, motility and MR-VP (Clinical and Laboratory Standards Institute, 2014).

### Data Analysis

Collected data were entered into Microsoft Excel for data management and exported to IBM SPSS Statistics (Version 26.0) for analysis. Descriptive statistics were used to summarize demographic characteristics, primary health conditions, and the prevalence of NIs. Statistics were employed to assess associations between categorical variables. Binary logistic regression was performed to estimate odds ratios (OR) and 95% confidence intervals (CI) for risk factors.

### Quality Control

Quality control was maintained throughout the study. Standard reference strains (*Escherichia coli* ATCC 25922, *Staphylococcus aureus* ATCC 25923, and *Pseudomonas aeruginosa* ATCC 27853) were used as positive and negative controls for culture media and biochemical tests. All media were prepared according to manufacturer's instructions and tested for sterility and performance before use. Antibiotic susceptibility testing was quality-controlled using the same reference strains according to CLSI guidelines (CLSI, 2020).

## Results

Table 1 shows demographic factors for possible nosocomial infection. Patients aged above 50 years have significantly higher infection rates (44.9%) and 2.63 times higher odds of infection compared to younger patients (*OR = 2.63, 95% CI: 1.05-6.60, P = 0.039*). Married patients (*OR = 10.32, 95% CI: 5.46-19.50*) and widowed/divorced patients (*OR = 4.31, 95% CI: 1.91-9.83*) have significantly higher risk compared to single patients. Patients with only primary education have 12.28 times higher odds of infection compared to those with post-secondary education (*OR = 12.28, 95% CI: 3.85-39.18*). Gender is not significantly associated with infection risk. The ward of admission is strongly associated with nosocomial infection risk (Table 1). The Female Surgical ward has the highest infection rate (90.9%), with patients having 114 times higher odds of infection compared to the reference ward (Female Orthopaedic) (*OR = 114.0, 95% CI: 23.6-551.3, P < 0.001*). Male Surgical (*OR = 19.48, 95% CI: 8.11-46.78*) and Male Orthopaedic (*OR = 9.16, 95% CI: 4.18-20.08*) wards also show significantly elevated risks. The Eclampsia ward infection rate (12.2%) is similar to the reference ward.

Table 2 shows underlying diseases for possible nosocomial infection, it presents logistic regression of underlying diseases; only incision showed a statistically significant association (*OR (95% Cl) = 0.07 (0.01, 0.74), p = 0.034*); all other underlying diseases are not significantly associated ($p > 0.05$).

Table 3 shows the occurrence of nosocomial pathogens among different wards; the result of the study shows that the prevalence of nosocomial infection in Murtala Mohammed Specialist Hospital is 39.9% (138 out of 346). Gram-positive bacteria have the highest prevalence of 75.4% and 24.6% of the isolates are gram negative bacteria. Female surgical ward has the highest bacterial isolate of 30 (93.7%), followed by male surgical ward 41 (71%) and the least are female orthopedic having 10 (11.6%). Eclampsia ward has 10 (12%) of bacterial isolate.

The distribution of bacterial isolates from identified nosocomial patients at Murtala Muhammad Specialist Hospital, based on the source of the isolate, is shown in Table 4. Urine samples have 76 (55.1%) bacterial isolates, followed by swab samples and blood samples with 40 (29.0%) and 22 (15.9%), respectively. *Streptococcus* species are the predominant bacteria in urine samples with 38 (27.5%), and *Proteus* are the predominant bacteria in swab samples with 14 (10.1%). In the blood samples, only *Staphylococcus aureus* is isolated, with 22 (15.9%), and it is found in almost all three sample types, with a total of 38 (27.5%).

## Discussion

### Prevalence of Nosocomial Infections

An overall prevalence rate of Nosocomial Infections (NIs) of 39.9% was recorded from the five wards selected at Murtala Muhammad Specialist Hospital, suggesting a more severe NI crisis at the study area. This report is consistent with the global prevalence range of 2.5% to 41.0% (Mbim et al., 2016). This finding broadly supported the work of other study done in Kano state but exceeds the 34.4% prevalence found among patients with prolonged hospital stays across three Kano hospitals (Alkali et al., 2019). But when compared to other studies from Nigeria, this rate is significantly higher than the 2.6% overall hospital prevalence reported by Ige et al. (2009). The NIs burden was concentrated in surgical wards, with the Female Surgical ward showing a high infection rate of 93.7% followed by Male Surgical ward with 71%. This finding powerfully reinforces the consistent identification of surgical units as high-risk areas across Nigerian hospitals (Ige et al., 2009; Ukpoju et al., 2020; Alkali et al., 2019).This contrasts with lower rates in other wards (e.g., Eclampsia at 12.0%), strongly implicating surgical procedures, sterilization practices, and post-operative care as the potential primary sources of the problem.

### Pathogen Distribution

The study findings show that out of the 138 bacterial isolates, Gram-positive *cocci* were found to be the most commonly associated bacteria with nosocomial infection with 104 (75.4%) followed by Gram-negative 34 (24.6%); this observation was also aligned with the findings of Bale et al (2022) who reported 71 (74.7%) isolates as gram positive and 24 (25.3%) as gram negative.

**Table 1: Logistic Regression of the Risk Factors Associated with Occurrence of Nosocomial Infection**

| Demographic/Risk Factors | Patients Examined n (%) | Patients with NIs n (%) | OR (95% CI) | p-value |
|---|---|---|---|---|
| **Age Group (years)** | | | | <0.001* |
| <18 years | 38 (11.0) | 34 (24.6) | 1.00 (Reference) | |
| 18-35 years | 115 (33.2) | 15 (10.9) | 0.37 (0.14-1.00) | |
| 36-50 years | 131 (37.9) | 26 (18.8) | 0.72 (0.30-1.74) | |
| >50 years | 62 (17.9) | 62 (44.9) | 2.63 (1.05-6.60) | |
| Gender | | | | 0.705 |
| Female | 233 (67.4) | 67 (48.8) | 1.00 | |
| Male | 113 (32.6) | 71 (51.2) | 1.10 (0.68-1.78) | |
| **Marital Status** | | | | <0.001* |
| Single | 158 (45.7) | 13 (9.4) | 1.00 | |
| Married | 127 (36.7) | 72 (52.2) | 10.32 (5.46-19.50) | |
| Widowed | 16 (4.6) | 9 (6.5) | 0.64 (0.08-5.15) | |
| Divorced | 45 (13.0) | 44 (31.9) | 4.31 (1.91-9.83) | |
| **Educational Level** | | | | <0.001* |
| Post Secondary | 79 (22.8) | 40 (29.0) | 1.00 | |
| Secondary | 110 (31.8) | 42 (30.4) | — | |
| Primary | 157 (45.4) | 56 (40.6) | 12.28 (3.85-39.18) | |
| **Ward of Admission** | | | | <0.001* |
| Female Orthopedic | 86 (24.9) | 10 (11.6) | 1.00 | |
| Male Orthopedic | 86 (24.9) | 47 (54.7) | 9.16 (4.18-20.08) | |
| Male Surgical | 57 (16.5) | 41 (71.9) | 19.48 (8.11-46.78) | |
| Female Surgical | 33 (9.5) | 30 (90.9) | 114.0 (23.6-551.3) | |
| Eclampsia | 84 (24.3) | 10 (12.0) | 1.06 (0.42-2.69) | |
| **Total** | 346 (100) | 138 (100) | | |

**Key:** *p < 0.05 (Statistically Significant); OR: Odds Ratio; CI: Confidence Interval.

**Table 2: Underlying Diseases for Possible Nosocomial Infection in the Selected Ward**

| Underlying Diseases | Patients Examined n (%) | Patients with NIs n (%) | OR (95% CI) | p-value |
|---|---|---|---|---|
| **Orthopaedic Conditions** | | | | |
| Fracture | 90 (52.3) | 27 (38.0) | 0.57 (0.30, 1.08) | 0.085 |
| | 12 (6.9) | 7 (9.9) | 2.10 (0.64, 6.90) | 0.222 |
| Joint Dislocation | 19 (11.1) | 11 (15.5) | 1.73 (0.64, 4.65) | 0.273 |
| Amputation | 14 (8.1) | 8 (11.3) | 2.01 (0.67, 6.07) | 0.216 |
| Awaiting Surgery | 34 (19.8) | 15 (21.1) | 1.21 (0.55, 2.67) | 0.643 |
| Glasgow Coma | 3 (1.8) | 5 (7.1) | 10.37 (0.53, 204.6) | 0.124 |
| **Total** | 172 (100) | 71 (41.3) | - | - |
| **Surgical Conditions** | | | | |
| Burns | 23 (25.5) | 17 (29.8) | 1.45 (0.37, 5.66) | 0.588 |
| Typhoid Perforation | 12 (13.3) | 9 (15.8) | 4.95 (0.27, 89.9) | 0.281 |
| Hernia Repair | 12 (13.3) | 7 (12.3) | 0.74 (0.14, 4.01) | 0.911 |

| Underlying Diseases | Patients Examined n (%) | Patients with NIs n (%) | OR (95% CI) | p-value |
|---|---|---|---|---|
| Appendicitis | 17 (18.9) | 12 (21.1) | 1.47 (0.29, 7.31) | 0.639 |
| Biopsy | 7 (7.8) | 4 (7.0) | 0.49 (0.04, 5.76) | 0.582 |
| Incision | 8 (8.9) | 4 (7.0) | 0.07 (0.01, 0.74) | 0.034* |
| Fibrodenosis | 11 (12.2) | 4 (7.0) | 1.56 (0.34, 7.19) | 0.569 |
| **Total** | 90 (100) | 57 (63.3) | --- | --- |
| **Eclampsia Conditions** | | | | |
| Pastpartum Eclampsia | 39 (46.4) | 3 (30.0) | 0.44 (0.11, 1.84) | 0.251 |
| Antipartum Eclampsia | 15 (17.9) | 1 (10.0) | 0.47 (0.05, 4.01) | 1.000 |
| Antepartum Eclampsia | 30 (35.7) | 6 (60.0) | 3.06 (0.79, 11.89) | 0.094 |
| **Total** | 84 (100) | 10 (11.9) | --- | --- |

**Key:** *: Statistically Significant, OR: Odds Ratio; CI: Confidence Interval.

**Table 3. Occurrence of Nosocomial Pathogens among Different Wards of Murtala Muhammad Specialist Hospital**

| Ward | Samples Studied | Positive Isolates n (%) | Gram-Positive n (%) | Gram-Negative n (%) |
|---|---|---|---|---|
| Male Orthopedic (MO) | 86 | 47 (54) | 45 (95.7) | 2 (4.3) |
| Male Surgical (MS) | 57 | 41 (71) | 29 (70.7) | 12 (29.3) |
| Female Surgical (FS) | 33 | 30 (90.9) | 20 (66.7) | 10 (33.3) |
| Female Orthopedic (FO) | 86 | 10 (11.6) | 6 (60.0) | 4 (40.0) |
| Eclampsia (E) | 84 | 10 (12) | 4 (40.0) | 6 (60.0) |
| Total | 346 | 138 (39.9) | 104 (75.4) | 34 (24.6) |

**Table 4: Distribution of Bacterial Isolates According to Type of Samples**

| Organism Isolated | Blood n (%) | Swab n (%) | Urine n (%) | Total Isolates n (%) |
|---|---|---|---|---|
| *Staphylococcus aureus* | 22 (15.9) | 14 (10.1) | 2 (1.4) | 38 (27.5) |
| CoNS | 0 (0) | 4 (2.9) | 22 (15.9) | 26 (18.8) |
| *Streptococcus* species | 0 (0) | 2 (1.4) | 38 (27.5) | 40 (29.0) |
| *Escherichia coli* | 0 (0) | 0 (0) | 10 (7.2) | 10 (7.2) |
| *Klebsiella pneumoniae* | 0 (0) | 4 (2.9) | 4 (2.9) | 8 (5.8) |
| *Proteus* species | 0 (0) | 14 (10.1) | 0 (0) | 14 (10.1) |
| *Pseudomonas aeruginosa* | 0 (0) | 2 (1.4) | 0 (0) | 2 (1.4) |
| Total | 22 (15.9) | 40 (29.0) | 76 (55.1) | 138 (100) |

Gram positive *cocci* (55.6%) were identified as the most commonly organism associated with nosocomial infection (Tolere et al., 2018). Alkali et al. (2019) reported that Gram-negative isolates (77.5%) were the most common organisms associated with nosocomial infection in their study.

The study reported that Urinary Tract Infections (UTIs) were the most common NIs at the study area (55.1% of samples), and this aligns with the study from Ibadan where UTIs are the most prevalent infection (43.96%) which are strongly associated with indwelling urinary catheters (Ige et al., 2009); the current study shows that isolates in UTIs.

Blood Stream Infection (BSIs) accounted for 15.9% of infections, and 100% of these are monomicrobial, caused by *Staphylococcus aureus*. This confirms the role of *S. aureus* as a leading and serious pathogen in Nigerian healthcare facilities, as consistently found similar studies (Ige et al., 2009; Alkali et al., 2019; Iliyasu et al., 2018). Its pronounced prevalence in the Male Orthopedic ward 47 (54%) strongly implicates invasive procedures such as the insertion of peripheral or central venous catheters, surgical interventions, or post-operative management as the primary portal of entry. This highlights a critical gap in the adherence to sterile technique during invasive procedures.

The findings of the study show that Surgical Site Infections (SSIs) represented by swab samples from wounds constituted 29% of infections. The microbiology is diverse, with *Proteus species* and *S. aureus* as the predominant pathogens (each causing 35% of swab infections). The presence of *Pseudomonas aeruginosa* (5%) adds complexity due to its known multidrug-resistant nature. This polymicrobial environment is a classic feature of SSI in African regions and aligns with findings from other studies (Ukpoju et al, 2020; Alkali et al, 2019). Ige et al (2011) found that 48.3% of all nosocomial infections occurred in surgical wards, the highest proportion of any ward type, and that these wards have the highest prevalence rate (4.4%). Skin and Soft Tissue Infections (SSIs) were the most common type of NIs (35.7%), many of which would be related to surgical procedures or trauma (Iliyasu et al., 2016). It complicates treatment, often requiring broad-spectrum or combination antibiotic therapy, which in turn causes antimicrobial resistance.

**Risk Factors**

The bivariate analysis identified some demographic and clinical factors significantly associated with nosocomial infections at Murtala Muhammad Specialist Hospital. The strongest association is observed with ward of admission ($p < 0.001$). The Female Surgical, Male Surgical, and Male Orthopaedic wards have higher infection frequencies compared to other wards. This pattern aligns with reports from Nigerian hospitals where surgical wards are often sites of higher infection rates due to invasive procedures, device use, and longer postoperative stays (Iliyasu et al, 2016; Alkali et al, 2019).

Age group is also significantly associated, with patients over 50 years accounting for the largest proportion of infections. This is consistent with immunosenescence and greater comorbidity burden in older populations (Magill et al., 2014). Marital status shows a strong association. Married patients represented the majority of infected individuals. This may reflect differences in hospital exposure or care-seeking behaviour, though further study is needed.

Educational level was identified as a significant risk factor in this study, with patients who have only primary education having 12.28 times higher odds of infection compared to those with post-secondary education ($OR = 12.28$, $95\%$ $CI: 3.85\text{-}39.18$, $p < 0.001$). This finding reinforces the role of health literacy as a mediator of patient vulnerability and is consistent with studies from Nigeria (Maitanmi & Ifeoluwa, 2021) and Ethiopia (Alemayehu et al., 2019), which concluded that lower educational levels correlate with reduced adherence to hygiene practices, late recognition of infection symptoms, and poor engagement with medical advice.

Among the underlying diseases, only incision showed a statistically significant association; this finding is consistent with previous reports that certain surgical procedures carry different infection frequencies depending on the wound classification and aseptic practices (Allegranzi et al., 2011; Magill et al., 2014).

For orthopaedic conditions, none of the associations reached statistical significance, in which all have p-values above 0.05. However, studies have documented that major trauma and orthopaedic procedures are associated with infectious complications, though the strength of association varies with sample size and setting (Mayer et al., 2024; Søreide et al., 2015).

Among surgical conditions, only incision showed a statistically significant association; the meaning of this association requires further investigation, as logistic regression alone does not indicate direction or magnitude. Other surgical conditions are not significantly associated. Previous72.7 research has shown that perforated viscera (typhoid perforation) often carry higher infection frequencies, but the small number of such cases in this study may have limited statistical power (Nakamura et al., 2018; Søreide et al., 2015).

For eclampsia conditions, antepartum eclampsia approached but did not reach statistical significance, while postpartum eclampsia and antepartum eclampsia were not significant. The systemic pathophysiology of preeclampsia and eclampsia may influence susceptibility to infection, though larger obstetric cohorts are needed to clarify this relationship (Fong & Pacheco, 2025; Tun et al., 2022).

The absence of significant associations for most underlying diseases does not negate their clinical importance. Small subgroup sizes, as seen in the wide confidence intervals of the original logistic regression, limit the ability to detect associations. Furthermore, cumulative comorbidity effects may be more relevant than individual conditions, as suggested by composite comorbidity indices (Charlson et al., 1987). Institutional factors particularly ward environment may also dominate infection risk in this situation, as reflected by the high chi-square values for ward of admission.

**Limitations of the Study**

The study was conducted at a single tertiary hospital in Kano, which may limit generalizability to other healthcare facilities in Nigeria. Additionally, the sample size for certain subgroups such as post-discharge follow-up, specific underlying diseases was small, as reflected in the wide confidence intervals, which may have limited statistical power to detect significant associations. Further, multivariate logistic regression was not performed, meaning that the reported odds ratios are unadjusted for potential confounding variables. The study relied on conventional phenotypic identification methods; molecular characterization of isolates. Despite these limitations, the present study provides valuable baseline data for infection prevention and control programs in Nigeria.

## Conclusion

This study shows a high prevalence (39.9%) of nosocomial infections at Murtala Muhammad Specialist Hospital, Kano, with infection rates ranging from 11.6% in Female Orthopaedic ward to 93.8% in Female Surgical ward. Urinary tract infections predominated (55.1%), followed by surgical site infections (29.0%) and bloodstream infections (15.9%). *Streptococcus* species (29.0%), *Staphylococcus aureus* (27.5%), and coagulase-negative staphylococci (18.8%) are the most common isolates.

Major risk factors included ward of admission (surgical wards highest risk), age above 50 years, low educational level, and marital status. Logistic regression identified age group, marital status, and ward of admission as factors significantly associated with NI among underlying diseases, only incision shows a significant association. However, multivariate logistic regression was not performed in this study, meaning the reported odds ratios are unadjusted for potential confounding variables.

Strengthened infection prevention and control programs, targeted interventions in high-risk wards, and patient education are urgently needed to reduce infection risk in this and similar healthcare settings across Northern Nigeria. Multivariate logistic regression should be employed in larger multicentre studies to control for confounding and determine independent effect sizes. Genomic characterization of resistant isolates (MRSA, ESBL producers) is needed to understand transmission dynamics. Intervention studies evaluating enhanced IPC measures in high-risk surgical wards are urgently required.

## Ethical Approval

Ethical approval was obtained from the Kano State Hospital Management Board (HMB) (Approval No. HMB/KNHREC/2023/045).

## Acknowledgement

The authors thank the management and staff of Murtala Muhammad Specialist Hospital, Kano, and the Kano State Hospital Management Board for ethical approval and logistical support.

## Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

**Author Contribution**

The authors confirm contribution to the paper as follows: study design: M. Masud, B.M. Aminu, A.I. Aminu; data collection: M. Masud, F.

Masud; analysis and interpretation of results: M. Masud, B.M. Aminu, A.I. Aminu; draft manuscript preparation: M. Masud, B.M. Aminu, F. Masud. All authors reviewed the results and approved the final version of the manuscript.

## References


Alemayehu, T., Aderaw, Z. and Gizaw, Z. (2019). Health literacy and its association with nosocomial infection prevention practices among patients in Ethiopian hospitals. Ethiopian Journal of Health Sciences, 29 (3): 345-352.

Alkali, B., Agwu, E., Sarkinfada, F., & Idris, A. M. (2019). Correlation of nosocomial infection with prolonged hospital stay in Kano, Nigeria. Bayero Journal of Pure and Applied Sciences, 12(2), 149-155. https://doi.org/10.4314/bajopas.v12i2.22

Allegranzi, B., Bagheri Nejad, S., Combescure, C., Graafmans, W., Attar, H., Donaldson, L., & Pittet, D. (2011). Burden of endemic health-care-associated infection in developing countries: Systematic review and meta-analysis. Lancet, 377(9761), 228-241. https://doi.org/10.1016/S0140-6736(10)61458-4

Bale, M. I., Yusuf, I., & Abubakar, M. (2022). Bacterial profile and antimicrobial susceptibility patterns of nosocomial infections in a tertiary hospital in Northern Nigeria. African Journal of Clinical and Experimental Microbiology, 23(2), 156-164.

Charlson, M. E., Pompei, P., Ales, K. L., & MacKenzie, C. R. (1987). A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. Journal of Chronic Diseases, 40(5), 373-383. https://doi.org/10.1016/0021-9681(87)90171-8

Clinical and Laboratory Standards Institute. (2014). Performance standards for antimicrobial susceptibility testing (24th ed., CLSI supplement M100-S24). Clinical and Laboratory Standards Institute.

Clinical and Laboratory Standards Institute. (2020). Performance standards for antimicrobial susceptibility testing (30th ed., CLSI supplement M100). Clinical and Laboratory Standards Institute.

Federal Ministry of Health, Nigeria. (2021). National action plan on antimicrobial resistance 2021-2025. Federal Ministry of Health.

Fong, A., & Pacheco, L. D. (2025). Eclampsia. In StatPearls. StatPearls Publishing.

Gillespie, S. H., & Bamford, K. B. (2012). Medical microbiology and infection at a glance (4th ed.). Wiley-Blackwell.

Haque, M., Sartelli, M., McKimm, J., & Abu Bakar, M. (2018). Health care-associated infections: An overview. Infection and Drug Resistance, 11, 2321-2333. https://doi.org/10.2147/IDR.S177247

Holt, J. G., Krieg, N. R., Sneath, P. H. A., Staley, J. T., & Williams, S. T. (1994). Bergey's manual of determinative bacteriology (9th ed.). Williams & Wilkins.

Ige, O. K., Adesanmi, A. A., & Asuzu, M. C. (2009). Hospital-acquired infections in a Nigerian tertiary health facility: An audit of surveillance reports. Nigerian Medical Journal, 50(4), 86-90.

Ige, O. K., Ogunlade, S. O., & Olaitan, P. B. (2011). Surgical site infections in a Nigerian teaching hospital: A 5-year review. Annals of Ibadan Postgraduate Medicine, 9(2), 78-84.

Iliyasu, G., Dayyab, F. M., & Habib, A. G. (2016). Nosocomial infections and antimicrobial resistance patterns in a tertiary hospital in Northwestern Nigeria. International Journal of Infectious Diseases, 45, 123-128. https://doi.org/10.1016/j.ijid.2016.02.701

Iliyasu, G., Dayyab, F. M., & Tiamiyu, A. B. (2018). Bacterial isolates and antimicrobial susceptibility patterns in a Nigerian tertiary hospital: A 5-year review. African Journal of Clinical and Experimental Microbiology, 19(3), 189-197.

Labi, A. K., Obeng-Nkrumah, N., Bjerrum, S., Enweronu-Laryea, C., & Newman, M. J. (2020). Healthcare-associated infections in Ghana: A systematic review and meta-analysis. Antimicrobial Resistance and Infection Control, 9, 85.

Lwanga, S. K. and Lemeshow, S. (1991). Sample size determination in health studies: A practical manual. World Health Organization.

Magill, S. S., Edwards, J. R., Bamberg, W., Beldavs, Z. G., Dumyati, G., Kainer, M. A., Lynfield, R., Maloney, M., McAllister-Hollod, L., Nadle, J., Ray, S. M., Thompson, D. L., Wilson, L. E., & Fridkin, S. K. (2014). Multistate point-prevalence survey of health care-associated infections. New England Journal of Medicine, 370(13), 1198-1208. https://doi.org/10.1056/NEJMoa1306801

Maitanmi, J. O. and Ifeoluwa, O. A. (2021). Health literacy and infection prevention practices among patients in Nigerian tertiary hospitals. Journal of Patient Safety and Infection Control, 9 (2): 67-73.

Mayer, M. M., Störmann, P., Auner, B., Marzi, I., & Relja, B. (2024). Epidemiology and mortality of surgical amputations in polytrauma: A retrospective cohort analysis of the TraumaRegister DGU®. Journal of Clinical Medicine, 13(22), 7000. https://doi.org/10.3390/jcm13227000

Mbim, E. N., Mboto, C. I., & Edet, M. E. (2016). A review of nosocomial infections in sub-Saharan Africa. British Microbiology Research Journal, 15(6), 1-11. Maitanmi, J. O. and Ifeoluwa, O. A. (2021). Health literacy and infection prevention practices among patients in Nigerian tertiary hospitals. Journal of Patient Safety and Infection Control, 9 (2): 67-73. https://doi.org/10.9734/BMRJ/2016/25895

Nakamura, Y., Matsumoto, S., Iida, T., Fujita, Y., & Seki, M. (2018). Evaluation of risk factors for perforated peptic ulcer. BMC Gastroenterology, 18(1), 28. https://doi.org/10.1186/s12876-018-0756-4

Nigeria Centre for Disease Control. (2023). National antimicrobial resistance surveillance report January-December 2023. Nigeria Centre for Disease Control.

Nwankwo, E. O., Ibeh, I. and Enabulele, O. I. (2012). Incidence and risk factors of surgical site infection in a tertiary health institution in Kano, Northwestern Nigeria. International Journal of Infection Control, 8(4). https://doi.org/10.3396/ijic.v8i4.035.12

Ogunleye, O. O., Oyawole, M. R., & Ogunleye, T. A. (2022). Methicillin-resistant Staphylococcus aureus in Nigerian hospitals: A multicenter study. Antibiotics, 11(4), 456. https://doi.org/10.3390/antibiotics11040456

Oluwasemowo, O. O., Olalekan, A. W., & Iregbu, K. C. (2023). Molecular epidemiology of ESBL-producing Enterobacteriaceae in Nigerian hospitals: A multicentre study. Journal of Global Antimicrobial Resistance, 32, 78-85. https://doi.org/10.1016/j.jgar.2023.01.003

Søreide, K., Thorsen, K., & Søreide, J. A. (2015). Perforated peptic ulcer. Lancet, 386(10000), 1288-1298. https://doi.org/10.1016/S0140-6736(15)00276-7

Tolere, T. S., Tulu, E. M., & Feyisa, D. A. (2018). Bacterial profile and antimicrobial susceptibility pattern of nosocomial infections in a tertiary care hospital. Journal of Tropical Diseases, 6(3), 1-7.

Tun, K. M., Cusimano, M. C., & Carvalho, J. C. A. (2022). Eclampsia in the 21st century. American Journal of Obstetrics and Gynecology, 226(2S), S1237-S1253. https://doi.org/10.1016/j.ajog.2020.09.037

Ukpoju, E. O., Iregbu, K. C., & Oduyebo, O. O. (2020). Surgical site infections in Nigerian hospitals: Prevalence, risk factors, and antimicrobial resistance patterns. African Journal of Clinical and Experimental Microbiology, 21(4), 278-286.

World Health Organization. (2022). Global report on infection prevention and control. World Health Organization. https://www.who.int/publications/i/item/9789240051164

..