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Prevalence Of Methicillin Resistant Staphylococcus Aureus Infections Among Hospitalized Patients With Different Illnesses In Adamawa State, Nigeria

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Abstract: Methicillin Resistant *Staphylococcus aureus* (MRSA) is a drug-induced strain of *S. aureus* due to its fast acquisition of drug-resistant genes which has given rise to the emergence and spread of drug mediated *S. aureus* infections that are difficult to treat in the healthcare settings leading to prolonged hospitalization, delayed cure rate, and high mortality rates. The adverse effect of MRSA infection has not been fully elucidated, due to paucity of data on adverse complication of MRSA among hospitalized patients in Adamawa state, hence this study. This study evaluates the prevalence, and risk factors of MRSA strains in Adamawa state, Nigeria. A total of 339 clinical samples were collected from patients with long-term hospitalization in various hospitals spread across the state. The study adopted a cross-sectional design that involved consecutive sampling method that enrolled patients with different ailments that had multiple episodes of diseases due to long term hospitalizations. The samples were processed bacteriologically and MRSA isolated were confirmed with ChromAgar MRSA.The data obtained were subjected to statistical analysis and significant level was taken at $p \leq 0.05$. The prevalence rate of MRSA, MSSA and CONSA isolated were 25.96% (88/339) and 8.6% (29/339) and 12.1% (41/339) respectively. The highest number of isolates obtained was from Yola-South LGA with 17.4%. It was observed that MRSA infections increases as the age of the patients increases with highest prevalence rate of 5.6% among those of 51+ year old. The risk factor that was statistically significant was residential area ($p = 0.031$) as those that lived in slum areas were five, seven, five and sixteen times more likely to acquire MRSA than those of rural, high density, semi-urban and low-density areas respectively. MRSA were observed to be high among those with non-diabetic foot ulcer, bone fractures and blood-borne infections with a prevalence rates of 5.6% (19/339), 3.5% (12/339) and 2.95% (10/339) respectively. In conclusion, the bacterium *Staphylococcus aureus* and its antibiotics induced strains, MRSA is prevalent in Adamawa state and this increases the disease pathological burdens. Continuous education and infection control interventions are highly recommended.

Keywords: Methicillin Resistant, Staphylococcus, Aureus, Infections, Hospitalized, Patients ,Illnesses.

Introduction

Staphylococcus aureus is the leading cause of bacterial infections involving the bloodstream, lower respiratory tract, skin and soft tissue, worldwide (Diekema *et al,* 2001). This organism has an extensive attributes of virulence factors, which are freely secreted and surface-bound factors that (Foster 2008) promote host colonization, alter leukocyte recruitment or function (Rooijakkers *et al*., 2007) inhibit complement (Collins *et al*., 2002) and antimicrobial peptides (Collins *et al*., 2002; Li *et al*., 2007), and cause destruction of leukocytes (Provost *et al*., 1995; Wang *et al*., 2007).

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The successful establishment of infection by this bacterium depends in part on the virulence factors produced through a wide spectrum of secreted and cell surface-associated virulence factors that is expressed to promote adhesion to the host extracellular matrix components, invasion into non-phagocytic cells, formations of biofilm and evasion of the immune system [Foster 2005]. The stimuli from the infection sites, depends on the activation or suppression expressed through multiple virulence factors thereby producing different phenotypes from the same bacterial strain. Many of these virulence genes encode toxins that are harmful to humans causing severe gastrointestinal illness [Umeda *et al*., 2017], which can be implicated as food poisoning due to the production of staphylococcal enterotoxins (ses) causing food-borne illnesses [De Buyser *et al.,* 2001 and Normanno *et al*., 2005].

As part of the normal bacterial flora, this bacterium colonizes the skin and mucosal membrane, the cutaneous and mucosal barriers may be disrupted due to skin conditions, wounds or surgical interventions, underlying diseases such as patients undergoing dialysis, diabetic patients, and persons with invasive medical devices (e.g. peripheral, central, venous and catheters) or compromised immune systems are particularly vulnerable to this organism [Lowy, 1998].

Methicillin-resistant *Staphylococcus aureus* (MRSA) has been one of the most significant healthcare-associated (HA) and community-associated (CA) pathogens, (Chambers *et al,* 2009; Kaech *et al*, 2006) causing a wide range of infections. These infections range from mild skin and soft tissue infections to life-threatening invasive diseases and associated high morbidity, mortality, prolonged length of hospital stays and high healthcare costs as compared to methicillin-susceptible *staphylococci* [Cosgrove et al., 2005].

In healthcare facilities, the risk of acquiring infections, due to bacterial agents is high because of antibiotics/drugs induced modifications of different bacteria species. Some patients, due to nature of their ailment, do have long-term hospitalization in various wards of the hospital. This condition most a times lead to the development of different ailment or bacterial infections due to hospital manipulations e.g., insertion of catheters, surgical operations, bone fracture due to accidents. All these procedures may involve high intakes of antibiotics and other drugs. With the prolonged hospital stay, colonization of pathogenic bacteria among the patients may increase the disease burden. As a highly pathogenic bacterium *S. aureus* strain, MRSA, presents with multiple infectious outcomes. Thus, the understanding of MRSA co-morbid infections is very important for proper therapeutic options and control in these patients with long-term hospitalization.

Staphylococcus aureus is an ubiquitous bacterium that colonizes both the human body, skins, animals and fomites. The bacterium is known for its versatility in inducing infections especially those with long term diseases. Most a times, these organisms act as secondary infectious agents among these group of patients and do complicate drug therapy in these patients. It can be community acquired or hospital acquired infections. Hospital associated infections remains a critical health challenge especially in persons with debilitating illness. Methicillin resistant staphylococcus aureus (MRSA) is majorly implicated as a hospital associated infections due to its multi-antibiotic resistant, that is propelled by high intake of antibiotics and the long-term hospitalized patients. The co-infections with MRSA either increases the illness symptoms or limits drug usage due to non-effect of the drugs or both. It is proper to understand the rate between hospitalized patients with different illness and acquired MRSA infection.

In Adamawa State, North-East region of Nigeria, the factors that helps MRSA to induced infections and to exacerbate in the disease outcome is not well understood. Therefore, this study will investigate the factors that are associated with *Staphylococcus aureus* infections with long term infections like sepsis, un-healing post operatives' wounds, pneumonia and open cancer ulcers.

Specific Objective

1. To ascertain the prevalence of Methicillin Resistant *Staphylococcus aureus* infections among patients hospitalized for more than twenty-one days with various clinical conditions in Adamawa state.
2. To identify hospital acquired MRSA colonization in these hospitalized patients in Adamawa State.

Thus, the goal of this study is to elucidate the prevalence of Methicillin Resistant *Staphylococcus aureus* among hospitalized patients with prolonged illness. It also assessed the risk factors for hospital acquired MRSA (HA-MRSA) infections.

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Material and Methods

Study Area : Adamawa state is a state in the North-East geopolitical zone of Nigeria, bordered by Borno to the northwest, Gombe to the west, and Taraba to the southwest, while its eastern border forms part of the national border with Cameroon. The state is one of the most heterogeneous in Nigeria, with over 100 indigenous ethnic groups. Adamawa is one of the largest states of Nigeria and occupies about 36,917 square kilometers (Victoria, 2019) with a Population size of 4,902,100 (Population census 2006-2022) and a population density of 81. The state accounts for 2.26% of Nigeria's total population. The inhabitants are mainly Fulani and Kanuri people with more than 100 minority ethnic groups. It lies at latitude 9°20 North and 12°30 East.

Study design: A cross-sectional study design was adopted. Patients that have been on admission for 21 days and above for different ailments, but developed infections ranging from urinary tract pressure ulcer, sepsis, and surgical operation wounds were recruited from the hospital wards, spread across major hospitals in Adamawa state. The causes of long-term stay in hospital by the subjects formed the inclusion criteria because these patients have been administered with different antibiotics and /or other drugs during the management of their illness. The patients may have been referred to tertiary hospital from private or rural cottage clinics. The patients that were attended to at the out-patient department for minor illnesses like fever, flu and daily hospital visit were excluded from the study.

Ethical Issues: The study protocol was reviewed and approved by the Health and Research committee of Modibbo Adama University Teaching Hospital, Yola and Adamawa state Ministry of Health. The approval References are as follows: MAUTHYOLA/HREC/23/256 and S/MoH/1131/I

Collection of Samples: The samples collected was based on the type of disease condition. These samples includes blood samples, Burn Swabs, soft-skin swabs, Urine samples, Sputum samples, Wound swabs, Eye swabs, Urethral swabs and Ear swabs from various wards of the hospitals.

If transport delays are anticipated, samples were stored in a transport Amies medium and kept in the refrigerator at 4°C or incubated at 37 °C in the laboratory before being processed and cultured.

Sample Size: A total of 339 different clinical samples were collected from patients with long-term hospitalization in various hospitals spread across Adamawa state using the formular

$[Z2 \times P (1-P)]/e2/1+[Z2\times P(1-P)]/e2\times N]$

N = population size (Population size for Adamawa state is 4,902,100). (Population census 2006-2022), Z= z-score (1.96), e = margin of error (0.05), p = standard of deviation (0.5). (GeoPoll's Sampling Techniques")

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Site of Samples size and distribution

LGA/ Hospital	No. of Samples collected (%)
Yola North : State Specialist Hospital, Yola.	46 (13.57)
Fortland Hospital, Jimeta.	42 (12.39)
Yola South: Modibbo Adama University Teaching Hospital, Yola.	199 (58.7)
Numan LGA: General Hospital, Numan	7 (2.1)
Hong LGA: Federal Medical Centre, Hong	6 (1.8)
Mubi South LGA: General Hospital, mubi.	21 (6.2)
Michika LGA: General Hospital, Michika.	16 (4.7)
Gombi LGA: Primary Healthcare Gombi.	2 (0.6)
Total	**339**

Laboratory Procedure

Blood Cultures

Blood samples collected were subjected to blood culture analysis. Briefly, blood samples were inoculated unto Brain heart infusion broth and incubated at 37°C for observed for turbidity for 7days. Those that appeared turbid were sub-cultured unto Mannitol salt Agar and blood agar plates for the presence of bacteria pathogens.

Urine samples, Sputum samples, Skin and Soft tissue swabs and wound swabs were inoculated unto Brain heart infusion broth, Mannitol salt Agar, and incubated at 37°C for 24 hours. All the samples inoculated unto Brain heart infusion broth were sub-cultured unto Mannitol salt Agar to confirm the initial growth patterns. The identification of Staphylococcus aureus was based on standard methods.These included the typical Gram stain reaction, and characteristics growth on MSA, including catalase and coagulase test.

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Confirmation of MRSA

The identified *Staphylococcus aureus* isolates were subjected to ChromAgar MRSA test. Those with change of colour ranging from Rose pink to mauve were identified as MRSA.

RESULTS

Characteristics of the study subjects

A total of 339 different clinical samples were collected from patients with long-term hospitalization in various hospitals spread across Adamawa state. They comprised of 57.5% (195/339) Males and 42.5% (144/339) Females. Majority of the subjects did not attend any formal education and accounted for 43.7% (148/339). This was followed by those with secondary, primary, and tertiary education with a frequency of 22.7% (77/339), 16.2% (55/339) and 13.3% (45/339) respectively. Also, most of the participants were married and consisting of 48.4% (164/339), while the single subjects were 38.1% (129/339).

The occupation of the subjects indicated that the subjects were artisans, farmers, traders and civil servants representing 48.7%, 21.2%, 14.5% and 8.6% respectively. The categories of residential areas showed that majority were of rural dwellings constituting 53.7% (182/339) while those residing in slum areas, high density areas were 8.6%, and 14.5% respectively. The moderate and low-density areas were 18.9% and 2.9% respectively (Table 1)

Table 1: Demographic Characteristics of the Subjects.

Variables	Frequency	Percentage (%)
Sex:		
Male	195	57.5
Female	144	42.5
Age group (Years):		
>1- 10		
11- 20	34	10.0
21- 30	47	13.9
31- 40	48	14.2
41- 50	58	17.1
51+	57	16.8
	95	28.0
Educational Status:		
None	148	43.7
Primary	55	16.2
Secondary	77	22.7
Tertiary	45	13.3
No Response	14	4.1
Marital Status:		
Single	129	38.1

Married	164	48.4
Divorced	6	1.8
Widower	9	2.7
Widow	23	6.8
Missing	8	2.4
Occupation:		
Farmer	72	21.2
Trader	49	14.5
Civil servant	29	8.6
Artisans	165	48.7
Missing	24	7.1
Residential:		
Rural dwellings	182	53.7
High density	49	14.5
Slum	29	8.6
Semi urban	64	18.9
Low density	10	2.9
Missing	5	1.5

Age group

The age range of the patients with long-term hospitalization was 1-91 year olds with a mean age of 38.66 ± 20.85 year-olds. It was observed that those of 51 years old and above constitute majority of the subjects accounting for 28.0% (95/339). Those of 31-40, 41-50 and 21-30 were 17.1%, 16.8% and 14.2% respectively. The younger participants ≤10 years and 11-20 were 10.0 % and 13.9% respectively.

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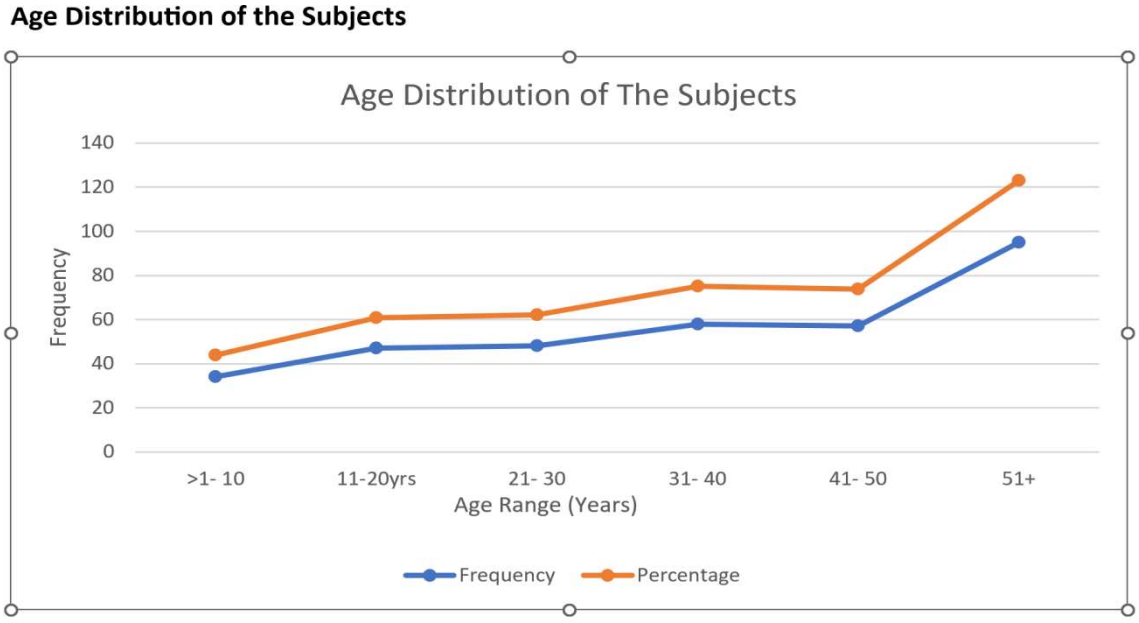

Figure1: Age distribution of the subjects.

Association of Risk Factors:

The risk factors for acquiring secondary infections while in hospital indicated that minority 24.5% (83/339) do not take their bath on a daily basis while 39.8% (135/339) and 30.7% (104/339) normally take their bath once and 3 times per day respectively. While some had stayed in the hospital for 0.8-12 months were 15.0% and those of 13-24 months and ≥ 25 months were 1.8% and 6.7% respectively. The co-morbid factors such as soft skin infections, surgery and chronic liver diseases indicated that 21.5% (73/339), 36.9% (125/339) and 4.7% (16/339) respectively had such conditions. The social habit of cigarette smoking showed that majority 86.7% were non-smokers while 8.6% previously involved in cigarette smoking. Among the subject 2.1% were still active cigarette smokers. In the hospital, majority of the patients used tap water and this constituted 56.7% (192/339) while others 31.3% (106/339) and 12.1% (41/339) used either well water or fetch water from the stream.

Table 2: Characteristics of the risk factors

Variable	Frequency	Percentage (%)
How often do you bath in a day?		
None	83	24.5
Once	135	39.8
3 times	104	30.7
Non-Respondence	17	5.0
Sharing of towels at home:		
Yes		
No	175	51.6
Missing	137	40.4
	27	8.0
Sharing of bed sheets		
Yes	232	68.4
No	81	23.9

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Missing	26	7.7
Duration as in-patient		
21(0.7)	259	76.4
0.8-12 months	51	15.0
13-24	6	1.8
≥25	23	6.7
Number of people living in a household		
1-5	127	37.5
6-10	135	39.8
11-15	40	11.8
16+	30	8.8
Missing	7	2.1
Smoking habit:		
None smoker	294	86.7
Ex-smoker	29	8.6
Current smoker	7	2.1
Missing	9	2.7
Soft skin or tissue infections in the last 12 months:		
Yes		
No	73	21.5
Missing	257	75.8
	9	2.7
Had surgery in the last 12 months:		
Yes	125	36.9
No	211	62.2
Missing	3	0.9
Suffered chronic liver disease?		
Yes		
No	16	4.7
Missing	311	91.7
	12	3.5
Type of water used:		
Well	106	31.3
Stream/River	41	12.1
Tap water	192	56.7
Use of antibiotics outside prescription:		
Yes	290	85.5
No	49	14.5

Staphylococcus aureus Isolates:

A total of 339 different samples were analyzed bacteriologically. Of this number, 73.5% (249/339) had a yield of bacterial growth while 25.4% (86/339) did not show any bacterial growth. A total of 1.2% (4/339) had growth that was grossly contaminated thus were discarded. Of the 249 that had bacterial growth, staphylococcus aureus was identified in 28.9% (98/339) as pure single isolates.

Some of the *S. aureus* isolated were identified as a mixed cultures in 25.1% (85/339), these isolates were separated and purified and regarded as *S. aureus* isolates. This gave a total of 183 *Staphylococcus aureus* isolates and were further characterized as MRSA, MSSA, and CoNSA. Some other bacterial isolates that were identified as pure isolates included *Pseudomonas aeruginosa,*

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*Escherichia coli, Streptococcus pyogenes and Klebsiella aeruginese at a prev*alence rate of 10.6%, 3.8%, 1.2% and 0.6% respectively.

Some of the samples had S. *aureus* + *Pseudomonas aeruginosa* accounting for 3.8% while *Escherichia coli* + *Pseudomonas aeruginosa* mixed bacterial growth with a yield of polybacterial agents. This groups accounted for 28.3% (96/339) of the total bacterial isolates.

Prominent among these is *S. aureus* + *E. coli* accounting for 15.6%, while *Klebsiella aeruginese* + *E. coli* +*Proteus mirabilis* accounted for 1.2% (4/339). Of importance in this polybacterial, is *Staphylococcus aureus* +*pseudomonas aeruginosa* gave a yield of 0.6% (2/339) (Table 3)

Table 3: Summary Of Bacteria Isolates from Different Samples Analyzed

Bacteria Isolates:	Frequency	Percentage (%)
Mono:		
Staphylococcus aureus	98	28.9
Escherichia coli	13	3.8
Pseudomonas aeruginosa	36	10.6
Klebsiella aeruginese	2	0.6
Streptococcus pyogenes	4	1.2
Polybacteria:		
Staphylococcus aureus + Escherichia coli	53	15.6
Staphylococcus aureus + Pseudomonas aeruginosa	13	3.8
Staphylococcus aureus +Klebsiella aeruginese	12	3.5
Staphylococcus aureus +Proteus mirabilis	3	0.8
Staphylococcus aureus + Streptococcus agalactia	4	1.2
Polybacteria:		
Escherichia coli +Klebsiella aeruginese	4	1.2
Escherichia coli + Streptococcus agalactia	1	0.3
Escherichia coli + Pseudomonas aeruginosa	2	0.6
Klebsiella aeruginese + Escherichia coli+ Proteus mirabilis	4	1.2
Total	249	(73.5)

Characterization *of Staphylococcus aureus* Isolates

A total of 183 *Staphylococcus aureus* isolates were subjected to characterization into MRSA, MSSA and CoNSA strains. One hundred and fifty-eight (86.3%) (158/183) were characterized into the various *S. aureus* strains while 13.7% (25/183) were lost during storage.

The obtained prevalence rate of MRSA was 25.96% (88/339), while MSSA and CoNSA strains had a yield of 8.6% (29/339) and 12.3% (41/339) respectively. (Table 4).

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Table 4: Categorization of *Staphylococcus aureus* Isolates.

Strain	Frequency (%)
Methicillin Resistant *Staphylococcus aureus* (MRSA)	88 (25.96)
Methicillin Sensitive *Staphylococcus aureus* (MSSA)	29 (8.55)
Coagulase Negative *Staphylococcus aureus* (CoNSA)	41 (12.09)
Staphylococcus aureus (missing due to storage)	25 (7.37)
TOTAL	183 (53.98)

Distribution of Isolates in relation to Disease condition:

Of the various samples collected, the highest MRSA isolates was obtained from non-diabetic foot ulcer patients 5.6% (19/339) followed by those with bone fractures accounting for 3.5% (12/339). Of importance is the identification of MRSA in 2.95% (10/339) from blood samples. Diabetic foot ulcer, Accidents victims with no fracture had 2.3% (8/339) each, while the patients with bed sores had 1.5% (5/339).The subjects with un-healing gun shot injury had MRSA Isolates of 1.2% (4/339).

The patients with Ear pus, Eye pus discharged and Burns had 0.9%, 0.3% and 2.65% MRSA strains respectively. The patients with Urinary tract infections and respiratory distress had no MRSA isolates. It was observed that the patients with post- Surgical wounds and Breast cancers had 0.9% (3/339) MRSA Isolates each (Table 5)

Table 5: Summary of Staphylococcus aureus Strains Isolated from different samples.

Samples	Number(n)	MRSA Isolates (%)	MSSA Isolates (%)	CoNSA Isolates (%)
Diabetic foot ulcer	18	8 (2.35)	-	1 (0.3)
Bone fractures	26	12 (3.5)	4 (1.18)	3 (0.88)
Accident (No fracture)	36	8 (2.36)	4 (1.18)	2 (0.59)
Gunshot injury	9	4 (1.18)	1 (0.3)	-
Bed sores	14	5 (1.5)	1 (0.3)	5 (1.47)
Post-surgical wounds	42	3 (0.88)	1 (0.3)	5 (1.47)
Breast cancer	8	3 (0.88)	3 (0.88)	1 (0.3)
Non-diabetic foot ulcer	36	19 (5.6)	7 (2.06)	4 (1.18)
Burns	13	9 (2.65)	1 (0.3)	3 (0.88)
Blood	97	10(2.95)	5 (1.47)	10 (2.9)
Sputum	9	-	1 (0.3)	1 (0.3)
Urine				

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Urethral swab	15	-	1 (0.3)	4 (1.18)
Pleural fluid	2	1 (0.3)	-	-
Eye swab	6	2 (0.59)	-	-
Ear swab	2	1 (0.3)	-	1 (0.3)
	6	3 (0.88)	-	1 (0.3)
Total	339	88 (25.95)	29 (8.6)	41 (12.1)

Distribution of MRSA among the Local Government Areas

The MRSA Isolates were obtained from the hospitals within the Local government areas (LGA). In Yola south LGA that harbored Modibbo Adama University Teaching Hospital, Yola had the highest yield of MRSA, 17.4% (59/339), followed by Yola North LGA (State Specialist Hospital and Fortland Hospital, Jimeta with a combined yield of 7.9% (27/339) of MRSA Isolates. Hong and Mubi south LGAs had MRSA isolates of 0.3% each, while all the samples collected from Michika, Gombi and Numan showed no MRSA isolates (Table 6).

Table 6: Distribution of Staphylococcus aureus strains in relation to Local Government Areas (LGAs) and Hospitals (n= 339).

	LGA/ Hospital	MRSA (n=88)	MSSA (n=29)	CoNSA (n=41)
1.	Yola North State Specialist Hospital, Jimeta.	11 (3.2)	3 (0.9)	9 (2.7)
	Fortland Hospital, Jimeta.	16 (4.7)	8 (2.4)	3 (0.9)
	2.Numan LGA			
	General Hospital, Numan.	-	-	1 (0.3)
	3.Hong LGA			
	Federal Medical Centre, Hong	1 (0.3)	-	-
	4. Mubi South General Hospital, Mubi	1 (0.3)	-	4 (1.2)
	5. Gombi LGA Primary HealthCare Centre, Gombi	-	-	1 (0.3)
	6. Michika LGA General Hospital,Michika	-	-	1 (0.3)

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7. Yola south Modibbo Adama University Teaching Hospital, Yola	59 (17.4)	18 (5.3)	22 (6.5)

Demographic features in relation to MRSA Isolates

Of the MRSA isolates 16.2% (55/339) were obtained from Males while the Females were 9.7% (33/339) though statistically not significant when compared with MSSA isolates (P=0.401). The Age group of the subjects showed that those within the age group of 31-40, 41-50 had 5.6% and 5.0% of MRSA isolates respectively. The age group of 11-20, 21-30 had MRSA isolates of 3.5% (12/339) each. The younger subjects of ≤10 years old had the lest of MRSA of 2.7% (9/339). Majority of the MRSA was obtained from those that were either married or single of 12.1% (41/339) and 10.9% (37/339).

The Educational attainment of the subjects indicated that those without any education were highly infected with MRSA 12.7% (43/339). This was followed by those with Secondary, Primary and Tertiary with 6.2%, (21/339), 3.5% (12/339) and 3.5% (12/339) respectively though not statistically significant.

The occupation of the subjects indicated that the artisans, farmers and traders had 12.7%, (43/339), 5.6% (19/339) and 4.4% (15/339) of MRSA, respectively.

The residential areas were statistically significant with a p-value=0.031. The occurrence of MRSA were more on those from the Rural hospital (rural dwellings) 12.1% (41/339), followed by those that are living in moderate (flats) homes in urban areas with 3.2% while the individuals living at high density / Slum settlement had 5.6% and 4.7% (Table 7)

Table 7: Demographic Characteristics in relation to MRSA and MSSA among the subject (n=339)

Variable	MRSA (%)	MSSA (%)	P-value
Sex:			0.401
Male	55 (16.2)	19 (5.6)	
Female	33 (9.7)	10 (2.9)	
Age group (Years):			0.828
<1 – 10	9 (2.7)	5 (1.5)	
11 – 20	12 (3.5)	6 (1.77)	
21 -30	12 (3.5)	4 (1.2)	
31-40	19 (5.6)	4(1.2)	
41-50	17 (5.0)	8 (2.36)	
51+	19(5.6)	2(0.6)	
Marital Status:			0.232
Single			
Married	37 (10.9)	13 (3.8)	
Divorced	41 (12.1)	10 (2.9)	
Widow	2 (0.6)	1 (0.3)	
Widower	6 (1.8)	3 (0.88)	
	2 (0.6)	2 (0.6)	
Educational Level:			0.559
None	43 (12.7)	15 (4.4)	
Primary	12 (3.5)	3 (0.88)	
Secondary	21 (6.2)	5 (1.5)	
Tertiary	12 (3.5)	6 (1.8)	

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Occupation:			0.182
Farmer	19 (5.6)	4 (1.2)	
Trader	15 (4.4)	3 (0.88)	
Civil servant	11 (3.2)	4 (1.2)	
Artisans	43 (12.7)	18 (5.3)	
Residential:			0.031
Rural dwelling			
High density	41 (12.1)	10 (2.95)	
Slum	11 (3.2)	4 (1.2)	
Semi-urban	16 (4.7)	0	
Low-cost/ GRA	19 (5.6)	11 (3.24)	
	1 (0.3)	4 (1.2)	

Assessment of Risk Factors

It was observed that the patients who bath once a day or 3 times per day acquire 10.3% and 8.0% of MRSA as against the patients that were confined to their bed and may not bath in a day with 7.7% (26/339) (Table 8). The number of days/months spent in the hospital wards indicated that the number of those ≤ 0.7 months (21 days) had majority of the MRSA Isolates i.e., 22.7% (77/339) while those between 0.8-12 months and 13-24month were 0.9% (3/339), 0.3% (1/339) and 1.2% (4/339) though not statistically significant p =0.414.

The smoking habit of patients showed none statistical significant. The non- smokers had 21.5% (73/339) MRSA while the ex-smoker were 4.1% (14/339) and 0.3% was obtained from a current smoker. The previous infections due to the soft skin infection, Surgical operations indicated that such individuals have suffered the infections constituted 4.7% (16/339), and 10.9% (37/339) of MRSA respectively.

The source of water supply was assessed and indicated that in hospital where they use well water, tap water and fetch water from stream, had 6.8%, 14.8% and 4.4% of MRSA. The patients that agreed to self -medications had majority of the MRSA isolate 20.9% (71/339) as against those that always go for physician prescription 5.0% (17/339) (Table 8)

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Table 8: Risk Factors associated with MRSA and MSSA infection.

Variables	MRSA (%)	MSSA (%)	P- Value
How often do you bath in a day:			0.643
None			
Once	26 (7.7)	8 (2.36)	
3 times	35 (10.3)	10 (2.6)	
	27 (8.0)	11 (3.2)	
Do you share towels with members of your family?			0.785
Yes	51 (15.0)	15 (4.4)	
No	37 (10.9)	14 (4.1)	
Do you share bed sheets with other people:			0.735
Yes			
No	66 (19.5)	23 (6.8)	
	22 (6.5)	6 (1.8)	
Length of stay in Hospital (months):			0.414
0.7	77 (22.7)	22 (6.5)	
0.8-12	3 (0.9)	3 (0.9)	
13-24	1 (0.3)	1 (0.3)	
≥36	4 (1.2	2 (0.6)	
	3 (0.9)	1 (0.3)	
No response			
No. of People in your household:			0.378
1-5			
6-10	36 (10.6)	16 (4.7)	
11-15	39 (11.5)	7 (2.1)	
16+	9 (2.7)	3 (0.9)	
	4 (1.2)	3 (0.9)	
Smoking Habit:			0.667
None Smoker			
Ex-smoker	73 (21.5)	25 (7.4)	
Current Smoker	14 (4.1)	3 (0.9)	
	1 (0.3)	1 (0.3)	
Any Soft skin or tissue infections in the last 12 months:			0.156

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Yes			
No	16 (4.7)	11 (3.24)	
	72 (21.2)	18 (5.3)	
Had surgery in the last 12 months			0.746
Yes	37 (10.9)	14 (4.1)	
No	51 (15.0)	15 (4.4)	
			1.000
Suffered chronic Liver disease			
Yes			
No	3 (0.88)	1 (0.3)	
	85 (25.1)	28 (8.3)	
Well water			0.648
Yes	23 (6.8)	8 (2.36)	
No	65 (19.2)	21 (6.2)	
River / Stream			0.664
Yes	15 (4.4)	5 (1.47)	
No	73 (21.53)	24 (7.1)	
Tap water			0.660
Yes	50 (14.8)	22 (6.48)	
No	38 (11.21)	07 (2.1)	
Use of antibiotic outside doctor´s prescription:			0.300
Yes			
No			
	71 (20.9)	26 (7.67)	
	17 (5.0)	3 (0.88)	

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DISCUSSION, CONCLUSION AND RECOMMENDATION

Discussion

The association of *Methicillin Resistant Staphylococcus aureus* (MRSA) as a secondary infection in individuals with persistent diseases remains a colossal public health problem worldwide.

In this study, a prevalence rate of MRSA, MSSS and CoNSA were 25.96%, 8.5% and 12.1% respectively, the high occurrence of MRSA poses a great risk to the populace and may lead to high morbidity and mortality rates and acts as source for intra and inter-hospital dissemination including the spread of epidemic strains. MRSA is also prevalent in health-care workers indicating that these workers might serve as a reservoir for the spread of HA-MRSA infections in hospitals. (Elie-Turenne *et al,* 2010).

Similarly, Adeiza *et al,* 2020 identified 46.9% of MRSA from the nares of patients and health care workers in Sokoto state. Akujobi *et al*, 2013, reported a prevalence rate of 30% of MRSA colonization among health care workers in Benin, similarly, earlier studies Taiwo *et al,* 2005, established 32% MRSA from a tertiary hospital in Ilorin.

The occurrence of MRSA is wide spread in Nigeria at varying prevalence rates. In this study, the subjects were hospitalized for different ailments with secondary infections due to hospital acquired MRSA, their condition may be exuberated thereby leading to high mortality. This agrees with the findings of Yilmaz *et al,* 2016 that MRSA are significantly associated with high mortality with individuals with *staphylococcus aureus* infections. It was also observed that *Methicillin -resistant staphylococcus aureus* (MRSA) strains cause serious nosocomial infections and spread worldwide which in turns has an extensive impact on patient management in health care settings and results in enormous increases in healthcare costs (Murray *et al*, 1978).

It was also observed that the majority of MRSA isolates centers in Modibbo Adama University Teaching Hospital with 17.4% of total MRSA isolates while the hospitals from rural areas had 0.3% of total MRSA isolates. The low frequency of MRSA among the rural dwellers may be due to the reduced drug pressure in the rural areas under observation that may result in low prescription of third (3^{rd}) generation Cephalosporins as these drugs tends to be more expensive (Newmann *et al*, 2011). This agrees with Dekkar *et al*, 2016 that reported low level of MRSA in Nigeria.

The factors that may be responsible may be included in the high frequency of patients visiting the hospital, high usage of antibiotics within the urban hospital and poor cleaning or due to non-functional disinfectants used in the hospital wards. Thus, the implication of these is that patients from rural areas that may have acquired MRSA from the hospital when discharged from the hospital may acts as transmission routes to others in the rural dwellings.

The culture of the people allows visitation to homes of any person that is discharged from the hospital to pay respects and to offer prayers for the persons' quick recovery, through this the patient may acts as a route of spread to unsuspecting individual to the immunocompromised patients e.g., diabetic patients. Thus, advocacy programs are needed to canvas and educate the people on disease infection control, so as to maintain the non-absence of MRSA in the rural areas of Adamawa state.

The detection of MRSA was more in the males 16.2% as against the females 9.7%, these agrees with the report of Casses, report predomination of the male subjects with MRSA carriage in a tertiary hospital in United states. Among the various reports it was observed that MRSA occurs in male subjects than the females (Klevens *et al*, 2007). This may be as a result of life-style such as alcohol intake and smoking habits of the male subjects which may enhance the acquisition of MRSA in these subjects, another possible reasons why gender may play a role in outcomes of MRSA infections may include different health-seeking behaviors adopted by women, the infecting MRSA clone and/or hormonal differences of the individual sex (Tong *et al,* 2009).

The age of the subjects was not statistically significant for the outcome of MRSA infection but remains a critical factor among the patients. It was observed in this study that the MRSA isolates increase as the age increases. The highest prevalence of MRSA was among those age 31-40 and 51 and above with 5.6% MRSA isolates. Romero-Vivas and colleagues (1995).

reviewed patients with Staphylococcus aureus bacteremia and found out that patients with MRSA bacteremia were significantly high in older patients and had significantly longer hospitalization, were administered more antibiotics and underwent more surgical procedures than patients with MSSA bacteremia.

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In Scandinavian countries, where data from the nationwide surveillance of staphylococcus aureus bacteremia are routinely collected and reported, the annual incidence of Staphylococcus aureus bacteremia increases with advancing age, with the lowest rates observed in pediatric populations, at approximately 8.4/100,000 population per year (Frederiksen *et al*, 2007).

Similarly, Benfield *et al,* 2007 and Laupland *et al*, 2008, reported that younger adults have lower incidence rates than older adults. Also, Kang *et al*, (2011) stated that other problems that may be associated with age, may be, aging, which include the presence and number of co-morbidities, indwelling medical devices, and health care contact.

Some of the higher death rates may be attributed to differences in Staphylococcus aureus bacteremia-related investigations and management of elderly patients (Big *et al*, 2010). However, in a case-controlled study, age remained a predictor of mortality despite elderly patients (≥65 years) having similar baseline characteristics and S. aureus bacteremia management (Tacconelli *et al,* 2006). Thus, the increased mortality from Staphylococcus aureus - associated with aging is directly linked to changes within the host as a consequence of the aging process, and age remains a significant con-founder when examining other variables that influence outcomes.

The residence of this subjects before being hospitalized was statistically significant for the outcome of the Methicillin Resistant Staphylococcus aureus (MRSA). The subjects who are residence of a rural dwelling were referred to tertiary hospital for proper health-care and well-being. This groups of subjects have stayed in the hospital for more than 21 days and thus, must have acquired Methicillin Resistance Staphylococcus aureus from the hospital environment.

This group prevalence of 12.1% MRSA infection detected among this group is important in the transmission cycle of MRSA as they may have harbored the MRSA during discharged from the hospital and circulates it within the community.

Although, the urban residence, semi-urban residence and those that live in over-crowded settlements (Slum) do share the acquisition of MRSA from the hospital. In effect, co-infection with MRSA is a generalized infectious cycle that may spread within the localities or niches and this may give rise to an epidemic. This is in correspondence of Creech *et al,* (2005) that stated that epidemiological data suggests that Community acquired Methicillin Resistance Staphylococcus aureus (CA-MRSA) carriage is on the rise in the human population.

The study of Ateba Ngoa *et al,* 2012 stated that higher carriage rate of staphylococcus aureus is more in rural populations. The reasons for these findings were included in higher inter-human transmissions due to crowding in bedrooms as observed in rural areas.

In slum areas, there is the problems of population over-crowding within households as families tend to maximize the usage of a room thereby leading to overcrowding and sharing of clothing's thus as these patients are discharged from the hospital and they mix up with their friends and family, the likelihood of transmitting these bacterial agents is increased, therefore, since hospital environment acts as route of MRSA infection and Staphylococcus aureus carriage.

Thus, the cycle of *Staphylococcus aureus /Methicillin Resistance Staphylococcus aureus* and *MRSA strain* transmission results from HA-MRSA to CA-MRSA colonization (Chen *et al*, 2014). The successful transfer of strains from hospital to community and vice versa has occurred, leading to ''community-acquired hospital onset," and ''hospital-acquired community onset" MRSA infections (Scanvic *et al*,2001; Klevens *et al*, 2001).

The level of educational attainment is a commitment to good personal hygiene and understanding of health safety and personal cares.

In Northeast Nigeria, the level of higher education attainment is low and thus most of the people do not have formal education. This is reflected in this study as the individuals without education accounted for 12.7% of MRSA infections constituting a major health problem when compared with those of primary and secondary, it was not statistically significant but remains a big factor in controlling infectious diseases (Chambers, 2001).

It has been established that those with tertiary education would be able to read and understand healthcare conditions and infectious disease control. Thus, educating the people in local languages on the need of maintaining a good hygiene and avoiding risk factors

for acquiring infectious agents, will help in reducing the infectious cycle of MRSA infections and carriage. The description of MRSA was firstly originated from England in 1961 and since then MRSA had spread all over the world including Nigeria. (Ghebremedhin *et al*, 2009).

The risk factors for the wide spread of this agents Methicillin Resistance Staphylococcus aureus (MRSA) have not been fully described in Nigeria especially in patients admitted in hospitals environments. The present study reveals for the presence of MRSA among hospitalized patients from more than 21 days. The risk factors assessed for the acquisition of MRSA were not statistically significant but it was observed that the length of stay in the hospital is very critical in acquiring MRSA.

In this study, those that have stayed 0.7months were highly co-infected with Methicillin Resistance Staphylococcus aureus (MRSA), accounting for 22.7% when compared with those that have stayed with the range of 0.8-36 months and accounted for 3.2% MRSA collectively, is an indication that either the patients had high carriage of *Staphylococcus aureus* before being admitted or due to excessive use of antibiotics before the referral to the tertiary hospital, they were able to be colonized by this MRSA strains.

This finding agrees with the earlier suggestion that prolonged hospitalizations predispose people to acquired infections due to high presences of *Staphylococcus aureus* carriage among healthcare workers and environment. (Gonsu *et al*, 2013; Bonten, 1998 and Truillet *et al* ,1998). This predisposition may result, in part, from the greater likelihood over time of becoming colonized with such bacteria or the generally poorer underlying immune status of the most seriously ill patients. In addition, the use of invasive devices, such as endotracheal tubes, intra-vascular catheters and urinary catheters, seems to encourage such infections. (Richards *et al*, 1999; Kollef *et al*, 1997).

Conclusion

In conclusion, the prevalence rate of MRSA in Adamawa state, Nigeria has increased from 8.0% to 25.96% between 2012 to date from this study, that is to say MRSA infections are on the increase hence, infection control measures have to be enforced.

Therefore, the continuous education, and infection control interventions are highly recommended in Adamawa State, Nigeria.

Recommendation

- Implementation of safety practices and control intervention to stop or cob the spread of MRSA isolates in the hospital and its environs should be enforced.
- Periodic fumigation of the hospital wards be carried out from time to time to eliminate the presence of S. aureus and its drug induced strains, (MRSA). Hospital rooms, surfaces and equipment should be cleaned ad disinfected regularly, using appropriate disinfectants that are very effective and efficient.
- The Knowledge of the incidence/prevalence and trend of MRSA infection is key to health care workers to guide choice of antibiotic therapy, and the strict adherence to safety procedures in handling patients is highly recommended (such as use of hand sanitizers, gloves, gowns and respirators during procedures) including isolation of infected patients to curb spread.

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