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ASSESSMENT OF INDOOR AIR BACTERIAL LOAD AND ANTIBIOTIC SUSCEPTIBILITY PROFILE OF BACTERIA FROM SOME HOSPITALS IN DUTSE, JIGAWA STATE

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ABSTRACT
Indoor air microbial communities play significant roles on the increase in hospitals acquired infections globally. In view of the importance of indoor air bacterial quality in the transmission of nosocomial infections, a study was conducted to assess the indoor air bacterial load and antibiotic susceptibility profile of bacteria from some hospitals in Dutse, Jigawa State. A total of 114 air samples were collected and analyzed using standard procedures from wards and units of Rasheed Shekoni Teaching Hospital Dutse, General Hospital Dutse and Primary Health Care Centre Shuwarin. Settling plate technique was employed and sampling was done twice daily (Morning and Afternoon). Aerobic mesophilic bacterial counts were conducted. Isolates were identified according to standard methods. The Medical Surgical Ward (MSW) revealed the highest airborne bacterial count ($2.770x10^3$ CFU/m^3), while the Operation Theaters (OT) revealed the least airborne bacterial count ($8.1x10^1$CFU/m^3). General Hospital Dutse was found to have higher indoor air bacterial load than Rasheed Shekoni Teaching Hospital and Primary Healthcare Centre Shuwarin. Airborne Gram positive cocci were the most frequently detected (100%) in all the indoor environments. Staphylococcus aureus, Klebsiella pneumoniae, Proteus mirabilis and Escherichia coli were the bacterial species identified in the study. It was observed that the bacterial isolates were more susceptible to gentimicin. The findings revealed the presence of five (5) methicillin resistant Staphylococcus aureus isolates (MRSA) 60% in Male Medical Ward (MMW), 20% in Female Medical Ward (FMW), and 20% in Post-natal Ward (PNW). In conclusion, 84.2% of the hospitals' units were having aerobic mesophilic bacterial counts within the acceptable limits. It is recommended that disinfection of male, female and post-natal wards should be intensified.
Key words: Indoor Air, Bacterial Load, Bacterial Counts, Antibiotics, MRSA, Hospital

INTRODUCTION

Good hospital indoor air quality is important towards the prevention and control of hospital acquired infections and various occupational hazards. It has been reported that between 17-25% of nosocomial infections are respiratory tract infections (Chin-seng *et al.,* 2009; Zemichael *et al.,* 2016). Microorganisms are discharged into the air as infectious droplets, droplet nuclei and infectious dust. Droplets are usually generated by sneezing, coughing or talking, which involve saliva and mucus while droplet nuclei are formed when small liquid droplets evaporate. The main sources of indoor bioaerosols in health care settings include patients, patient family members and healthcare personnel (Chin-seng *et al.,* 2009). Dusts are also released into the air during activities such as sweeping, tillage of the soil, movement of heavy vehicles, blasting of stone and air turbulence (Mende *et al.,* 2014).

Indoor Air Quality can be affected by microbial contaminants (mold, bacteria), or any mass or energy stressor that can induce adverse health conditions (WHO, 2009).

Poor hospital indoor air quality (IAQ) may lead to nosocomial infections and sick hospital syndrome (Sandra *et al.,* 2015). Measures are crucial for reducing dissemination of airborne biological particles in hospital (Cabo *et al.,* 2015). The health and well being of the public/patients may be affected by the biological properties of the indoor environment; however the quality (of the indoor environment) is not easily defined or controlled and can potentially placed human occupants at risk. Studies conducted globally have shown that the indoor bacterial loads of many wards and units of many hospitals are above the WHO (2005) acceptable limits (1.0×10^3 CFU/M^3).

High indoor air bacterial load of up to 1271CFU/M^3 was observed in medical ward at Gonder Teaching Hospital, Northwest, Ethiopia (Zemichael *et al.,* 2016), likewise, some levels of indoor air bacterial contaminations were observed in some hospitals in Portugal (Sandra *et al.,* 2015). In Nigeria, the findings of the works of Kenneth and Best (2016) in some tertiary hospitals in South-south and Agwaranze *et al.* (2020) in a General Hospital in North-Eastern Nigeria revealed higher bacterial loads in the indoor air of some wards and units. The most bacteria encountered in the hospital indoor air include, *S. aureus, K. pneumoniae, S. pneumoniae, S. pyogenes, Bacillus* spp., *Proteus mirabilis, Pseudomonas aeruginosa*, micrococci and *E. coli* among others. The study was aimed at assessing the indoor bacterial quality, antibacterial sensitivity profile and detection of MRSA from some hospitals in Dutse Emirate, Jigawa State.

MATERIALS AND METHODS

Study Area

The study was carried out in Dutse, Jigawa State. It is one of thirty-six states that constitute Federal Republic of Nigeria.

History of the Hospitals

Rasheed Shekoni Teaching Hospital Dutse

Rasheed Shekoni Teaching Hospital Dutse was established on 17th March, 2011 as a specialist hospital for Jigawa State, but late 2017 the hospital was converted to a teaching hospital of Federal University Dutse (F.U.D). The hospital is currently a 350 beds capacity tertiary health facility.

General Hospital Duste

The hospital was established in 1972 as Dutse Comprehensive Health Care (CHC) by old Kano State government. The CHC was on 8th August 1985, converted to Dutse General Hospital. The hospital is currently a 200 beds capacity secondary health facility.

Primary Health Care Center Shuwarin

The hospital was established in February, 2010 by then Governor of Jigawa State Alh. Sule Lamido.

Sampling Sites

The sampling sites were: - Operation Theatres, Consultation rooms, and Wards (Male and Female Medical, Male and Female Surgical, Post-natal and Paediatric) of the Hospitals.

Ethical Clearance

Institutional ethical approval was obtained for this research from the Jigawa State Ministry of Health and Rasheed Shekoni Teaching Hospital.

Sampling Sites and Sample Collection

The sampling sites were: - Operation Theatres, Consultation rooms, and Wards (Male and Female Medical, Male and Female Surgical, Post-natal and Paediatric) of the Hospitals.

Total numbers of 114 samples for bacteriological analysis were collected using settle plate technique at the height of one meter and 1 meter away from walls. Nutrient Agar (NA) plates were used for total viable bacterial counts. The plates were exposed to the air for 30 minutes (Bogomolova *et al.,* 2009; Borrogo *et al.,* 2010). Samples were collected in duplicates in the morning (from 8:00 a.m. to 10:00am) and in the evening (from 4:00pm to 6pm). After exposure, plates were immediately conveyed to the laboratory and incubated for 24 hours at 37°C (Cheesbrough, 1991). During each sampling, triplicate air samples were collected from the hospital rooms (First portion after entrance of the room, center of the room and the end of the room). Due to large number and sizes of sampling sites at RSTHD and GHD, samples were taken weekly for a period of 3 weeks, while samples were collected at PHCS for a period of one week.

Isolation and Identification of Indoor Air Bacteria

A distinctive colony from mixed culture was picked using a sterile wire loop and placed on a fresh nutrient agar medium. After streaking, the Petri dish was incubated for 24 hours at 37°C. All isolates from this pure culture were maintained in an agar slant for further analyses. Bacterial isolates were identified according to their physical (colonial) and biochemical characteristics (Manga and Oyeleke, 2008).

Gram Staining and Biochemical Tests

Gram staining was carried out as described by Cheesbrough (2004). Isolates were identified as Gram positive when they appeared blue, while Gram negative appeared red. Biochemical tests such as motility test, catalase, citrate utilization, coagulase, indole, voges proskauer, urease, and methyl red were carried out to identify the bacteria as described by Manga and Oyeleke (2008).Antimicrobial Susceptibility Testing of Indoor Air Bacterial Isolates.

Standardization of Test Organisms

A sterile loop was used to pick a loopful of freshly (24 hours) grown bacterial culture of each isolalate. This was then transferred and suspended in a tube of sterile normal saline (NaCl 8.5g, distilled water 1 litre). The tube was compared with the 0.5 McFarland turbidity standard (1.5×10^8).

Antibiotics susceptibility of each bacterial isolate was determined by the disk diffusion method (Kirby-Bauer) according to the Clinical and Laboratory Standards Institute (CLSI, 2012) recommendations, using Mueller-Hinton medium. Standardized bacterial inoculum was used to inoculate the entire surface of a Mueller-Hinton agar plate. In order to allow the medium to absorb excess moisture, the plate was kept for 5 minutes and appropriate antibiotic test disks were placed using sterile forceps. The plates were incubated at 37 °C for 24 hours. The diameters of the zones of inhibition were measured and recorded in millimetres and the values obtained were compared with those of the interpretive chart for standardization, reporting the organism as resistant, intermediate or susceptible as revealed by CSLI (2012).

Identification of methicillin resistant *Staphylococcus aureus* (MRSA) strains

All the *S aureus* identified in the study were subjected to MRSA using the protocols of CLSI (2012). Methicillin resistant *Staphylococcus aureus* (MRSA) was identified by using oxacillin (1 µg) and cefoxitin (30 µg) disks. Plates were incubated at 35°C. Plates containing oxacillin disk were read following a 24 hour incubation period. The diameter of the zone of inhibition (ZOI) of growth was recorded and interpreted as susceptible or resistant according to the criteria of CLSI. *Staphylococcus aureus* isolates were deemed methicillin resistant when the ZOI was ≤10 mm with the oxacillin disk or ≤21 mm with the cefoxitin disk.

Detection Methicillin Resistance Gene

All the MRSA isolates were confirmed by molecular analyses as described by CLSI (2012). The processes involved DNA extraction, amplification using polymerase chain reaction electrophoresis and products viewed and picture of bands was taken.

Statistical Analyses

Results obtained in the study were analyzed using t-test, analyses of variance (one-way and two-way).

RESULTS

Mean Aerobic Mesophilic Bacterial Counts (CFU/ m^3) in locations at Rasheed Shekoni Teaching Hospital, General Hospital Dutse and Primary Health Care Centre Shuwarin were assessed. MSW1 ($2.770x10^3$) in the morning in Rasheed Shekoni Teaching Hospital Dutse (RSTHD) recorded the highest indoor airborne bacterial population and closely followed by MMW ($1.385 x10^3$) in the evening and FSW1 ($1.022x10^3$) in the evening. In General Hospital Dutse (GHD), similarly the MSW ($6.67x10^2$) in the morning recorded the highest airborne bacteria followed by MMW ($5.40x10^2$) in the morning and FMW ($4.74x10^2$) in the morning, but in Primary Health Care Centre Shuarin (PHCS) the Consultation room (CR)($4.29x10^2$) in the evening recorded the highest airborne bacteria followed by MMW ($4.28x10^2$) in the evening and FMW ($2.96x10^2$) in the evening (Table 1).

The biochemical characterizations of bacterial isolates indicated the presence of *Staphylococcus aureus, Klebsiella pneumoniae, Proteus mirabilis,* and *Escherichia coli* (Table 2).

The frequency of occurrence of bacterial isolates from sampled units, in Rasheed Shekoni Teaching Hospital, General Hospital Dutse and Primary Health Care Centre Shuwarin, shows that *Staphylococcus aureus* (45.78%), was the most frequently isolated bacterium followed by *Klebsiella pneumoniae* (25.30%), *Proteus mirabilis* (16.87%) and *Escherichia coli* (13.25%) (Table 3, 4 and 5).

The findings revealed the presence of Methicillin resistance *Stayphylococcus aureus* in some units of the hospitals such as Male medical wards, Female medical ward and Post-natal ward (Table 6).

It was observed that most of the isolates were sensitive to the antibiotics tested. Oxacillin and Cefoxitin were effective to some *S. aureus* isolates from female surgical wards, operation theatres, consultation rooms and paediatric wards, while those antibiotics were found not effective against *S. aureus* isolates sourced from male and female medical wards and postnatal ward. The isolates were susceptible to Gentamicin, Co-trimoxazole, Ofloxacin, Ceftriaxone and Levofloxacin, however, the isolates were not susceptible to Netillin, Tetracycline, and amoxyclav (Table 7, 8, 9, 10).

Five isolates of *S. aureus* were confirmed by molecular analysis as MRSA; they include 3 isolates from male medical wards, one isolate each from female medical and post natal wards respectively plate I.

Table 1: Mean Aerobic Mesophilic Bacterial Counts (CFU/ m^3) at some sections of Rasheed Shekoni Teaching Hospital, General Hospital Dutse and Primary Health Care Centre Shuwarin.

	Sampling Duration			
	8:00am – 10:00am Morning	4:00pm – 6:00pm Evening	Mean	WHO (2005) LMT.
Sampling sites	Counts	Counts		
MMW1	$5.19x10^2$	$1.385 x10^3$	$9.52×10^2$	$1.0×10^3$
MMW2	$5.40x10^2$	$4.22x10^2$	$4.73×10^2$	
MMW3	$3.85x10^2$	$4.28x10^2$	$4.01×10^2$	
MSW1	$2.770x10^3$	$6.22x10^2$	$1.696×10^3$	
MSW2	$6.67x10^2$	$6.22x10^2$	$6.45×10^2$	
FMW1	$3.33x10^2$	$3.18x10^2$	$3.26×10^2$	
FMW2	$4.74x10^2$	$4.37x10^2$	$4.56×10^2$	
FMW3	$2.88x10^2$	$2.96x10^2$	$2.92×10^2$	
FSW1	$3.11x10^2$	$1.022x10^3$	$6.67×10^2$	
FSW2	$3.85x10^2$	$2.81x10^2$	$3.33×10^2$	
PNW1	$4.66x10^2$	$3.26x10^2$	$3.96×10^2$	
PNW2	$3.26x10^2$	$3.63x10^2$	$3.45×10^2$	
PEAD. W1	$3.18x10^2$	$2.59x10^2$	$2.89×10^2$	
PEAD. W2	$3.55x10^2$	$3.85x10^2$	$3.70×10^2$	
OT1	$1.04x10^2$	$8.8x10^1$	$9.6×10^1$	
OT2	$8.1x10^1$	$6.7x10^1$	$7.4×10^1$	
CR1	$4.59x10^2$	$1.33x10^2$	$2.96×10^2$	
CR2	$1.85x10^2$	$1.19x10^2$	$1.52×10^2$	
CR3	$3.85x10^2$	$4.29x10^2$	$4.07×10^2$	

P=0.5708

Key: MMW= Male Medical Ward, MSW= Male Surgical Ward, FMW= Female Medical Ward, FSW= Female Surgical Ward, PNW= Post-natal Ward, PEAD. W= Peadiatric Ward, OT= Operations Theatre, and CR= Consultation room, 1= Rasheed Shekoni Teaching Hospital Dutse, 2= General Hospital Dutse, 3= Primary Health Care Centre Shuwarin.

Table 2: Biochemical Characteristics of Bacterial Isolates

		Biochemical Characteristics										
S/No	**Microscopic Morphology**	**Grm**	**H_2S**	**Ca**	**Co**	**Mr**	**Vp**	**Ind**	**Cit**	**Ur**	**Mo**	**Organisms Identified**
1.	Cocci in bunches	+	-	+	+	+	+	-	+	+	-	*S. aureus*
2.	Rod –shaped	-	+	+	-	+	-	-	+	+	+	*P. mirabilis*
3.	Short rod	-	-	+	-	+	-	+	-	-	+	*E. coli*
4.	Rod-shaped	-	-	+	-	-	+	-	+	+	-	*K. pneumoniae*

Key: NA= not applicable; - = Negative, + = Positive, Gram's stain (Grm), Catalase (Ca), Oxidase test (Ox), Methyl red test (Mr), Voges proskauer test (VP), Indole (Ind), Citrate (Cit), Urease (Ur), Coagulase (Co), Motility (mo), Hydrogen sulphide (H_2S).

Table 3: Frequency of Occurrence of Isolates from Units of Rasheed Shekoni Specialist Hospital Dutse.

	UNITS							
Isolates	MMW	MSW	FMW	FSW	PNW	PAED.W	CR	OT T
S. aureus	3	2	3	1	2	1	2	1
K. pneumoniae	1	2	1	1	-	-	2	2
Escherichia coli	-	-	-	1	1	2	-	-
Proteus mirabilis	-	-	-	1	1	1	-	-

Key: MMW= Male Medical Ward, MSW= Male Surgical Ward, FMW= Female Medical Ward, FSW= Female Surgical Ward, PNW= Post-natal Ward, PEAD. W= Peadiatric Ward, OT= Operations Theatre, and CR= Consultation room

Table 4: Frequency of Occurrence of Isolates from Units of General Hospital Dutse.

	UNITS							
Isolates	**MMW**	**MSW**	**FMW**	**FSW**	**PNW**	**PAED.W**	**CR**	**OT**
S. aureus	1	1	4	1	3	2	1	1
K. pneumoniae	3	1	-	1	-	-	2	1
Escherichia coli	-	2	-	-	-	1	-	-
P. mirabilis	-	-	-	2	1	1	1	-

Key: MMW= Male Medical Ward, MSW= Male Surgical Ward, FMW= Female Medical Ward, FSW= Female Surgical Ward, PNW= Post-natal Ward, PEAD. W= Peadiatric Ward, OT= Operations Theatre, and CR= Consultation room.

Table 5: Frequency of Occurrence of Isolates from Units of Primary Health Care Centre Shuwarin

	UNITS		
Isolates	**MMW**	**FMW**	**CR**
Staphylococcus aureus	2	4	3
Klebsiella pneumoniae	1	1	2
Escherichia coli	1	2	1
Proteus mirabilis	-	3	2

Key: MMW= Male Medical Ward, FMW= Female Medical Ward, and CR= Consultation room.

Table 6: Occurrence of MRSA from Sampled Units of the Hospitals

		UNITS/ PERCENTAGE OF OCCURRENCE		
Isolates	**No. Iso.**	**MMW**	**FMW**	**PNW**
MRSA	5	3(60%)	1(20%)	1(20%)

Key: MMW= Male Medical Ward, FMW= Female Medical Ward, PNW= Post-natal Ward, Iso = Isolates,

Table 7: Susceptibility profile (mm) of the *Staphylococcus aureus* Isolates to some Antibiotics

Isolates No.	**OX (1µg)**	**FOX (30µg)**	**CTR (30µg)**	**GEN (10µg)**	**COT (25µg)**	**TE (30µg)**	**AMC (30µg)**
MMW1	0	13	18	20	24	11	0
MMW2	0	22	24	23	22	13	0
MMW3	10	19	24	19	16	11	0
FMW1	0	23	17	22	22	22	0
FMW2	15	21	16	16	20	15	0
FMW3	13	15	23	17	15	18	0
MSW1	15	19	15	15	20	14	0
FSW2	17	28	22	18	15	10	0
PNW1	19	24	23	19	16	12	0
PNW2	0	12	20	21	23	16	0
PEAD.W2	11	24	25	20	19	12	0
CR1	17	26	24	19	22	16	0
CR2	16	27	25	15	24	13	0
CR3	15	22	23	20	21	14	0
OT1	18	29	27	16	18	17	0
OT2	18	25	24	18	20	15	0

Key: OX = Oxacillin, FOX = Cefoxitin, CTR = Ceftriaxone , GEN = Gentamicin, COT = Co-trimoxazole, TE = Tetracycline, AMC = Amoxyclav, mm= milimetre.

Table 5b: Susceptibility profile (mm) of the *Klebsiella pneumoniae* Isolates to some Antibiotics

Isolates No.	CTR (30µg)	GEN (10µg)	COT (25µg)	LE (5µg)	NET (30µg)	TE (30µg)	AMC (30µg)	OF (5µg)
MMW1	17	32	15	18	0	19	0	30
MMW2	24	16	11	21	13	14	0	29
MMW3	26	20	10	18	15	11	0	22
MSW1	23	25	18	22	0	13	0	24
MSW2	20	18	18	24	14	20	0	24
FMW1	15	22	20	25	11	10	0	22
FMW3	15	16	11	21	0	18	0	27
FSW1	11	26	0	0	16	16	0	26
FSW2	10	24	0	0	20	16	0	28
CR1	16	23	10	20	12	11	0	21
CR2	21	17	16	23	10	17	0	20
OT1	24	28	21	26	10	17	0	28
OT2	19	19	14	13	11	21	0	25

Key: CTR = Ceftriaxone, GEN = Gentamicin, COT = Co-trimoxazole, LE = Levofloxacin, NET = Netillin, TE = Tetracycline, AMC = Amoxyclav, OF = Ofloxacin, mm= milimetre

Table 5c: Susceptibility profile (mm) of the *Proteus mirabilis* Isolates to some Antibiotics

Isolates No.	CTR (30µg)	GEN (10µg)	COT (25µg)	LE (5µg)	NET (30µg)	TE (30µg)	AMC (30µg)	OF (5µg)
FMW3	26	15	11	24	21	21	0	23
FSW1	24	25	20	21	23	21	0	28
FSW2	25	15	11	25	20	12	0	21
PNW1	27	23	27	23	22	12	0	30
PNW2	24	20	15	25	18	20	0	27
PAED. W1	30	22	11	24	23	10	0	30
PAED. W2	29	18	09	30	15	15	0	25
CR1	30	25	18	22	20	11	0	30
CR3	23	16	20	26	17	10	0	24

Key: CTR = Ceftriaxone, GEN = Gentamicin, COT = Co-trimoxazole, LE = Levofloxacin, NET = Netillin, TE = Tetracycline, AMC = Amoxyclav, OF = Ofloxacin, mm= milimetre.

Table 5d: Susceptibility profile (mm) of *Escherichia coli* Isolates to some Antibiotics

Isolates No.	CTR (30µg)	GEN (10µg)	COT (25µg)	LE (5µg)	NET (30µg)	TE (30µg)	AMC (30µg)	OF (5µg)
MMW3	25	24	14	25	10	11	0	24
FMW1	24	27	16	23	15	21	0	27
FMW3	15	23	10	22	12	17	0	26
MSW2	21	18	21	30	13	12	0	22
PNW1	16	15	24	27	11	15	0	21
PAED. W1	22	23	20	25	0	13	0	23
PAED. W2	19	20	28	21	0	14	0	25
FSW1	18	18	11	19	12	18	0	29

Key: CTR = Ceftriaxone, GEN = Gentamicin, COT = Co-trimoxazole, LE = Levofloxacin, NET = Netillin, TE = Tetracycline, AMC = Amoxyclav, OF = Ofloxacin, mm= milimetre.

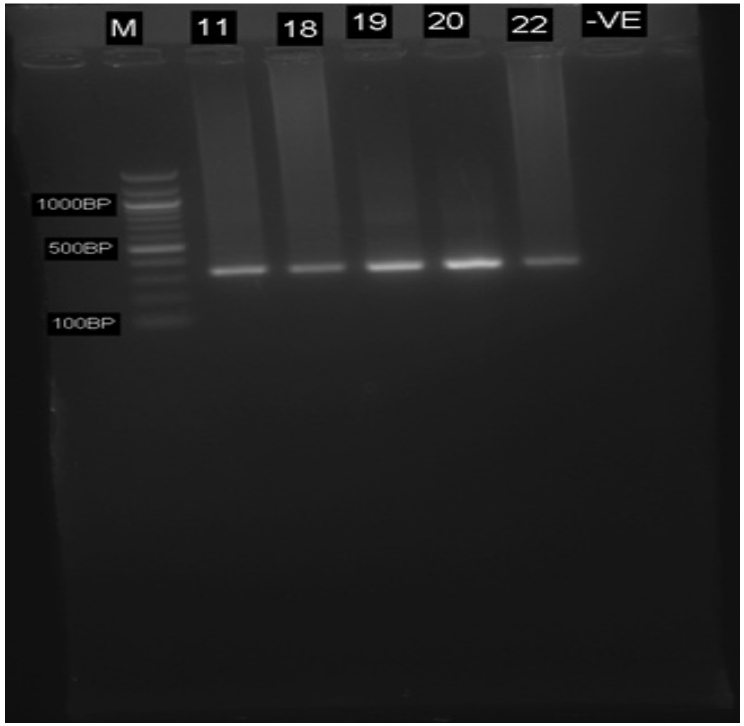

Plate I: Molecular Identification of Methicillin Resistant *Staphylococcus aureus* (MRSA)

Key: M = Molecular marker, 11 = Male Medical Ward 1, 18 = Male Medical Ward 2, 19 = Male Medical Ward 3, 20 = Female Medical Ward 3, 22 = Post-natal Ward 2 and –ve = Negative

DISCUSSION

The male surgical wards of the two hospitals (RSTHD and GHD) had the highest aerobic mesophilic bacterial counts ($2.770x10^3$ and $6.67x10^2$ CFU/m^3) respectively in the morning. This could be attributed to large turnout of patients observed during sampling. Zhang *et al*.(2007) reported that density of people greatly affect the population of airborne bacteria. The counts dropped in evening to $6.22x10^2$ and $6.22x10^2$ in the wards. The reduction in counts of the airborne bacteria can be linked to significant reduction in the number of individuals in the wards. Generally more counts were recorded in the morning than in the evening hours except in MMW1, MMW3, FMW3, FSW1, PNW2, PEAD. W2 and CR3. This could be attributed to increase in the number of human activities in the wards in the evening. However no significant difference (P value =0.5708) was recorded between the morning and evening sampling durations. This is because the three hospitals are visited by patients and their relations frequently. More than 84% of the counts in this study were within the acceptable limits of the WHO (2009). Operation theatres of both RSTH and GHD were the units recorded with least indoor airborne bacterial population of the hospitals. The structural design and regular scrubbing of the OTs and restriction of movement in and out of it might be responsible for the low bacterial population of its indoor air.

Since the p value (0.5708) is greater than 0.05, hence there is no statistically significant difference between the counts. Therefore the differences between the count means are likely due to chance.

The following bacterial species were found in the indoor air of the hospitals, *Staphylococcus aureus, Klebsiella pneumoniae, Proteus mirabilis,* and *Escherichia coli*. The presence of these bacteria can be attributable to a number of outdoor sources, such as soil emissions, water, dust, air, faeces, vegetation, wounds and abscesses (Aydogdu *et al.,* 2010). Some of these clinical isolates like *Staphylococcus aureus and Klebsiella pneumoniae* have been reported by earlier researchers (Yagoub *et al*., 2010, Ekhaise *et al*., 2010; Tambekar *et al.,* 2007). However, since the isolated bacteria could be pathogenic if contact is established with patients, it is pertinent that their presence should be controlled.

It was observed that *Staphylococcus aureus* was the most frequently isolated bacterium followed by *Klebsiella pneumoniae, Escherichia coli* and *Proteus mirabilis*. This finding supports previous studies which state that *Staphylococcus* sp is the frequently isolated pathogen in air (Kalwasinska *et al.,* 2012). Sandra *et al.* (2015) reported that 88% of the isolates recovered from indoor air at different sites were cocci and *S. aureus* accounted for 51%. *Staphylococcus aureus* has been incriminated in various diseases such as post operative infections, urinary tract infections, skin infections, respiratory infections and food poisoning (Buchanan *et al.,* 1974 Murray *et al*., 1995).

Methicillin resistant *Staphylo*coccus *aureus* were detected from male and female medical wards and post-natal wards. Incidence of 13.16% MRSA was observed during the study, this was lower than 19.2% recorded by Olowe *et al.* (2013) in a study conducted in some hospitals in Ekiti State, Nigeria. Factors such as seasonal influences (e.g., temperature), soil composition, water activity, and the microbial community on soil surfaces can all influence the viability of methicillin resistant *Staphylococcus aureus* in an outdoor and indoor environment (Chapple *et al.,* 1992; Falkinham, 2009). Further supporting evidence that exposure to high risk healthcare settings is a strong predictor of MRSA colonization, it's association with other healthcare pathogens, such as a history of *Clostridium difficile* infection or VRE carriage. Beyond high risk healthcare exposure, such pathogens may also be a proxy measure for underlying factors that increase acquisition risk, which is antibiotic exposure, which is thought to increase the risk of MRSA colonization through selective pressure (Tacconelli *et al.,* 2008; Paterson, 2004). Co-morbidities associated with an increased likelihood of MRSA carriage at hospital admission included congestive heart failure, diabetes, chronic obstructive pulmonary disease (COPD), renal failure, and immune-suppression (McKinnell *et al.,* 2013). Screening may be justified in patients with extensive or infected wounds because they may present a high risk for transmission to others.

High level of sensitivity to gentamicin and ofloxacin was seen in the present study. Oxacillin and cefoxitin were effective to some *S. aureus* isolates in some units. The low sensitivity of the isolates generally to netillin, tetracycline, and amoxyclav could be linked to common use of these antibiotics. As Chollet *et al.* (2004) indicated that single drug treatment can lead to cross-resistance to other unrelated antibiotics.

Regulation of antibiotics usage is poor with their easy and over the counter availability without prescription. This could be linked to the high level of resistance observed in the study. Some health care workers and pharmacists are often paid incentives by the pharmaceutical companies to prescribe or sell irrelevant antibiotics (Ansari *et al.,* 2014). Medical practice by unqualified personnel, who often prescribe irrelevant antibiotics, is yet another common problem in Nigeria. Locally produced antibiotics are of questionable quality and compliance of the patients is also considerate (Ansari *et al.,* 2014).

CONCLUSION AND RECOMMENDATIONS

It can be concluded that majority (84.2%) of the sampled units of the hospitals have their aerobic mesophilic bacterial counts within the standard. Four bacterial species namely; *Staphylococcus aureus, Klebsiella pneumoniae, Escherichia coli and Proteus mirabilis* were identified from the air samples of the hospitals units. Gentimicin was found to be the most effective antibiotic while amoxyclav was the least effective drug. Methicillin resistant *Staphylococcus aureus* (MRSA) was detected at male medical ward, female medical ward and post-natal ward with 60%, 20% and 20% prevalence respectively. Regular monitoring is essential to assess air control efficiency and to detect introduction of airborne particles via patients, visitors and/or medical staff.

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