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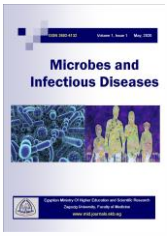

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Original article

Superbug *Acinetobacter baumannii* infections: Insights from tertiary hospital in Kebbi State, Nigeria

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ABSTRACT

Background: *Acinetobacter baumannii* was classified by the World Health Organization (WHO) as one of the ESCAPE organisms that cause nosocomial infection in many healthcare settings. The pathogen was reported to be resistant to the most commonly prescribed antibiotics in healthcare settings. The WHO recommends antibiotic surveillance as one of the strategies to tackle the spread of the bacterium. The research aimed to investigate the superbug *Acinetobacter baumannii* infections from tertiary hospitals in Kebbi State. **Methods:** This was a cross-sectional descriptive hospital-based study in which 185 samples were involved from urine catheter, wound swab and nasal intubation from patients who were ≤14 years of age admitted to Sir Yahaya Memorial Hospital Birnin Kebbi (SYMHBK) and Kebbi Medical Center Kalgo (KMCK). The samples were processed using the standard microbiological method. The isolates were cultured using MacConkey agar (HiMedia Laboratories Pvt Ltd, Mumbai, India, M173) and *A. baumannii* was identified using biochemical tests and confirmed using conventional PCR and Sanger sequencing methods. The antibiotic resistance pattern of the bacterial isolates was determined using the disc diffusion method. **Results:** The prevalence of *A. baumannii* was found to be 15/185 (8.1%) from all the hospitals studied. Prevalence of *A. baumannii* was found to be higher among males 8/82 (9.8%). Age groups 6-11 years 9 (12.2%) had the highest prevalence of *A. baumannii*. Kebbi Medical Center Kalgo had a high prevalence of 4/46 (8.7%). *A. baumannii* had a higher distribution of 15 (34.8%) among all bacteria isolated. *A. baumannii* was found to be 100% resistant to cefpodoxime, cefepime, cepotaxime and meropenem. Sanger sequencing results revealed 3/43 (7.0%) A. baumannii. **Conclusions:** This research revealed the presence of *A. baumannii* in the studied hospitals in Kebbi State which were resistant to cefpodoxime, cefepime, cepotaxime and meropenem.

Introduction

The genus *Acinetobacter* includes the genus *Coccus*, an aerobic, non-motile bacterium known as *Acinetobacter baumannii* [1] *Acinetobacter* is a member of the *Acinetobacter calcoacetate-Acinetobacter baumannii* complex, which consists of four different *Acinetobacter* species composition [1]. *A. baumannii*, *A. pittii*, *A. nosocomialis*, and *A. calcoaceticus*. Taxonomically, *Acinetobacter* belongs to Proteobacteria, Moraxaceae, Pseudomona [2, 3]. Depigmentation-resistant *Acinetobacter baumannii* sometimes resembles Gram-positive cocci. As a non-picky bacterium, *A. baumannii* cannot biochemically produce cytochrome oxidase, urease, citrate, or indolease. However, it can produce catalase [1] at a temperature of 35°- 37°C, and *A. baumannii* can be

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grown on a variety of media, including blood agar, chocolate agar, MacConkey agar, and Acinetobacter leeds agar. After 18 to 24 hours of incubation at 37°C, morphologically, colorless, non-hemolytic, glossy, mucoid-like colonies with a smooth structure and 1-2 mm in diameter will develop on blood agar. It also produces colorless, glossy slime-like and grave-like colonies on MacConkey agar, demonstrating its non-lactose fermenting ability [1]. Colonies of a pink tint appear on the selective Leeds Acinetobacter medium [4]. *A.baumannii* can be found on a variety of surfaces in hospitals, including dormitories, drapes, walls, roofs, medical equipment, staff supplies, water basins, cell phones, door handles, hand sanitizer dispensers, trolleys, trash cans, and even computers [1]. *A.baumannii* is an opportunistic pathogen that poses minimal risk to healthy individuals. However, immune-compromised individuals with chronic lung disease or diabetes may be more susceptible to *A. baumannii* infection [5]. *A. baumannii* causes a wide range of infections in the hospital and community, including dermatitis and soft tissue infections, urinary tract infections, meningitis, bacteremia, and pneumonia [6]. Hospital-acquired infections are most common in critically ill patients; specific risk factors for *A. baumannii* infection include prolonged hospital stay, immunosuppression, advanced age, comorbidities, major trauma or burns, prior antibiotic use, invasive procedures, and indwelling catheters or mechanical ventilation [7]. Due to the lack of exhaustive data, especially from the African continent, epidemiological investigations suggest that the burden of disease caused by *A.baumannii* remains unclear [8].Many researches have demonstrated that the burden of *A. baumannii* infection can be up to 35% [9] with death rate of 26% and this can be up to 45% in intensive care unit (ICU) [1]. Nigeria like other African countries, the story stays the same, but **Uwingabiye et al.** [10] reported that 8.4% of the intensive care unit patients of tertiary centers come up with *A. baumannii* infection. A comparative study carried out by **Bashir et al.** [11] in three tertiary hospitals including Aminu Kano Teaching Hospital (AKTH), Murtala Muhammad Specialist Hospital (MMSH) and Muhammad Abdullahi Wase Specialist Hospital (MAWSH) in Kano State City showed the prevalence of 5%, 6%, 3% of *A. baumannii* infections respectively. Similarly [12] reported that, 11% of the patients admitted to the intensive care unit of Owerri Teaching Hospital developed *A. baumannii* infection. Furthermore [13] reported that the prevalence of *A. baumannii* in Ladoke Akintola University Teaching Hospital, Osogbo, Nigeria was 8.5% which corresponds to the findings of similar studies carried out by [14, 15, 16] with their percentage prevalence being 11%, 8.8%, and 9.4%, respectively.

Therapeutic options have become very limited raising infection control concerns worldwide. Furthermore, the ability of this bacterium to develop resistance immediately has brought the suggestion that unless newer antibiotics are developed, we may be closer to the end of the antibiotic era with *A. baumannii* similar to methicillin-resistant *Staphylococcus aureus* [17]. The capacity of *Acinetobacter* species for extensive antimicrobial resistance may be due to the organism's relatively impermeable outer membrane, efflux pumps, mutation and its environmental exposure to a large reservoir of resistance genes [18, 19].

Carbapenems remain the treatment of choice if isolates are susceptible to this antimicrobial class [19]. Regrettably, carbapenem-resistant *Acinetobacter* isolates are progressively reported globally. Sulbactam, a β lactamase inhibitor, has been used to treat patients with multi-drug resistant *Acinetobacter* ventilator related pneumonia [20], while tigecycline, a relatively new glycylcycline agent has been reported to have antimicrobial activity against multi-drug resistant *Acinetobacter* species [21]. Other therapeutic options include aminoglycoside such as tobramycin and amikacin if found to be susceptible. These agents can be used in conjunction with another active antimicrobial agent [19]. Despite the tireless infection control efforts, nosocomial acquisition of multi-drug resistant *A. baumannii* is still a problem due to its great ability to disseminate from and colonize human and environmental reservoirs [22]. This leads to delay of patients in the hospitals due to treatment failure. More than 90% of the research done on *A. baumanii* in Nigerian health care settings focused broadly on identification and antimicrobial resistant profile with a mild emphasis on the molecular aspect which gives more insight on the different types of strains involved in healthcare-associated infections and antimicrobial resistance within a particular community [11]. However, most research done considers adult patients forgetting the children which can also be carriers and continue to spread infection within the community after

hospitalization. Therefore, this research aimed at molecular identification of *A. baumannii* isolated from children admitted to two major hospitals in Kebbi State.

Materials and methods

Study area

The study was conducted in the Kebbi State Northwest geopolitical zone of Nigeria between latitudes 10°N - 30°N and longitudes 3°E - 6°E. According to the 2018 projected population, the state has a total population of 3,238,628 (based on the 2006 population census) distributed in 21 government areas, majority of the peoples are civil servant, traders, farmers, teachers and students [23]. The study Hospitals include Sir Yahaya Memorial Hospital located in Birnin Kebbi, Kebbi State, it was built in 1952 with native authority funds. The hospital provides medical services in surgery, pediatrics, obstetrics, ophthalmology, otorhino-laryngology, gynecology, arteriovenous fistulas, demonology, and resection of the prostate with over two hundred and eighty beds capacity [24]. Specialist Hospital Kalgo is located along the Birnin Kebbi-Kalgo road in the Kalgo Local Government Area of Kebbi State, Nigeria, with a geographical distance of 14 km from Birnin Kebbi, the state capital. The hospital was built in 2016 and commissioned in 2017 **(Fig.1)**. It comprises different wards and departments, which includes the general outpatient department (GOPD), medical outpatient department (MOPD), surgical outpatient department (SOPD), medical laboratory department, pharmacy department, medical record department, accident and emergency (A&E), orthopedic, intensive care unit (ICU), ear nose and throat (ENT) unit, male medical ward, male surgical ward, pediatric medical ward, pediatric surgical ward, female medical ward, female surgical ward, maternity medical ward, maternity surgical ward. It is a fully functional hospital with over two hundred and fifty beds capacity [25].

Study design

This was a cross sectional descriptive hospital-based study which involved molecular identification of *A. baumannii* isolated from urine catheters, wound swabs and nasal tubes from patients who were ≤14 years of age admitted in Sir Yahaya memorial hospital Birnin Kebbi (SYMHBK) and Kebbi Medical Center Kalgo (KMCK). The isolated *A. baumannii* were identified using polymerase chain reaction (PCR) and confirmed by using Sanger sequencing method. Moreover, the antibiotic resistant pattern of *A. baumannii* was determined using modified Kirby Bauer method [27].

Sample size determination

A total number of 185 samples were concluded using standard formula developed by **Kish and Leslie** [28]

$$N = Z^2 p (1-p) / d^2$$

where: n = Number of sample (sample size), Z = standard normal deviate at 95% confidence interval =1.96, ***p*** = prevalence from previous study carried out in Kano State Metropolis = 9.0% [11] and d= allowable margin of error = 0.05

Inclusion criteria and exclusion criteria

All patients ≤ 14years in ICU, pediatric and surgical wards whose relatives consented to the study were included. Patients who had surgery. All intubated or mechanically ventilated patients. All patients who had urethral catheters. Nonconsenting patients, patients stayed less than 24 hrs in the ICU, pediatric and surgical wards, and patients above 14 years were excluded.

Ethical approval

Ethical approval for this study was obtained from Kebbi State Ministry of Health and research ethics review committee of Sir Yahaya Memorial Hospital Birnin Kebbi and Kebbi Medical Center, Kalgo.

Samples collection

Verbal and written informed consents were sought from parents or caregiver of each participant; socio-demographic data of each consented participant was obtained from the care giver or a case file. A total of 185 samples which included urine catheter samples (38), wound swabs (124) and nasal tubes (23) were collected using standard methods. The samples were collected from patients who had spent at least 48hrs in intensive care unit (ICU), pediatric medical and surgical wards of the selected hospitals. Urine catheter samples were collected by disconnecting urethral catheter urine bag and then clamping it for about 15mins after which opening of the catheter was cleaned with normal saline, the clamp was remove and urine was allowed to drop into a wide mouth sterile container [11, 29]. Nasal intubation samples were collected using a mucus extractor attached to a suction machine; the resulting intubation was sealed and transported to the laboratory for further analysis

[30]. Wound swabs, in areas where there were disruptions in the continuity of skin, the swab samples were collected after debridement of the wound boundaries and washing with physiological saline, using a sterile swab sticks dipped in 0.85% saline solution, the inner most part of the wound was swabbed [31] and put into sterile test tube containing nutrient broth. All samples were level accordingly and transported ice cool box to microbiology laboratory, Kebbi state University of Science and Technology Aliero for microbiological further analysis.

Isolation of *A. baumannii* and other bacterial pathogens

All samples were inoculated on freshly prepared MacConkey agar (HiMedia Laboratories Pvt Ltd, Mumbai, India, M173) medium and incubated at 37°C for 24 hours. After incubation period, suspected *A. baumannii* isolates that produced shiny mucoid and tomb shaped was sub-cultured on Leed Acinetobacter Medium (HiMedia Laboratories Pvt Ltd, Mumbai, India, M1839) and incubated at 37°C for 18-24 hours. Other suspected bacterial pathogens were sub-cultured on MacConkey agar (HiMedia Laboratories Pvt Ltd, Mumbai, India, M173) incubated at 37°C to have pure isolates. After incubation period each isolate was stored in refrigerator at 20°C in nutrients agar slant for further analysis [11].

Identification of *A. baumannii* and other bacterial pathogens

Suspected 24hrs *Acinetobacter* spp on Lead Acinetobacter Medium (that showed pink color) colonies and other bacterial pathogens on MacConkey agar medium were identified using Gram staining, and biochemical tests such as catalase, coagulase, indole, citrate, urea, oxidase, methyl red, Voges-Proskauer, and motility tests [11].

Molecular identification of *A. baumannii*

DNA extraction

DNA was extracted from 24hr suspected *Acinetobacter* spp colonies by boiling method. Three colonies of isolates were taken in a 2 ml microcentrifuge tube (ExtraGene, Taiwan). One ml of distilled water was added and then boiled in a water bath at 100°C for 10 minutes. The tubes were centrifuged for 5 minutes at 1000rpm (Hermle Z 233 M-2, Labnet international inc. USA). Supernatant was used for PCR or stored at −20°C until analysis [32].

Polymerase chain reaction and sequencing

PCR was performed using the extracted DNA as template. A set of two primers, 27 **F**: AGAGTTTGATCCTGGCTCAG and 1429 **R**: GGTTACCTTGTTACGACTT. The PCR cocktail mixture consisted of 2.5µl of 10x PCR buffer,1µl of 25mM $MgCl_2$, 1µl each of forward primer and reverse primer, 1µl of DMSO, 2µl of 2.5mMDNTPs, 0.1µl of 5µ/µl Taq DNA polymerase, and 3ul of 10ng/µl DNA. The total final reaction volume was made up to 25µl using 13.4 ul nuclease free water. The PCR conditions included an initial denaturation at 94˚C for 5mins, followed by 36 cycles of denaturation at 94˚C for 30sec, annealing at 56˚C for 30secs and elongation at 72˚C for 45sec. Followed by a final elongation step at 72˚C for 7 minutes and hold temperature at 10 ˚C forever. Amplified fragments were visualized on ethidium bromide stained 1.5% agarose electrophoresis gels. The size of the amplicon is about 1500bp and the DNA ladder used was 1kbp ladder from NEB. ABI 3500 sequencer was used for sequencing using 96 well plate for cycle and the products were purified using Ethanol/ EDTA precipitation method. 25ng of the PCR product was used to perform cycle sequencing. The obtained sequence were BLAST on NCBI database for the isolate identification [11].

Antibiotics susceptibility testing

The antibiotics susceptibility testing of *A. baumannii* isolates was done using disk diffusion method [26]. A newly prepared Mueller Hinton agar (Oxoid, UK) plates were inoculated with 0.5 McFarland standard of *Acinetobacter* spp suspension. Different antibiotics disk were placed on the inoculated plates: amoxicillin/cluvanic acid (AMC, 30 µg.disk-1), cefpodoxime (CPD 10 µg.disk-1), cefepime (FEP 30 µg.disk-1), cepotaxime (CTX 30 µg.disk-1), meropenem (MEM 10 µg.disk-1), imepenem (IMP 10 µg.disk-1).The plates were allowed to stand for 5-10 min at room temperature and then incubated at 37°C for 24 hours, after which the zone of inhibition was measured and interpreted according to the method described by CLSI [27].

Statistical analysis

The data obtained during the course of this study were analyzed using the Statistical Package for the Social sciences (SPSS) version 21. Data was

presented using frequency tables, charts, Chi square and cross tabulation was used to study relationships and association between variables. Statistical significance was set at 5%.

Results and discussion

Socio-demographic characteristics and prevalence of *A. baumannii*

One hundred and eighty-five (185) participants were enrolled in this study from the selected hospitals. Majority of the participants were female 103/185 (55.7%). The age of the studied participants ranged from 1 to 14 years while 12 – 14 years had the highest number among the study participants 87/185 (47.0%). Sir Yahaya Memorial Hospital Birnin Kebbi had the highest number of the studied participants 139/185 (75.1%). The pediatric medical ward had the highest number of participants among all the wards studied 105/185 (56.8%) **(Table 1)**.

Prevalence of *A. baumannii* was found to be 15/185 (8.1%) from the two hospitals studied. This was in line with study done by **Odewale et al.** [13] who reported 8.5% *A. baumannii* positive at Ladoke Akintola University Teaching Hospital Osogbo, Nigeria though their study involved both young and old ages. **Alkali et al.** [33] reported (10.1%) prevalence of *A. baumannii* from patients with prolonged hospital stays in three tertiary hospitals of Kano Metropolis, Northwestern Nigeria. **Odih et al.** [34] reported higher prevalence of *A. baumannii* from an intensive care unit, Southwest Nigeria. **Nwadike et al.** [12] reported 14.0% prevalence of *A. baumannii* from patients admitted into intensive care unit of the University College Hospital, Ibadan. This was contrary to the findings of **Alotaibi et al.** [35] who reported (3.37%) prevalence of *A. baumannii* infection among the adult patients admitted to the intensive care unit at King Fahad University Hospital from 1 January 2013 to 31 December 2017. The reasons for the differences could be as result of the higher level of standards of their studied hospital compared to our hospital where even disinfecting material are still challenges. Among WHO strategic plan to convert infection caused by *A. baumannii* complex is the continuous surveillance study especially in African continent where comprehensive data about the magnitude of the healthcare associated infection is lacking [36].

Prevalence of *A. baumannii* infection according to the sex of the studied participants showed that male had the high prevalence of *A. baumannii* infection 8/82 (9.8%) compared to their female counter part 7/103(6.8%). **Odewale et al.** [13] reported higher prevalence of *A. baumannii* (63.6%) in male compared to their female counter part. **Alkali et al.** [33] also reported the higher prevalence (57.1%) of *A. baumannii* infection among the males than the females. This was contrary to the finding of **Nwadike et al.** [12] who reported 16.7% prevalence of *A. baumanii* infection among the females admitted into intensive care unit of the University College Hospital, Ibadan. The difference could be due to the differential innate immune responses between the sexes where females were reported to have strong innate immune in the context of response to infection compared to their male counterparts [37].

However, age group 6-11years 9/24 (12.2%) had the highest prevalence of *A. baumannii* infection while age groups 1-5years had the least 1/24 (4.2%). This was contrary to the finding of **Odewale et al.** [13] who reported lower prevalence of *A. baumannii* infection (9.1%) among age groups >10 years. **Nwadike et al.** [12] also reported 0.0% prevalence of *A. baumannii* >20years age group from patients admitted into intensive care unit of the University College Hospital, Ibadan. Patient's age group has been described as major risk factor for acquiring nosocomial infection caused by *A. baumannii.*

Prevalence of *A. baumannii* between the studied hospitals showed that Kebbi Medical Center Kalgo had the high prevalence 4/46 (8.7%). Intensive care unit showed a high prevalence 4 / 20 (20.0%) among all the wards studied while pediatric surgical ward had the least 3/60 (5.0%) *A. baumannii* infections. *A. baumannii* infection was found more in nasal intubation samples 4/38 (10.5%) while catheter urine samples had the lowest 1/23 (4.3%) **(Table 1)**. This was in line with finding of **Odewale et al.** [13] who reported higher prevalence of *A. baumannii* infection (72.7%) from ICU among patients admitted into intensive care unit of the University College Hospital, Ibadan. According to the CDC [38], Patients admission in ICU is among the major risk factors for acquiring *A. baumannii* infection in the hospitals.

Distribution of *A. baumannii* and other bacterial species

A total of 185 samples were collected from wound swabs, urine catheters and nasal tubes from Sir Yahaya Memorial Hospital Birnin Kebbi

(SYMHBK) and Kebbi Medical Center Kalgo (KMCK). From these samples, 43 bacterial species belonging to three genera were isolated **(Table 2)**. The most common bacterial species isolated was *A. baumannii* 15 (34.8%) followed by *P. aerugenosa* 13 (30.2 %), *E. coli* 10 (23.2%), while *K. pneumoniae* had the least 5 (11.6%). This was contrary to the finding of **Bashir et al.** [11] who reported higher prevalence of *E. coli* from tertiary hospitals of Kano than *A. baumannii*. *A. baumannii* distribution according to the sources of sample showed that 10 (33.3%) of *A. baumannii* was observed from wound swabs samples and least in urine catheter samples 1 (20.0%). This was contrary to the findings of **Nwadike et al.** [12] who reported higher prevalence of *A. baumannii* 12 (86.0%) from tracheal aspirate than the wound swab. However, **Bashir et al.** [11] also reported a higher prevalence of *A. baumannii* in urine and urine catheter than the wound swabs.

Antibacterial resistance patterns of *A. baumannii* and other bacterial pathogens

According to CDC [39], antimicrobial resistance kills at least 1.27 million people worldwide and is associated with nearly 5 million deaths in 2019. In Nigeria, experts caution Nigerians against indiscriminate use of antibiotics to reduce future health crisis [40]. The WHO recommends the continuous antibiotics surveillance study to tackle the spread of dangerous organisms including *A. baumannii*. All 43 bacterial species belonging to 3 genera identified in this study were subjected to antibiotics susceptibility testing to determine their resistance pattern. *A. baumannii* was found to be 100% resistance to cefpodoxime, cefepime, cefotaxime and meropenem. Less resistance of *A. baumannii* isolates was observed against imipenem (46.6%) **(Table 3)** and **(Fig. 1)**. This is in line with study done by **Nwadike et al.** [12] who reported 100% of *A. baumannii* ????to amoxicillin-clavulanate, ceftriaxone, ciprofloxacin, ofloxacin, gentamicin and ampicillin-sulbactam. **Yousefi et al.** [41] also reported 83.3% of multi drug resistance of *A. baumannii* isolates from different wards of Children's Medical Center in Tehran. **Alkali et al.** [23] also reported higher resistance (85.7%) of A. *baumannii* against imipenem from three tertiary hospitals in Kano. This is contrary to the study done by **Odewale et al.** [13] who reported (63.6%) resistance of *A. baumannii* against meropenem from Ladoke Akintola University Teaching Hospital.

Molecular characterization of resistant *A. baumannii*

A. baumannii was phenotypically detected in 15 (34.9%) of the 43 identified bacterial isolates. All the *A. baumannii* specimens that had been phenotypically identified underwent molecular characterization using both the traditional PCR and Sanger sequencing methods **(Fig. 2)**. The analysis revealed that 5 out of 43 (11.6%) of the total bacterial isolates were positively identified by PCR as being *A. baumannii*. However, only 3 isolates were identified as *A. baumannii* based on sequencing results and a blastn search in the NCBI database. When compared to findings by **Karah et al.** [15] and **Odewale et al.** [13], who reported prevalence of 8.8%, 9.4%, and 8.5%, respectively, using molecular technique, the prevalence of *A. baumannii* 3/43 (7.0%) observed in this study was lower. **Alkali et al.** [23] reported 10.1% prevalence of *A. baumannii* from three tertiary hospitals from Kano. However, the results indicated that we cannot completely rely only on biochemical tests for identification of *A. baumannii*, but there is need to also use molecular techniques such as PCR and sequencing for accurate diagnosis. The unique character of *A. baumannii* is resistance to most antibiotics that makes it an organism of high importance especially in hospital setting as a nosocomial pathogen among immune compromised and patients with prolonged hospital stay. Prior to the 1970s, it was possible to treat *Acinetobacter* infections with a range of antibiotics, including aminoglycosides, β-lactams, and tetracyclines. However, resistance to all known antibiotics has now emerged in *A. baumannii*, thus leaving the majority of today's clinicians in unfamiliar territory.

Table 1. Socio-demographic characteristics and prevalence of *A. baumannii* in the studied hospitals.

Variables	**No. samples collected n (%)**	**No. of positive samples n (%)**
Sex		
Male	82 (44.3)	8 (9.8)
Female	103 (55.7)	7 (6.8)
Total	**185 (100)**	**15 (8.1)**
Age (years)		
1-5	24 (13.0)	1 (4.2)
6-11	74 (40.0)	9 (12.2)
12-14	87 (47.0)	5 (5.7)
Total	**185 (100)**	**15 (8.1)**
Type of Hospitals		
SYMHBK	139 (75.1)	11 (7.9)
KMCK	46 (24.9)	4 (8.7)
Total	**185 (100)**	**15 (8.1)**
Hospitals wards		
ICU	20 (10.8)	4 (20.0)
PMW	105 (56.8)	8 (7.6)
PSW	60 (32.4)	3 (5.0)
Total	**185 (100)**	**15 (8.1)**
Sampling sites		
Wound swabs	124 (67.0)	10 (8.1)
Catheter urine	23 (12.5)	1 (4.3)
Nasal intubation	38 (20.5)	4 (10.5)
Total	**185 (100)**	**15 (8.1)**

Key: SYMHBK: Sir Yahaya Memorial Hospital Birnin Kebbi, KMCK: Kebbi Medical Center Kalgo, ICU: Intensive care unit, PMW: Pediatric medical ward and PSW: Pediatric surgical ward

Table 2. Distribution of *A. baumannii* and other bacterial species according to sampling sites.

Bacterial isolates	**Sampling sites**			**Total n (%)**
	Wound swab n (%)	**Catheter urine n (%)**	**Nasal intubation n (%)**	
A. baumannii	10 (33.3)	1 (20.0)	4(50.0)	15 (34.9)
P. aerugenosa	7 (23.3)	2 (40.0)	4 (50.0)	13 (30.2)
E. coli	8 (26.7)	2 (40.0)	0 (0.0)	10 (33.3)
K. pneumoniae	5(16.7)	0 (0.0)	0 (0.0)	5 (11.6)
Total	**30 (69.8)**	**5 (11.6)**	**8 (18.6)**	**43(100)**

Table 3. Antimicrobial susceptibility profile of the bacteria associated with healthcare associated infection.

Antibiotics (µg)	**Bacterial species**			
	A. baumannii **n=15 (%)**	***P. aerugenosa*** **n=13 (%)**	***E. coli*** **n=10 (%)**	***K. pneumonia*** **n=5 (%)**
Amoxicillin/clavonic acid	14 (93.3)	13 (100.0)	10 (100.0)	5 (100.0)
Cefpodoxime	15 (100.0)	13 (100.0)	10 (100.0)	5 (100.0)
Cefepime	15 (100.0)	13 (100.0)	10 (100.0)	5 (100.0)
Cefotaxime	15 (100.0)	13 (100.0)	10 (100.0)	5 (100.0)
Meropenem	15 (100.0)	13 (100.0)	10 (100.0)	5(100.0)
Imipenem	7 (46.6)	5 (38.4)	8 (80.0)	3 (60.0)

Fig. 1: Map of Kebbi State showing the local government areas of the studied hospitals [27].

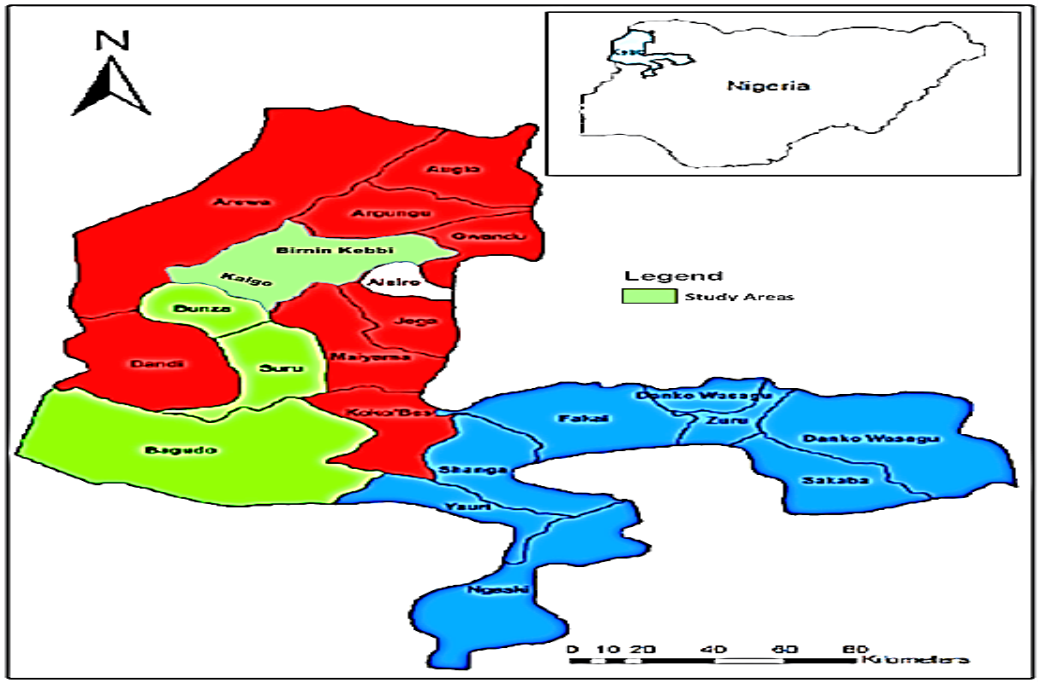


Fig. 2: Antibiotics resistant pattern of *A. baumannii* isolated from wound swabs, urine catheter and nasal intubation samples (n = 15).

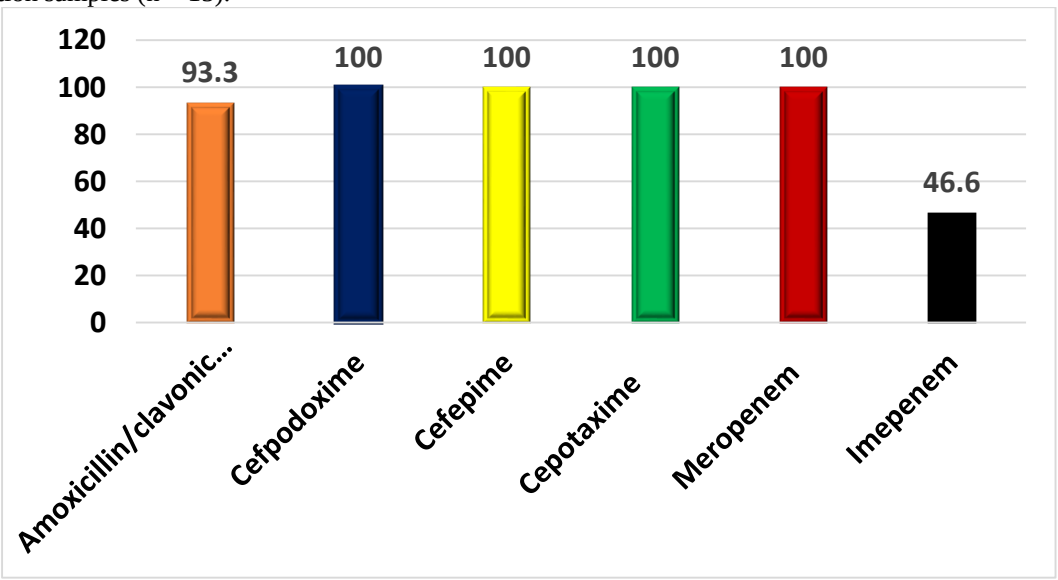
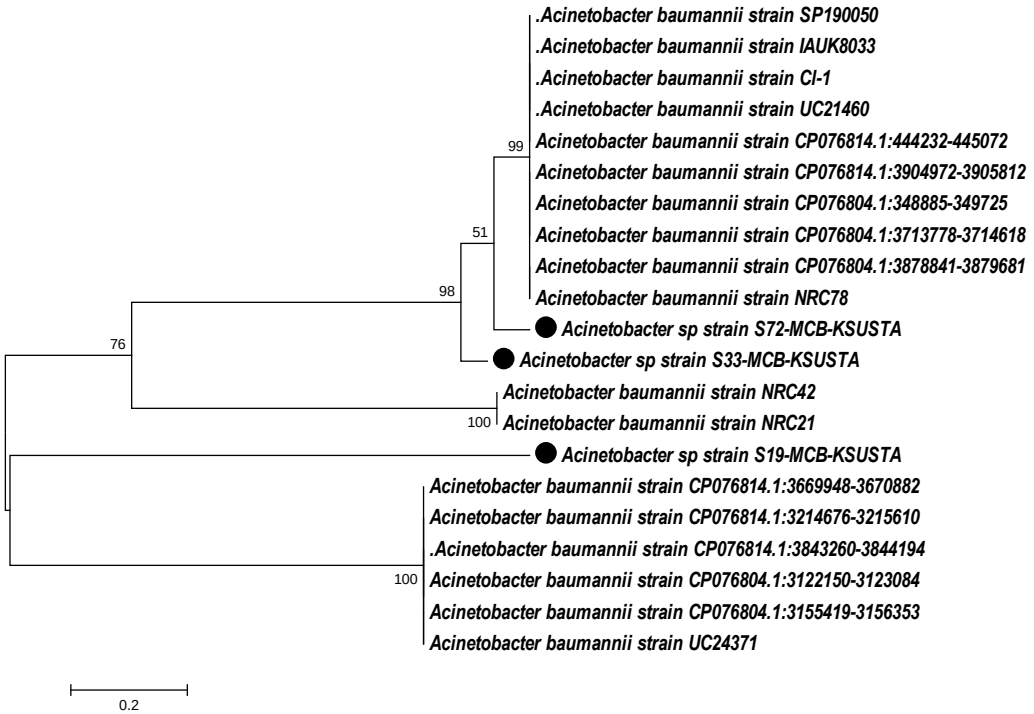


Fig. 3: Molecular Phylogenetic analysis by Maximum Likelihood method. The three was constructed using Maximum MEGA6.



Conclusion

The research reported the prevalence of *Acinetobacter baumannii* from the studied hospitals. The A.baumannii isolated was resistant cefpodoxime, cefepime, cepotaxime and meropenem. Further research should be done to other health care faculties in the state in order to have the comprehensive information about the bacteria as it's link to healthcare associated infection. Research should also be carried to detect the gene associated with resistance in the *A. baumannii* isolated.

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Authors' Contributions

Sani Mohammed conducted the laboratory work of this study. The first mentioned author and Daniel Danladi Attah, Adamu Saleh, Ahmad Ibrahim Bagudo, Sule Sahabi Manga contributed equally to its content (Conceptualization, methodology, resources, writing, original draft preparation, review, editing, supervision, project administration, funding acquisition etc.) apart from the laboratory part. All authors read and approved the final version of this manuscript before submission.

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Conflicts of Interest

The authors declare no conflict of interest.

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