EFFICACY OF SOME ANTIBIOTICS ON NOSOCOMIAL BACTERIA ISOLATES FROM SELECTED HOSPITALS IN MAKURDI, NIGERIA

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Abstract: Nosocomial bacterial pathogens are bacteria that are responsible for infections acquired from hospitals. The infections could be from an inanimate objects or substances recently contaminated from another human source. Bacteria encountered in the study were isolated on bacteriological media, their biochemical tests were carried out and the antibiotic susceptibility pattern of the bacterial isolates was determined by disc diffusion method. Nosocomial bacteria, particularly, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Staphylococcus species*, *Escherichia coli* and *Klebsiella spp* are the predominant pathogens associated with hospital acquired infections. Hence, the aim of the study is to determine the efficacy of antibiotics on bacterial pathogens associated with nosocomial infections in some selected hospitals from Makurdi, Nigeria. The samples were collected from different surfaces of the selected hospitals environment, isolated and characterized using different cultural, morphological and biochemical tests before carrying out antibiotic susceptibility testing and *in-vitro* determination of antibiotic susceptibility. The efficacy of antibiotic susceptibility pattern on *Staphylococcus species*shows highest level of antibiotic sensitivity which were demonstrated by Cloxacillin and Ofloxacin with 50%; Augumentin and Cefuroxime with 40%, Gentamicin (30%), Erythromycin (20%) and least sensitivity with Ceftriazone (10%) while Ceftazidime has the highest resistance recorded 0% sensitivity. *Escherichia 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%). Therefore, in-vitro antibiotics sensitivity testing further reveals that *Pseudomonas aeruginosa* and *Klebsiella* strains had considerable resistance to many antibiotic employed. Therefore, information on resistance patterns of bacterial pathogens evolved will assist in making improvement in management of nosocomial infections.

Keywords: Bacterial pathogens, antibiotics, resistance patterns, nosocomial infections, susceptibility patterns

Introduction

The ubiquity of bacteria makes it easier for them to survive in different environments of which hospital is not an exception. These organisms are found on different surfaces in hospital and as well as hospital air (Katz, 2004; Leung and Chan, 2006; Traub-Dargatz *et al.,* 2006). They serve as agents of an infection referred to as nosocomial infection. Nosocomial infection is used to describe any infection acquired in hospital environment (Awosika *et al.,* 2012). In other words, nosocomial infections are infections acquired in hospitals by patients who are admitted for a reason other than that infection and which first appear 48 hours or more after hospital admission or within 30 days after-discharge (Ducel *et al*. 2002; ENP, 2005). Nosocomial infections do not affect the general health of patients only, but it also result 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 (Jain *et al.,* 2005; WHO, 2002). These infections affect quite a number of ill-individual across the world leading high death rate; to the extent that a report from WHO (2016) shows that about 15% of all patients in hospitals are being infected with nosocomial infections.

Therefore, most common nosocomial bacterial pathogens include commensal and pathogenic bacteria; commensal bacteria are found in normal flora of healthy humans and have a significant protective role by preventing colonization by pathogenic microorganisms; although some commensal bacteria may cause infection if the natural host immunity is compromised; an example is cutaneous coagulase-negative staphylococci and intestinal *Escherichia coli* (WHO, 2002); while, pathogenic bacteriahave greater virulence and cause infections which are either sporadic or epidemic regardless of host condition (Lepoutre *et al*., 2005; Chikere *et al.,* 2008). Anaerobic Gram-positive rods, Clostridium cause gangrene; while Gram-positive bacteria, *Staphylococcus aureus* causes cutaneous bacteria that colonize the skin andnose of both health care staff and patients and leading to a wide variety of lung, bone, heart and bloodstream infections which are normally resist drugs as in the case of beta-haemolytic Streptococci (Lyytikainen *et al.,* 2005; Pollack, 2010). In people with compromise immunity, Gram-negative bacteria such as *Escherichia coli*, *Proteus*, *Klebsiella*, *Enterobacter*, *Serratia marcescens*may colonize catheter insertion, bladder catheter, cannula insertion or surgical site in the body and then cause severe infections (Abdulaziz *et al.,* 2015; CDC, 2016) while *Pseudomonas* species are often isolated in water and damp areas may localize in the digestive tract of sicked people in hospitals (Aloma *et al.,* 2016; Yayan *et al.,* 2015).

Nosocomial infection is known to be one of the major troubles in public health all over the world, its risk increases on both patients and health care workers; and the effect of the infections is not only on their health but also on their finance (Klevens *et al.,* 2007). Thus, Nosocomial infection has posed a very serious threat to health sector via its transmission through pathogens-host-environment relationship (Liziola *et al.,* 2003).

In Nigeria, despite the fact that hospital acquired infections are serious problems in health care settings and adversely affect the mortality and morbidity regardless of antimicrobial therapy and advances in supportive care (Chirinius *et al.,* 2014; Hammuel, *et al.,* 2015; Nwankwo and Azeez, 2015). Yet there is no proper awareness of these infections to the public (Ige *et al.,* 2011). This study will unveil the seriousness of nosocomial infections and the threat it poses to successful management of health in health care centre as well as the attendant effects on patients, of which little or no previous attempts have been made to investigate in the previoustime.

The aim of the current study is to determine the efficacy of antibiotics on bacterial pathogens associated with nosocomial

infections in some selected hospitals from Makurdi, Benue State. While the objectives of the study includes isolation and characterization of bacteria pathogens from hospital environments, determination of the antibiogram of the bacterial isolates as well as the determination of the minimum inhibitory concentration (MIC) of the antibiotics against the resistant bacteria pathogens isolated from the selected hospitals in Makurdi.

Materials and Methods

The study area

The study area of the work encompasses Bishop Murray Medical Centre (BMMC), City Hospital Makurdi (CHM) and Federal Medical Centre (FMC) all in Makurdi Metropolis of Benue State in Nigeria. These hospitals were selected for the study because many patients visit them.

Study population and ethical approval

This study was conducted in Makurdi metropolis, with samples collected from the hospital environment in three different hospitals in the metropolis. Before the samples were collected, information regarding the study was explained to the individual hospital managements and consent for participation in the study was gotten following the defense before the approval by the ethical committee of the hospitals. Thus, a total number of two hundred and forty (240) samples including hand swab, surface swabs and air samples were taken for the study.

Samplesize

The samples size was determined by the use of the equation described by Naing *et al.*, (2015).

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

Where: N - Minimum sample size; Z - The standard normal distribution at 95% confidence interval = 1.96; P - The known prevalence of the infection from a previous study; d - The desired level of precision or significance which is taken as 5% = 0.05; using the above formula and the prevalence rate "P" of 19.1% from a previous study conducted by Ahoyo *et al.* (2014).

Therefore, N =? $Z = 1.96^2$ P = 19.1% d = 0.05 (5%)

$$N = \frac{1.96^2 \text{ x } 0.191(1-0.191)}{0.05^2}$$

$$N = \frac{1.96 \text{ x } 1.96 \text{ x } 0.191(1-0.191)}{0.05 \text{ x } 0.05}$$

$$N = \frac{3.8416 \text{ x } 0.191\ (0.809)}{0.0025}$$

$$N = \frac{0.7337 \text{ x} 0.809}{0.0025}$$

$$N = \frac{0.5936}{0.0025}$$

$$N = 237.44$$

$$N \approx 240 \text{ samples}$$

Procedure for sterilization

Glare wares such as test-tube, petri-dishes and others were sterilized at 121ºC for 15 minutes by autoclaving.

Sampling design and techniques

Air samples were taken by plate exposure methods for about 20 min while hand and surface swabs were collected using sterile swab sticks. The surfaces analysed include hospital floors, door knobs, nurse table tops, bedrails, stretchers, operation table, toilet seats, sink and hand swab of nurses and some hospital staff for the purposes of isolating microorganisms from these sources and transported to the laboratory for analysis within one hour for a period of five months between October 2016 and February 2017. These samples were inoculated into nutrient agar plates.

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

Cultural method

The 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 was 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); Cheesbrough (2000); Cheesbrough (2006).

Antibiotic susceptibility testingand in-vitro determination of antibiotic susceptibility

Nutrient Agar (NA) medium and commercial multidisc sensitivity discs were used for the susceptibility test following the method described by Clinical Laboratory Standards Institute. The susceptibility testing was performed on isolates based on the agar disc diffusion technique. The suspension of the test organism was prepared by picking parts of similar test organisms with a sterile wire loop. The test organisms were striked uniformly over the NA and exposed to a concentration gradient of antibiotic diffusing from antibiotic impregnated paper disk into the agar medium. The medium was then incubated at 35ºC for 24 h. Grades of susceptibility pattern were recognized as sensitive and resistant by comparison of zone of inhibition as indicated in the manufacturer's guide (CLSI, 2012).

Antibiotic susceptibility of isolates was performed by disk diffusion according to Clinical Laboratory Standards Institute (CLSI, 2012) guidelines**.** The multidisc contained the following antibiotics; Augmentin (AUG) 30 µg, Ceftazidime (CAZ) 30 µg, Ceftriazone (CTR) 30 µg, Cefuroxime (CRX) 10 µg, Cloxacillin (CXC) 10 µg, Erythromycin (ERY) 30 µg, Gentamicin (GEN) 10 µg and Ofloxacin (OFL) 5 µg. 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.

Results and Discussion

The distribution of the isolates in relation to the sample size analysed from the selected hospitals in Makurdi reveals total of seventy-one bacteria pathogenswhich include 21(29.58%), 37(52.11%) and 13(18.31%) were cultured from hand swabs, surfaces of hospital environments and hospital air respectively. Two-hundred and forty samples were tested for efficacy of antibiotics on nosocomial bacteria in hospitals. Thus, 97(40.4%) were collected from hand palm of nurses and

some of the hospital staff, 104(43.3%) were from various surfaces in the three selected hospitals; whereas, 39(16.3%) of the samples' collected were from air sample as shown in Table 1.

Table 1: Distribution of the isolates in relation to the source in hospitals environment in Makurdi metropolis

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

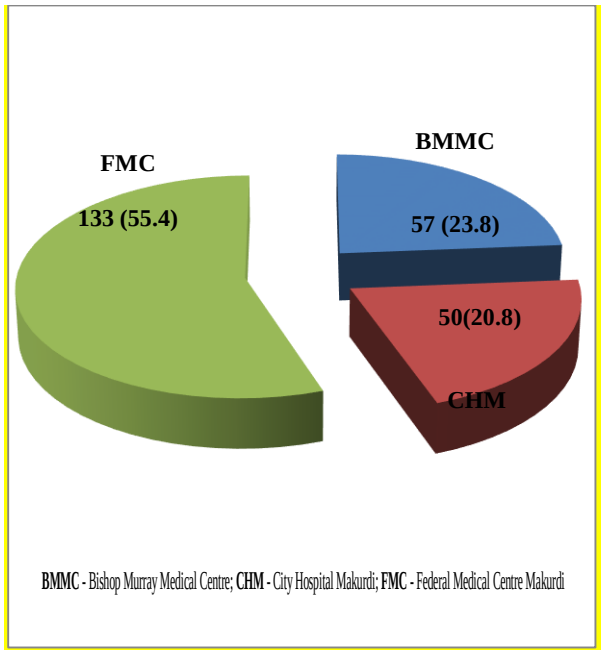

Fig. 1: Distribution of the samples size from the hospitals environments in Makurdi metropolis

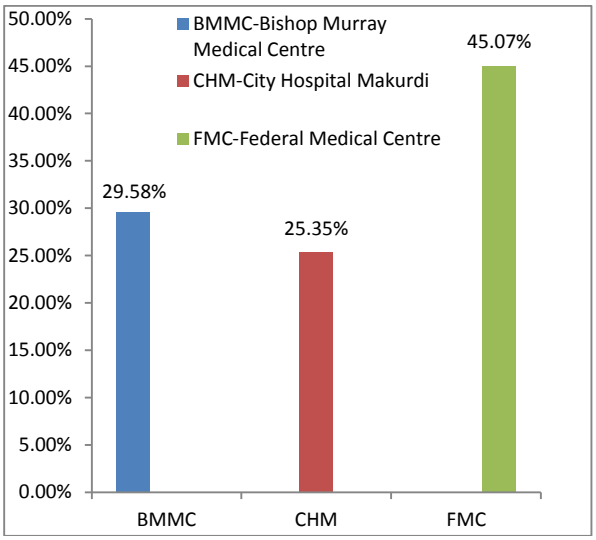

Fig. 2: Occurrence of positive of nosocomial bacterial pathogens from the three selected hospitals within Makurdi metropolis

Incidence of bacterial isolates in relation to hospitals in Makurdi

The data represented in Fig. 1 is distribution of the samples size from the hospitals environments in Makurdi metropolis, this was informed by the size of the hospitals used for the study while Fig. 2 reveals the frequency of the bacteria responsible for nosocomial infections in each of the selected hospitals. This in every way agrees with the studies carried out by Pollack (2010) on growing disease that can be acquired in hospitals and the drug-resistant strain of different bacteria pathogens. It can be observed that 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.

Profile of comparison of nosocomial bacteria in relation to the three selected hospitals in Makurdi

Nosocomial bacterial pathogens as shown in Table 2 reveals that, 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*; whereas 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%) *Escherichia coli*, while the isolates evolved from 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* species. 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%).

Table 2: Comparison of nosocomial bacteria in the three selected hospitals in Makurdi

Hospitals	*S. aureus* (%)	*S.*species (%)	*P. aeruginosa* (%)	*E. coli* (%)	*K.* species (%)
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 incidence of nosocomial bacterial pathogens in relation to sample source and hospitals in Makurdi metropolis

The data in Table 3 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 isolates that evolved from the surface swabs 13(35.14%) emerged from BMMC showing the highest profile 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 3. 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 isolated from bed rails and nurse table top while two were from sinks. In City Hospital Makurdi one *Staphylococcus* species was cultured from hand swab and toilet seats; while at Federal Medical Centre profile of *Staphylococcus* species constituting three at hand palm and one from bed rails.

Antibiogram of bacteria isolates from Hospitals in Makurdi

The data in Table 4 represent antibiogram of bacteria isolates from hospitals in Makurdi. Thus the susceptibility patterns of the bacteria pathogens isolates evolved from three selected hospitals in Makurdi shows that 50(70.4%) and 33(46.5%) isolates were sensitive to Ofloxacin (OFL) and Cloxacillin (CXC) respectively, while 30 isolates each were resistant to Augumetin (AUG) and Gentamicin (GEN) suggesting that the four antibiotics would be very useful for combating nosocomial bacterial pathogens. There may be only a slight variation when compared to other works.

Table 3: Incidence of nosocomial bacterial pathogens in relation to sample source from the three selected hospitals in Makurdi

Sample Source	HOSPITALS			Total positive Isolates (%)	*Staphylococcus aureus*	*Staphylococcus* species	*P. aeruginosa*	*Klebsiella* species	*Escherichia coli*
	BMMC Isolates	CHM Isolates	FMC Isolates						
HS	4	5	12	21(29.6)	6(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)	(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)	(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

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

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

Multidrug resistance bacteria isolates in Hospitals in Makurdi

Table 5 shows themultidrug resistance bacteria isolates in selected hospitals in Makurdi. Out of the 36 *Staphylococcus aureus* isolates, 30(83.3%) constituting 5(13.9%), 7(9.4%) and 18(50%) isolates were multi-resistant to 3(37.5), 4(50%) and 5(62.5%) or more of the eight antibiotics employed respectively. 2(20%), 3(30%) and 5(50%) isolates of 10 *Staphylococcus* species were multi-resistant to three, four and five or more antibiotics of the eight antibiotics. Whereas, 9 *Pseudomonas aeruginosa* evolved were resistant to 5(62.5%) or more antibiotics employed; while 3(27.3%), 1(9.1) and 5(45.5%) out of 11 isolates of *Escherichia coli* were multi-resistance to 3(37.5%), 4(50%) and 5(62.5%) or more of the eight antibiotics employed. Whereas, with regards to *Klebsiella* species none was resistant to 4(50%) antibiotics but 1(20%) was resistant to 3(37.5) and 5(62.5%) or more antibiotics employed each. This is congruent with other studies on Drug resistance in bacterial pathogens such as studies by Levy, (1993) shows that bacteria have caused a lot of harm against antimicrobial drug. Nonetheless, Nwachukwu *et al.* (2009) point of view was that resistance to antibiotics was due to misuse of drugs exclusive of doctor's recommendation. Further investigations by Nwachukwu *et al.* (2009) on antibiotics susceptibility patterns, shows that antibiotic susceptibility of Staphylococcus aureus were; ciprofloxacin (60%), erythromycin (40%), gentamicin (60%), streptomycin (60%). Also Investigations by Atata *et al.* (2013) suggest that, there is a tendency of progression in increasing order; rather than retrogression order in antimicrobial drugs use in health care centre. So, extended - spectrum cephalosporin, vancomycin, metronidazole, and amphotericin B have been observed.

Wide use of antibiotics in health care settings, whether suitable or not, has reflective effect on those who receive the drugs as well as the bacterial pathogens, (WHO 2002).

The efficacy of antibiotics 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 bacteria 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 of *Staphylococcus* species in Table 4 reveals the highest level of sensitivity demonstrated by Cloxacillin and Ofloxacin with 50% each, followed by Augumetin and Cefuroxime with 40%, Gentamicin (30%), Erythromicin (20%) while the least sensitivity with Ceftriazone (10%). But,Ceftazidime has highest resistance recorded 0% sensitivity. The efficacy of antibiotics on *Escherichia coli* from the reveals that 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, followed by Cefuroxime (45.5%), Ceftriazone and Erythromycin constituting 27.3% each (Table 4 and 5). Further investigation on the efficacy of antibiotics on*Pseudomonas aeruginosa* and *Klebsiella* strains shows that the two both microorganisms had considerable resistance to many antibiotic employed. Thus, susceptibility pattern of *Pseudomonas aeruginosa* reveals resistance to Augumetin, Erythromycin, Ceftriazone and Ceftazidime constituting 0% sensitive were particularly striking as shown in Table 4and 5. A similar finding in which the *Pseudomonas aeruginosa* were resistant to Augumetin and Ceftazidime had been reported by Yayan *et al*. (2015). So, the issue of antibiotic-resistant*Pseudomonas aeruginosa*and *Staphylococcus* species recovered from Makurdi has been reported by, Aloma *et al*. (2016); so this present study is also in agreement with the reports of Aloma and others, Aloma *et al*. (2016). The *Klebsiella* strains encountered from this study were highly sensitive to 6(75%) 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 in Table 5. The resistant *Klebsiella* species 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 *Staphylococcus 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 Centre Makurdi. Gentamicin (an aminoglycosides) and Cefuroxime (Second generation cephalosporin) are active towards *Staphylococcus* spp. Third generation cephalosporin, (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 consistency in the *in-vitro* antibiotics susceptibility patterns of the nosocomial bacteria against the commonly used antibiotics employed in this study.

Conclusion

In a nutshell, the study reveals the presence of highly resistant species of *Pseudomonas aeruginosa*in the selected hospitals which should make any clinician carry out further investigation to combat the bacteria. This has confirmed the fear of present day clinical researchers on the issue of infections caused by Multi drug resistant pathogens also known as Superbug infections, which has resulted in the consideration of an alternative treatment procedure known as Phage Therapy – a more selective approach to antimicrobial therapy. Also, this research 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.

References

Abdulaziz Z, Atef A, Abdulhakim G, Ashrf A & Sami H 2015. Prevalence of device-associated nosocomial infections caused by gram-negative bacteria in a Trauma Intensive Care Unit in Libya. *Oman Medical Journal*, 30(4): 270–275.

Aloma AA, Olonitola OS & Jatau ED 2016. Isolation, characterization and antibiotic susceptibility patterns of *Pseudomonas aeruginosa* and *Staphylococcus aureus* from hospital environment in Kaduna Metropolis, Kaduna State. *Int. J. Scientific and Res. Publications*, 6(4): 141.

Awosika SA, Olajubu FA & Amusa NA 2012. Microbiological assessment of indoor air of a teaching hospital in Nigeria. *Asian Pacific Journal of Tropical Biomed.*, 465-468.

CDC Atlanta, Georgia 2016. Diseases and Organisms in Healthcare Settings. Healthcare-associated infections (HAIs) [Online] Available from: https://www.cdc.gov/hai/organisms/organisms.html [Accessed on 10th August, 2016]

Cheesbrough M 2000. District Laboratory Practice Manual in Tropical Countries Part 2, pp.178-179. Cambridge University Press.

Cheesbrough M 2006. District Laboratory Practice Manual in Tropical Countries Part 2, pp.157-180. Cambridge University Press.

Chikere CB, Omoni VT & Chikere BO 2008. Distribution of potential nosocomial pathogens in a hospital environment. *African J. Biotechn.*, 7(20): 3535-3539.

Chrinius H, Edward DJ & Clemen MZW 2014. Prevalence and Antibiogram Pattern of Some Nosocomial Pathogens Isolated from Hospital Environment in Zaria, Nigeria. *Aceh Int. J. Sci. & Techn*., 3(3): 131-139.

Clinical & Laboratory Standards Institute 2012. Performance standards for antimicrobial suscep-tibility testing. Twenty-second Informational Supplement. CLSI/ NCCLS M100–S22. Wayne, PA: Clinical and Laboratory Standards Institute.

Ducel L, Fabry J & Nicolle L 2002. Guide pratique pour la tutte contreed. Prevention and Control of Nosocomial Infection

English National Point 2005. Prevalence Survey on Healthcare-associated Infections and Antimicrobial Use." *(PDF). Health Protection Agency*. `Retrieved 28 November 2015.

Federaal Kenniscentrum voor de Gezondheidszorg 2009. Nosocomiale Infecties in België, deel II: Impact op Mortaliteiten Kosten. KCE-rapport 102A.

Hammuel C, Idoko MO, Migap HH & Ambrose N 2015. Occurrence and antibiogram profile of *Staphylococcus aureus* isolated from some hospital environment in Zaria, Nigeria. *African J. Microbio. Res.*.9(19): 1304-1311.

Harley & Prescott 2002. Laboratory Exercises in Microbiology, Fifth Edition. *Bacterial Morphology and Staining*, pp. 38-39.

Jain SK, Persaud D, Perl TM, Pass MA, Murphy JM, Scholl PF, Casella JF & Sullivan DJ 2005. Nosocomial Malaria and Saline Flush. *Emerging Infect. Dis*., 11(7): 1097–1099.

Klevens RM, Edwards JR, Richards CL, Horan TC, Gaynes RP, Pollack DA & Cardo DM 2007. Estimating Health Care-Associated Infections and Deaths in U.S Hospitals, 2002. *Public Health Reports*,122: 160-166.

Lepoutre A, Branger B, Garreau N, Boulétreau A, Ayzac L, Carbonne A, Maugat S, Gayet S, Hommel C & Parneix P 2005. Tran B pour le Réseau d'alerte, d'investigation et de surveillance des infections nosocomiales (Raisin). Deuxième enquête nationale de prévalence des infections nosocomiales, France, 2001, Surveillance nationale des maladies infectieuses, 2001-2003. Institut de veille sanitaire, 11 pp. Résumé.

Liziolia A, Privitera G, Alliata E, Antonietta Banfi EM, Boselli L, Panceri ML, Perna MC, Porretta AD, Santini MG & Carreri V 2003. Prevalence of nosocomial infections in Italy: Result from the Lombardy survey in 2000. *Journal of Hospital Infections*, 54: 141-8.

Lyytikainen O, Kanerva M, Agthe N & Mottonen T 2005. The Finish Prevalence Survey Study Group. National Prevalence Survey on Nosocomial Infections in Finnish Acute Care Hospitals. *10th Epiet Scientific Seminar*. Mahon, Menorca, Spain.

Nwachukwu NC, Orji FA & Okike UM 2009. Antibiotic susceptibility patterns of bacterial isolates from surgical wounds in Abia State University Teaching Hospital (ABSUTH), Aba-Nigeria. *Res. J. Med. and Medical Sci.*, 4(2): 575-579.

Nwankwo EO & Azeez OA 2015. Microbial contamination in the operating theatre of a tertiary health institution in Kano, Northwestern Nigeria. *Nig. J. Microbiology*, 27(1): 2671-2679.

Rania MK, Mohamed FM, Rasha MF, Ahmed I & Nader AN 2014. Pattern of Blood Stream Infections within Neonatal Intensive Care Unit, Suez Canal University Hospital, Ismailia, Egypt. *International Journal of Microbiology*, Article ID 276873, 6 pages.

Saana OY & Amani E 2010. Isolation of potential bacteria from the air of hospital –delivery and nursing room. *Journal of Applied Science.* ISSN 1812-5654.

Sax H & Pittet D 2005. pour le comité de rédaction de Swiss-NOSO *et le* réseau Swiss-NOSO Surveillance. Résultats de \ l'enquête nationale de prévalence des infections nosocomiales de 2004 (snip04). *Swiss-NOSO*, 12(1): 1-4.

Tambekar, D.H., Gulhane, P.B. and Bhokare, D.D. (2007). Studies on environmental monitoring of microbial air flora in hospitals. *Journal of Medical Scences* 67-73

Theodore CE 1998. Antibiotics and nosoconial infection in hospital infection 4th edition. *Lippincott- Reven Publishes*.

WHO 2016. The burden of health care-associated infection worldwide. [Online] Available from: http://www.who.int/gpsc/country_work/burden_hcai/en/ [Accessed on 10th August, 2016]

Yayan J, Ghebremedhin B & Rasche K 2015. Antibiotic Resistance of *Pseudomonas aeruginosa* in Pneumonia at a Single University Hospital Center in Germany over a 10-Year Period. *PLoS ONE* 10(10): e0139836. https://doi.org/10.1371/journal.pone.0139836.

Baka ZA, Abou MI, Ahmed D. El-Sayed KA & Badawy SA 2014. Isolation and characterization of some multi-antibiotic resistant bacterial pathogens associated with nosocomial infections. *Scientific J. Damietta Faculty of Sci.*, 3(1): 33-42.