Original article:

Profiling of the bacterial pathogens associated with hospital acquired infections in hospitals within makurdi metropolis, middle belt, nigeria.

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Abstract

Background: Nosocomial bacteria are bacteria that cause diseases acquired from the hospital environments. ***Aim:*** This study looked into profile of bacterial pathogens associated with nosocomial infections in hospitals within Makurdi metropolis. ***Result:*** A total of 71 bacterial pathogens were encountered from 240 samples analysed from three hospitals in Makurdi metropolis. Of the 71 isolates, 46(64.8%) were Gram positive and 25(35.2%) were Gram negative. The Gram positive constituting S. aureus (50.70%) and staphylococcus spp (14.08%) while the Gram negative constituting E. coli (15.50%), klebsiella spp (7.04%) and P. aeruginosa (12.68%). Out of 21(29.58%) isolates cultured from hand swabs, the bacterial pathogens from hand swab at F M C was the highest 12(57.14%) followed by C H M 5(23.81%) while B M M C has the least profile of 4(19.05%). With regards to hospital air, the highest profile of nosocomial bacteria was also from F M C 8(61.54%), followed by B M M C 4(30.77%) while C H M had just only one isolate 1(7.69%). Of 21(29.58%) isolates from B M M C; 10(47.62%) S. aureus, 4(19.05%) Staphylococcus spp, 2(9.52%) P. aeruginosa and 5(23.81%) Escherichia coli were obtained. In C H M, out of 18(25.35%) bacterial pathogens evolved constituting 12(66.67%) S. aureus, 2(11.11%) Staphylococcus spp, 1(5.56%) P. aeruginosa and 3(16.67%) E. coli. Whereas, the profile of 32(45.07) isolates in Federal Medical Centre Makurdi constituting 14(43.75%) S. aureus, 4(12.50%) Staphylococcus spp, 6(18.75%) P. aeruginosa, 3(9.38%) E. coli and 5(15.63%) Klebsiella spp were obtained. The antibiotic susceptibility pattern to Staphylococcus spp reveals that the highest level of sensitivity were demonstrated by Cloxacillin and Ofloxacin with 50%, followed by Augumentin and Cefuroxime with 40%, Gentamicin (30%), Erythromycin (20%) and least sensitivity with Ceftriazone (10%) while Ceftazidime has the highest resistance recorded 0% sensitivity. E. coli has the highest sensitivity on Ceftazidime having 81.8% and Gentamicin 63.6%, Ofloxacin also displayed a high level of sensitivity to isolates tested with 63.6% sensitive, follow by Cefuroxime (45.5%). ***Conclusion:*** This study showed that nosocomial bacterial pathogens particularly, S. aureus, P. aeruginosa, Staphylococcus spp and enteric bacteria, E. coli and Klebsiella spp are the predominant pathogens associated with infections acquired in hospital environment.So, information on resistance patterns of isolates encountered in this study will assist the clinicians in making improvement in management of nosocomial infections.

Keywords: Bacterial Pathogens; resistance patterns; Nosocomial infection; susceptibility patterns; Gram positive; Gram negative

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Introduction

The fact that bacteria are ubiquitous in nature is now a common knowledge which makes it easier for them to survive in different environments of which the hospital environment is not an exception. These organisms are found on different surfaces in hospital and as well as hospital air. They serve as agents of an infection referred to as nosocomial infection[1,2,3]Nosocomial infection is any infection acquired in hospital environment, hence it is also known as hospital acquired infections (HAI).[4] Apart from the fact that nosocomial infections affect the general health of patients, it also have a negative effect on their finance due to increase in patients' illnesses as well as their emotional stress which invariably may lead to situation that shorten the life span of such an infected person[16]. Nonetheless, Awosika *et al.* (2012)[5] reported that nosocomial infections can be contracted from contact with a carrier directly or indirectly through inanimate objects or air. *Is*hida *et al*. (2006*)*[6] *also showed that, airborne bacteria are* major source of infection after operation and a serious illness in the Intensive Care Unit. In the United States, approximately 1.7 million hospital-associated infections from all types of bacteria are responsible for 99,000 deaths each year; so about 10%, or 2 million patients are being infected each year,[7,8] In France, According to Lepoutre *et al*. (2005)[9]Heshowed that prevalence of nosocomial infection was 5.9% in 2001. Worse still, around 2004-2005, about 9,000 people died each year with a nosocomial infection, of which about 4,200 would have survived without this infection[10]. In Italy a survey in Lombardy gave a rate of 4.9% of patients in 2000[11]. While in United Kingdom in 2012 the Health Protection Agency reported the prevalence rate of hospital acquired infection in England was 6.4% in 2011, against a rate of 8.2% in 2006[12]. With regards to Switzerland estimates range between 2 and 14%[13]reports revealed that a survey conducted nationally gave a rate of 7.2% in 2004, Lyytikainen *et al.* (2005)[14] shows that in Finland the rate of epidemiology of nosocomial infections were estimated at 8.5% of patients in 2005. Moreover according to a report release by Federaal Kenniscentrum voor de Gezondheidszorg (2009)[15]the prevalence of nosocomial infections is about 6.2% in Belgium; therefore about 125,500 patients contract the infection every year which usually leads to about 3000 deaths. In addition, *the m*ainroutes of transmission of nosocomial infection can either be via airborne transmission,contact transmission, vector borne transmission ordroplet transmission. Microbes carried in this mode can spread in air and may become inhaled by a susceptible host in the same room or over a longer distance from an infected patient, depending on environmental factors; so adequate precautions should be observed in those ill individuals suspected to have airborne, contact or droplet infections. *Clostridiumspp*, an anaerobic Gram-positive rods, causes gangrene; while a wide variety of lung, bone, heart and bloodstream infections which are normally resistant to drugs as in the case of beta-haemolytic *Streptococci*.Gram-positive bacteria, *Staphylococcus aureus* causes cutaneous bacteria that colonize the skin and nose of both health care staff and patients. In people with compromise immunity, Gram-negative bacteria, family Enterobacteriacae like *Escherichia coli*, *Serratia marcescens, Klebsiella, Proteus, Enterobacter* may colonize catheter insertion, bladder catheter, cannula insertion or surgical site in the body and then cause severe infections[16,17]; while *Pseudomonas spp* are often isolated in water and damp areas may localize in the digestive tract of sicked people in hospitals[18].

This study aimed at investigating the profile of bacterial pathogens associated with nosocomial infections in different hospital environment within Makurdi metropolis, Benue State, North Central, Nigeria.

Materials and methods

Collection of samples

The samples were collected in the morning before commencement of work but hand swab of the staff were collected during working hours. Thus, the analyses of samples collected are as follows: (a) City Hospital Makurdi: 10 hand swabs, 30 surface swabs, and 10 air samples; so total of 50 samples were collected from the hospital. (b) Bishop Murray Medical Centre: 10 hand swabs, 32 surface swabs, and 15 air samples; so total of 57 samples were collected from the hospital. (c) Federal Medical Centre: 77 hand swabs, 42 surface swabs, and 14 air samples; so total of 133 samples were collected from the hospital.

Method of isolation

Culture method: The surface samples were cultured using sterile swab sticks to make an inoculum on the plates while air samples were cultured by plate exposure method before streaking is done using a sterile wire loop.

Isolation and characterization of isolates

The organisms cultured from the air and the swabs were directly inoculated on nutrient agar and later sub-

cultured on blood agar, chocolate and MacConkey agar near benzene burner. The inoculated media were incubated at 37oC for 24 h and then examined for bacterial growth. Therefore, the organisms evolved were characterized using cultural characteristics, microscopy (Gram's staining), biochemical test (catalase test, coagulase test, indole test, citrate utilization test, oxidase test, mannitol salt agar test, and sugar fermentation test) as described by Harley and Prescott (2002)[19]; Cheesbrough (2000)[21]; Cheesbrough (2006)[20].

In-vitro determination of antibiotic susceptibility: Antibiotic susceptibility of isolates was performed by disk diffusion according to Clinical Laboratory Standards Institute[22] guidelines**.** The multidisc contained the following antibiotics; Augmentin (AUG) 30µg, Ceftazidime (CAZ) 30µg, Ceftriazone (CTR) 30µg, Cefuroxime (CRX) 10µg, Cloxacillin (CXC) 10µg, Erythromycin (ERY) 30µg, Gentamicin (GEN) 10µg and Ofloxacin (OFL) 5µg. Zones of inhibition were used to determine the level of susceptibility of the isolates to the test antibiotics.

Statistical Analysis: Data were analysed by the use of descriptive statistics via percentages and charts to show the frequency distribution nosocomial bacterial pathogens.

Results and discussion

Table 1 displays the distribution of the isolates in relation to the sample size analysed from hospitals within Makurdi metropolis; thus a total of seventy-one bacterial isolates including 21(29.58%), 37(52.11%) and 13(18.31%) were cultured from hand swabs, surfaces of hospital environments and hospital air respectively. Therefore, two-hundred and forty samples were examined for profile of bacterial pathogens responsible for nosocomial infections in hospitals within Makurdi metropolis; 97(40.4%) were collected from hand palm of nurses and some of the hospital staff, 104(43.3%) were from surfaces in hospital environments and 39(16.3%) of the sample collected were from the air.

Table 1: Distribution of the isolates in relation to the sample analysed from hospitals within Makurdi metropolis

Source	Sample size	Total positive isolate	Total % positive isolate
Hand swabs	97(40.4)	21	29.58
Surface swabs	104(43.3)	37	52.11
Air samples	39(16.3)	13	18.31
Total	**240(100)**	**71**	**100**

Table 2: Occurrence of positive isolates in relation to samples sources from hospitals within Makurdi metropolis

Sample source	Sample size	Total positive isolate	Total % isolate
HS	97	21	29.6
NT	15	5	7.0
BR	15	8	11.3
DK	14	1	1.4
ST	8	1	1.4
SK	15	9	12.7
OT	8	2	2.8
FL	15	5	7.0
TS	14	6	8.5
AR	39	13	18.3
Total	**240**	**71**	**100**

HS- Hand swab, NT- Nurse Table Top, BR- Bed Rails, DK- Door knobs, ST-Stretchers,

SK- Sink, TS- Toilet seat, OT- Operation table, FL-Floor, TS - Toilet Seat, AR-Hospital air

The data represented in Figure 1 is distribution of the samples size from the hospitals environments in Makurdi metropolis while Figure 1 reveals the frequency of the bacteria responsible for nosocomial infections. Federal Medical Centre (FMC) takes the lead, followed by Bishop Murray Medical Centre and City Hospital Makurdi with incidence rate of 32(45.07%), 21(29.58%) and 18(25.25%) respectively.

Table 3 shows the comparison of nosocomial bacteria in relation to the hospitals in Makurdi metropolis which shows that the profile of isolates in Bishop Murray Medical Centre Makurdi constituting 21 nosocomial bacteria, including 10(47.62%)*Staphylococcus aureus*, 4(19.05%) *Staphylococcus* spp, 2(9.52%)*P. aeruginosa* and 5(23.81%)*E.coli*; in City Hospital Makurdi, the nosocomial bacteria constituting 12(66.67%) *Staphylococcus aureus*, 2(11.11%)*Staphylococcus* spp, 1(5.56%) *Pseudomonas aeruginosa* and 3(16.67%)*E.coli*, while the isolates encountered in FMC constituting 14 (38.9) *Staphylococcus aureus*, 4(40.0) *Staphylococcus* spp, 6(66.7) *Pseudomonas aeruginosa*, 3(27.3) *Escherichia coli* and 5(100) *Klebsiella* spp. Hence, all the klebsiella isolates encountered in the study were from FMC. However, the total rate of occurrence of *Staphylococcus* spp at Bishop Murray Medical Centre and Federal Medical Centre is the same constituting 4(40.0%) each while the rate of occurrence at City Hospital Makurdi constituting 2(20.0%).

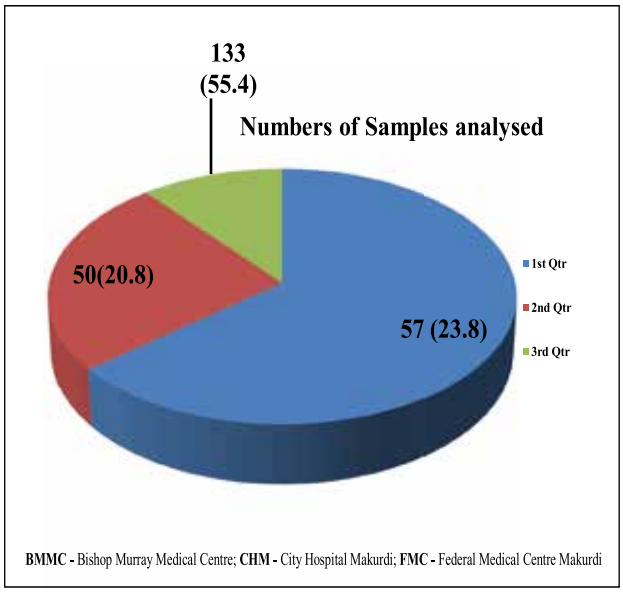

Figure 1: Distribution of the samples size from the hospitals environments in Makurdi metropolis

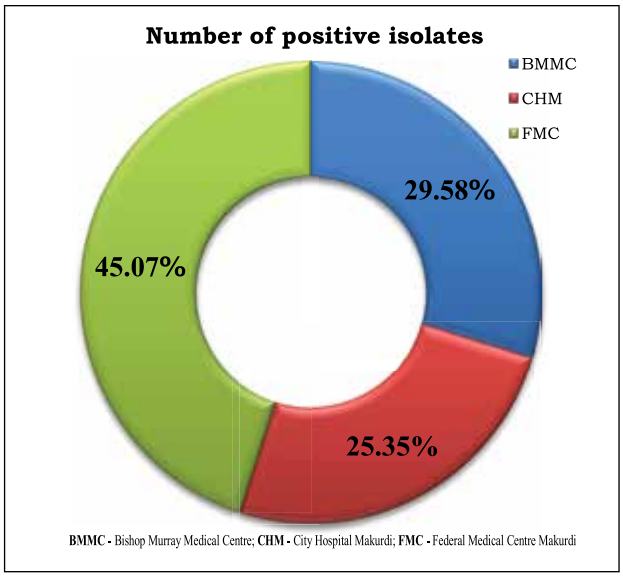

Figure 2: Occurrence of positive isolates of nosocomial bacterial pathogensfrom the hospitals within Makurdi metropolis

Table 3: Comparison of nosocomial bacteria in hospitals within Makurdi metropolis

Hospitals	Profle of *S. aureus* (%)	Profle of *Staphylococcus* spp (%)	Profle of *P. aeruginosa* (%)	Profle of *E. coli* (%)	Profle of *Klebsiella* spp (%)
BMMC	10 (27.8)	4 (40.0)	2(22.2)	5(45.5)	0
CHM	12(33.3)	2(20.0)	1(11.1)	3(27.3)	0
FMC	14(38.9)	4(40.0)	6(66.7)	3(27.3)	5(100)
Total	**36(100)**	**10 (100)**	**9 (100)**	**11(100)**	**5(100)**

BMMC-Bishop Murray Medical Centre; **CHM**-City Hospital Makurdi; **FMC**-Federal Medical Centre Makurdi. *Values in brackets (%) are the rates of occurrence of the nosocomial bacterial pathogens

The data in Table 4 shows the incidence of nosocomial bacterial pathogensin relation to the hospitals environments within Makurdi metropolis. With regards to hand swabs FMC has the highest profile of bacteria 12(57.14%), followed by CHM 5(23.81%), while BMMC 4(19.05%) has the least profile bacteria cultured from the hand swabs. Of 37 isolate evolved from the surface swabs highest profile 13(35.14%) emerged from BMMC while FMC and CHM has the same rate of bacterial pathogens constituting 12(32.43%) each. In the profile from hospital air, findings shows that these bacteria thrive more in the air of FMC with the prevalent rate of 13(18.32%) followed by BMMC 4(30.77) and the least profile emerged from the air of samples of CHM with prevalent of 1(7.69%). The profile of *staphylococcus aureus* was very high from hand swabs which constituting 16(44.4%) and followed by bed rails and toilet seats constituting 4(11.1%) each as shown in Table 4. Whereas the rate of bacterial isolates from air constituting 3(8.3%) and from sinks, operation tables and floors isolates evolved constituting 2(5.6%) each; and with regards to nurse table top, door knobs, and stretchers the isolates were 1(2.8%) each. In addition, in Bishop Murray Medical Centre one *Staphylococcus* spp was encountered from bed rails and nurse table top while two were from sinks. In City Hospital Makurdi one *Staphylococcus* spp was cultured from hand swab and toilet seats; while at Federal Medical Centre profile of *Staphylococcus* spp constituting three at hand palm and one from bed rails. Therefore, ten *Staphylococcus* spp isolates were encountered in from hospitals in the course of the study.

Bar chart in Figure 2 shows that profile of *staphylococcus aureus* was very high from hand swabs which constituting 16(44.4%) and followed by bed rails and toilet seats constituting 4(11.1%)

Table 4: Profile of nosocomial bacterial pathogens in relation to sample source and hospitals within Makurdi metropolis

	H O S P I T A L S								
Sample Source	**BMMC** Isolates	**CHM** Isolates	**FMC** Isolates	Total positive Isolates (%)	***S. aureus***	***Staphylococcus* spp**	***P. aeruginosa***	***Klebsiella* spp**	***E. coli***
HS	4	5	12	21(29.6)	16(46.2)	4(16.7)	0(0)	0	1(9.1)
NT	2	2	1	5(7.0)	1(2.6)	1(16.7)	2(18.2)	0	1(9.1)
BR	3	2	3	8(11.3)	4(12.8)	2(16.7)	1	0	1(9.1)
DK	1	0	0	1(1.4)	1(2.6)	0	0	0	0
ST	0	1	0	1(1.4)	1(2.6)	0	0	0	0
SK	2	2	5	9(12.7)	2(7.7)	2(16.7)	3(27.3)	0	2(18.2)
OT	0	2	0	2(2.8)	2(5.1)	0	0	0	0
FL	3	1	1	5(7.0)	2(5.1)	0	1(9.1)	0	2(18.2)
TS	2	2	2	6(8.5)	4(10.3)	1(16.7)	1(9.1)	0	0
AR	4	1	8	13(18.3)	3(5.1)	0	1(18.2)	5(100)	4(36.4)
Total	**21**	**18**	**32**	**71(100)**	**36(100)**	**10(100)**	**9(100)**	**5(100)**	**11(100)**

BMMC-Bishop Murray Medical Centre; CHM–City Hospital Makurdi; Federal Medical Centre Makurdi, HS-Hand swab, NT-Nurse Table Top, BR-Bed Rails, DK- Door knobs, ST-Stretchers, SK- Sink, TS- Toilet seat, OT-Operation table, FL-Floor, TS-Toilet Seat, AR-Hospital air

each. Whereas the rate of bacterial isolates from air constituting 3(8.3%) and from sinks, operation tables and floors isolates evolved constituting 2(5.6%) each; and with regards to nurse table top, door knobs, and stretchers the isolates were 1(2.8%) each. Figure 4 is the profile of *Staphylococcus* spp in relation to the sources in hospitals environment. Hence, in Bishop Murray Medical Centre has one *Staphylococcus* spp was encountered from bed rails and nurse table top while two were from sinks. In City Hospital Makurdi one *Staphylococcus* spp was cultured from hand swab and toilet seats; while at Federal Medical Centre profile of *Staphylococcus* spp constituting three at hand palm and one from bed rails. Furthermore, bar chart in Figure 4 is the profile of *Pseudomonas aeruginosa* in relation to the sources in hospitals within Makurdi metropolis. In Bishop Murray Medical Centre the profile of *Pseudomonas aeruginosa* emerged from the nurse table top and the toilet seats thereby constituting one each from the two sites. The only one from City Hospital Makurdi evolved from the bed rails, while 3 isolates of *Pseudomonas aeruginosa* from the Federal Medical Centre Makurdi were from sinks and the rest *Pseudomonas aeruginosa* were nurse table top, floor and air sample each constituting one each. The chart shown in Figure 5 reveals the profile of *E. coli* in relation to the sources in hospitals environments. In Bishop Murray Medical Centre the incidence of the bacterial pathogen was from hand swab and the remaining 4 was from hospital floor and air sample which constituting 2 each. With regards *E. coli* in City Hospital Makurdi three environments where the bacteria were encountered include nurse table top, bed rails and sink constituting 1 each as shown in figure 6. However, the result of the sample analysed from Federal Medical Centre revealed just only three incidences of the bacteria, 1 and 2 from sink and air samples respectively. Nevertheless, profile of *Klebsiella* species in relation to the sources in hospitals within Makurdiconstituting 5(7.04%) of the 71 nosocomial pathogens encountered in the course of the study. All the Klebsiella constituting 5(15.6%) were from air samples of Federal Medical Centre (Table 4). HS- Hand swab, NT- Nurse Table Top, BR- Bed Rails, DK- Door knobs, ST-Stretchers, SK- Sink, TS- Toilet seat, OT-Operation table, FL- Floor, TS-Toilet Seat, AR-Air sample of Hospital.

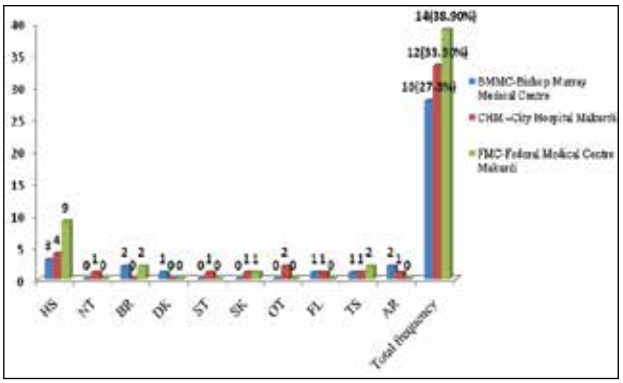

Figure 3: Profile of Staphylococcus aureus in relation to the sources in hospitals within Makurdi metropolis

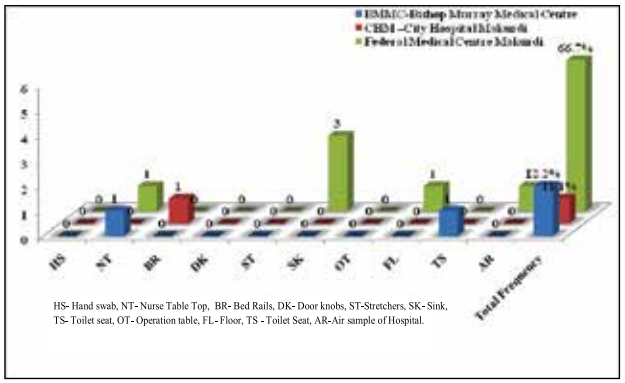

Figure 5: Profile of Pseudomonas aeruginosa in relation to the sources in hospitals within Makurdi metropolis

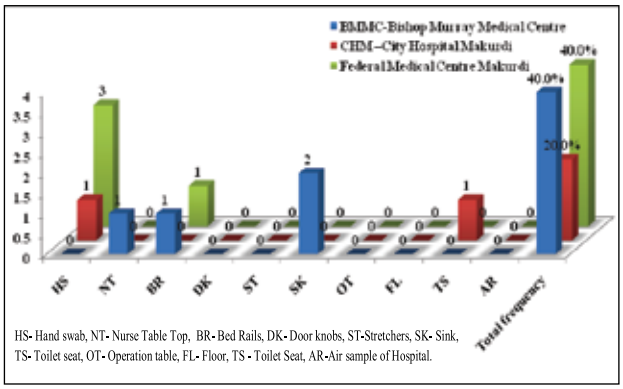

Figure 4: Profile of Staphylococcus spp in relation to the sources in hospitals within Makurdi metropolis

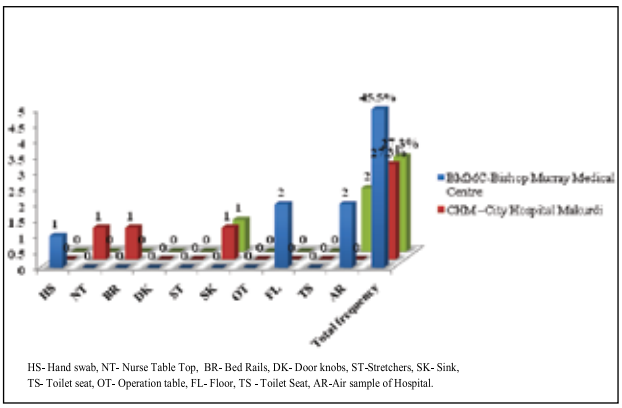

Figure 6: Profile of Escherichia coli in relation to the sources in hospitals within Makurdi metropolis

Table 5: Profile of Multidrug Resistance Bacteria Isolates in Hospitals within Makurdi metropolis

Isolates	No tested	No resistant to				
		3 drugs	4 drugs	≥5 drugs	Total MDR	%MDR
Staphylococcus aureus	36	5	7	18	30	83.3
Staphylococcus spp	10	2	3	5	10	100
Pseudomonas aeruginosa	9	0	0	9	9	100
Escherichia coli	11	3	1	5	9	81.8
Klebsiella spp	5	1	0	1	2	40
Total	**71**	**11(15.5)**	**11(15.5)**	**38(53.5)**	**60(84.5)**	

AUG – Augumetin ERY - Erythromycin CAZ- Ceftazidime CTR- Ceftriazone CRX – Cefuroxime CXC- Cloxacillin GEN – Gentamicin OFL – Ofloxacin MDR-Multidrug Resistance

The data in Table 5 is theprofile of multidrug resistance bacteria isolates in hospitals within Makurdi metropolis. Of the 36 *Staphylococcus aureus* isolates, 30 constituting 5, 7 and 18 isolates were multi-resistant to 3, 4 and 5 or more of the eight antibiotics employed respectively. 2, 3 and 5 isolates of 10 *Staphylococcus* spp were multi-resistant to three, four and five or more antibiotics of the eight antibiotics. Whereas, 9 *Pseudomonas aeruginosa* encountered were resistant to 5 or more antibiotics employed; while 3, 1 and 5 out of 11 isolates of *Escherichia coli* were multi-resistance to 3, 4 and 5 or more of the of the eight antibiotics. With regards to *Klebsiella* spp none of the isolates was resistant to 4 antibiotics but 1 was resistant to three and five or more antibiotics employed each.

Table 6: Antibiogram of bacteria isolates from Hospitals within Makurdi metropolis

Bacteria		No. (%) of Susceptible to							
		AUG	CAZ	CXC	CRX	CTR	ERY	GEN	OFL
Staphylococcus aureus		13(36.1)	7(19.4)	17(47.2)	14(38.9)	3(8.3)	3(8.3)	15(41.7)	30(83.3)
Staphylococcus spp	10	4(40)	0	5(50)	4(40)	1(10)	2(20)	3(30)	5(50)
Pseudomonas aeruginosa	9	0	0	3(33.3)	2(22.2)	0	0	1(11.1)	4(44.4)
Escherichia coli	11	9(81.8)	1(9.1)	4(36.4)	5(45.5)	3(27.3)	3(27.3)	7(63.6)	7(63.6)
Klebsiella spp	5	4(80)	4(80)	4(80)	4(80)	0	0	4(80)	4(80)
Total	**71**	**30**	**12**	**33**	**29**	**7**	**8**	**30**	**50**

AUG – Augumetin ERY - Erythromycin CAZ- Ceftazidime CTR- Ceftriazone CRX – Cefuroxime CXC- Cloxacillin GEN – Gentamicin OFL – Ofloxacin Values in brackets (%) are the susceptibility rates

The data in Table 6 is the antibiogram of bacteria isolates from Hospitals within Makurdi metropolis. Thus the susceptibility patterns of the 71 isolates cultured from hospitals within Makurdi metropolis revealed 50 and 33 isolates were sensitive to Ofloxacin (OFL) and Cloxacillin (CXC) respectively, while 30 isolates each were resistance to Augumetin (AUG) and Gentamicin (GEN) suggesting that the four antibiotics would be very useful for combating of nosocomial bacterial pathogens.

The profile of nosocomial bacterial pathogens in hospitals within Makurdi metropolis reveals that; seventy-one isolates were encountered from two hundred and forty samples collected from the three selected hospitals in Makurdi. 21 isolates cultured from hand swabs of nurses and other hospital staff, 37 isolates from hospital surfaces and 13 isolates cultured from hospital air as shown in Table 1, suggesting a polymicrobic nature of bacterial pathogens in hospital premises as it had been previously reported by Hammuel, *et al.* (2015)[23] and Chikere *et al*. (2008)[24]. In addition, out of 71 bacterial isolates in Table 3 and 4 constituting 46(64.8%) Gram positive and 25(35.2%) Gram negative obtained from this study is in agreement with the findings ofMuhammad *et al*. (2014)[25] that this could be due to the fact that the Gram positive bacteria are the most common organisms found on the skin. The Gram positive were *S. aureus* (50.70%)and coagulase negative staphylococci (14.08%), while the Gram negative were majorly enteriobacterioceae including *E. coli* (15.50%)and *klebsiella* spp (7.04%). Other gram negative includes *P. aeruginosa* (12.68%) whichis higher than the prevalent rate *E. coli*; this observation is in agreement with the reports of other investigators.[26,27,28] Out of 32 Gram positive cocci isolates, *S. aureus* predominated constituting 36(78.3%) while *Staphylococcus* spp constituting 10(21.8%). The predominance of *Staphylococcus aureus* in nosocomial infections is in conformity with the reports by Chrinius *et al*. (2014)[27] and Rania*et al.* (2014)[26] that *S.aureus* is among the commonest bacteria in etiology of nosocomial infection. Therefore, *S.aureus* onstituting 78.3% in the study is among the culprit bacteria capable of causing infection to an immune-compromise patient. The high profile of *S.aureus* encountered in the study could be due to the fact that *S. aureus* is among normal flora

(Table 4). On the other hand, Table 4 also reveals the *Staphylococcus* spp obtained constituting 21.8% of the Gram positive cocci from this investigation corroborates the findings by Nwankwo and Azeez (2015)[18] that coagulase negative *Staphylococcus* spp is among organisms of clinical importance in transmission of nosocomial infections. The profile of Gram negative bacteria shows that *P. aeruginosa* constituting 9(36.0%) from the six 6(60%) source out of the ten sample sources examined suggesting that they are commonly involved in nosocomial infection in general senses as shown in Figure 4. This finding is similar and also in agreement to the findings executed in Zaria and Kaduna metropolis in Nigeria by Aloma *et al.* (2013)[29] and Chrinius *et al.* (2014)[27] respectively that one of the most commonly used surfaces in the hospital environment was found contaminated by *P. aeruginosa* which could be as a result of inadequate decontamination of the surfaces and that *P. aeruginosa* can be isolated from toilet seat and other moist environment in hospitals. Other Gram negative rods include *E. coli* and *Klebsiella* spp constituting 11(44.0%)and 5(20.0%) of the isolates encountered respectively (Figure 5). Therefore the microbiology of bacterial pathogens responsible for nosocomial infections cannot be overemphasized among other bacterial illnesses, it is clearly seen from the present study that a good number of bacterial species are associated with infections acquired in hospital environments; similar studies by Nwankwo and Azeez (2015)[18] shows that, the pattern of bacteria most frequently isolated bacterial pathogens from operating theatres could cause nosocomial infections in patients undergoing surgery abound on inanimate objects in the operating theatre which is one of the environments under consideration in this study.

Moreover, hand swab and other hospitals environments including air evaluated from Federal Medical Centre, City Hospital and Bishop Murray Medical Centre which are public, private and missionary hospital respectively reveals that; of the 21(29.58%) isolates encountered from hand swabs, the profile of bacteria obtained from the hand swab at Federal Medical Centre the nosocomial was highest 12(57.14%) followed by City Hospital Makurdi 5(23.81%) while Bishop Murray Medical Centre has the least profile of 4(19.05%) of nosocomial bacterial pathogens (Table 3). The result obtained from eight surfaces reveals the same profile of nosocomial bacteria 12(32.43%) in private and the public hospital whereas there is a slight increase of one more isolate 13(32.43%) in the missionary hospital (Table 4). With regards to hospital air, the highest profile of nosocomial bacteria was also encountered from Federal Medical Centre 8(61.54%), followed by Bishop Murray Medical Centre 4(30.77%) while City Hospital had just only one isolate 1(7.69%) (Table 4). In addition, Table 6 reveals the profile nosocomial bacteria of the three selected hospitals; of 21(29.58%) isolates from Bishop Murray Medical Centre Makurdi, 10(47.62%)*S. aureus*, 4(19.05%) *Staphylococcus* spp, 2(9.52%)*P. aeruginosa* and 5(23.81%)*E. coli* were obtained. Out of 18(25.35%) bacterial pathogens evolved constituting 12(66.67%) *S. aureus*, 2(11.11%)*Staphylococcus* spp, 1(5.56%) *Pseudomonas aeruginosa* and 3(16.67%)*E.coli* while, the profile of 32(45.07) isolates in Federal Medical Centre Makurdi constituting 14(43.75%)*S. aureus*, 4(12.50%)*Staphylococcus* spp, 6(18.75%) *P. aeruginosa*, 3 (9.38%)*E. coli* and 5(15.63%) *Klebsiella* spp were obtained.The occurrence of these organisms can be associated with their opportunistic tendencies of causing nosocomial infections especially through feacal oral contamination from the hospital environment. It is obvious that isolation of the genera Klebsiella even in hospital air in this present study corroborates the findings of Saani and Amani (2010)[30] in the research done at Khartoun in Sudan where Klebsiella and *E. coli* were isolated as potential pathogenic bacteria from air of hospital-delivery and nursing rooms. Similar investigation by Zakaria *et al*. (2014)[31] on nosocomial bacterial pathogens shows that nosocomial infections are frequent complications of hospitalization, caused by opportunistic pathogens that gain access to hosts undergoing invasive procedures. Incidence of *Klebsiella* spp *and P.aeruginosa* was (7.04%) and (15.50%) respectively suggesting an association with hospital acquired illnesses as had been previously reported by Abdulaziz *et al.* (2015)[28]; *Klebsiella Pneumonia, Pseudomonas aeruginosa* among others are nosocomial bacterial pathogens which has been explained to be responsible for the infections due to variable degree of resistance against commonly used antibiotics. Klebsiella 5(7.04%) of the 71 isolates were encountered in hospital air (Table 4) affirm the fact Klebsiella possess several characteristics some of which are associated with respiratory tract thereby causing infection to the patient with weak immunity. With regards to *P. aeruginosa* associated with nosocomial infections is an extremely virulent organisms because it resists most of the antibiotics employed hence patients can easily be infected with it through hospital environment such as sinks and toilet seat, bed rails nurse table top and even in hospital air among other hospitals environments

(Figure 4); this is result shows consistency to the reports of findings by Tambekar *et al*. (2007)[32]; Saana and Amani (2010)[30]. The antibiotics testing on the nosocomial bacterial pathogens carried out to provide vital information for those whose study antibiotics to which these organisms were sensitive. Although resistance of nosocomial bacterial pathogens against antibiotics are regularly reported; so it is difficult to compare results since variation in methodology may contribute to some extent to these differences. The susceptibility pattern *Staphylococcus* spp shown in Table 6 reveals that the highest level of sensitivity demonstrated by Cloxacillin and Ofloxacin with 50%, followed by Augumetin and Cefuroxime with 40%, Gentamicin (30%), Erythromicin (20%) and least sensitivity with Ceftriazone (10%) while Ceftazidime has highest resistance recorded 0% sensitivity. *E.coli*, highest sensitivity was with Ceftazidime having 81.8% and Gentamicin 63.6%, Ofloxacin also displayed a high level of sensitivity to isolates tested with 63.6% sensitive, followed by Cefuroxime (45.5%), Ceftriazone and Erythromycin constituting 27.3% each (Table 5 and 6). The *in-vitro* antibiotics sensitivity testing reveals that *P. aeruginosa* and Klebsiella strains had considerable resistance to many antibiotic employed. The susceptibility pattern of *P. aeruginosa* reveals resistance to Augumetin, Erythromycin, Ceftriazone and Ceftazidime constituting 0% sensitive were particularly striking (Table 5and 6). A similar finding in which the *P. aeruginosa* were resistant to Augumetin and Ceftazidime had been reported by Yayan *et al*. (2015)[33]. So, the issue of antibiotic-resistant *P. aeruginosa*and *Staphylococcus* spp recovered from Makurdi has been reported by, Aloma *et al*. (2016)[29]; so this present study is also in agreement with their reports[29]. The *Klebsiella* spp strains encountered from this study were highly sensitive to six of the eight antibiotics employed which include Augumetin, Ceftazidime, Ceftriazone, Cefuroxime, Cloxacillin, Gentamicin and Ofloxacin with 80% sensitivity while very high level of resistance was also recorded from the bacteria with 0% sensitive from Erythromycin and Ceftriazone (Table 6). The resistant *Klebsiella* spp were encountered in the air sample of the public hospital environments in Makurdi, Benue State, Nigeria. Further study in this research shows that in Bishop Murray Medical Centre, the cell wall inhibitor drug cloxacillin are highly sensitive to *S. aureus*;while ofloxacin a member of fluoroquinolones which is inhibitors of nucleic acid synthesis also shows a very high sensitivity to the same pathogens at Federal Medical Centre and City Hospital Makurdi. Third generation cephalosporins (Ceftriazone), are active against *P. aeruginosa* in City Hospital Makurdi while erythromycin (macrolides) a member of cell inhibitors of protein synthesis is also active against *Klebsiella* spp in Federal Medical Centrel Makurdi. Gentamicin (an aminoglycosides) and Cefuroxime (Second generation cephalosporins) are active towards *Staphylococcus* spp. Third generation cephalosporins, (Ceftazidime and Ceftriazone), amino glycosides (Gentamicin), fluoroquinolones the inhibitor of nucleic acid synthesis (Ofloxacin and Augmentin) are active against *Escherichia coli*. Therefore, there was a degree of constitency in the *in-vitro* antibiotics susceptibility patterns of the nosocomial bacteria against the commonly used antibiotics employed in this study[34].

Conclusion

This present study reveals that the profile of Gram positive bacteria was more than the profile of Gram negative bacteria in hospitals environment. It also shows a higher profile of bacterial pathogens from the hand swab than air and other surfaces in hospitals. This study also reveals nosocomial bacterial pathogens particularly, *Staphylococcus aureus,Pseudomonas aeruginosa, Staphylococcus* spp *Escherichia coli* and *Klebsiella* spp as the predominant pathogens associated with infections acquired in hospital environments. Antibiotics susceptibility tests indicates the presence of highly resistant species of *Pseudomonas aeruginosa* which suggests the risk of reliance on specific susceptibility patterns of bacteria to antibiotics employed for treatment of nosocomial infections.

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Conflict of Interest

The authors declare that there are no conflicts of interest.

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Data gathering and idea owner of this study: Onifade EO, Aremu SO

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