Science World Journal Vol. 15(No 2) 2020
www.scienceworldjournal.org
ISSN 1597-6343
Published by Faculty of Science, Kaduna State University

Full Length Research Article

BACTERIAL CONTAMINATION OF OPERATING THEATRES: A CASE STUDY OF A HOSPITAL IN NORTHERN NIGERIA

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ABSTRACT
Microbial contamination of the Operating Theatre (OT) has continued to increase the prevalence of nosocomial infections. This study assessed the level of microbial contamination and the antimicrobial pattern of the bacterial isolates. Swab plate method was used to collect samples from surfaces and other articles in the major OT. Collected samples were transported and microbiologically processed using standard procedures. Three hundred and fifty (350) swab specimens were collected from various inanimate objects and surfaces in the operating theatre. Of the three hundred and fifty specimens collected, two hundred and five (205=58.6 %) swab specimens had bacterial growth. The total of 393 bacterial pathogens were recovered from all specimens processed during the study. Among these, 245(62.3 %) were Gram-positive and 148(37.7 %) were Gram-negative bacteria. The bacteria isolates were, *Staphylococcus aureus* 50(57.5 %), Coagulase negative *Staphylococci* 19(21.8 %), *Bacillus* species 9(10.3 %), *Enterobacter* species 6(3.8 %), *Micrococcus* species 6(6.9 %), *Streptococcus* species 3(4.4 %).*Proteus* species 128(86.5 %), *E. coli* 13(8.8 %), and *Salmonella* species 7(4.7 %). Antibiotic susceptibility pattern of bacterial pathogens showed overall sensitivity of 95 % to Rocephin. 3(100 %). Erythromycin and Gentamycin were resistant to the tested organisms. In general, the results indicate that *Staphylococcus aureus*, coagulase-negative *Staphylococci* and *Proteus* species were the major species contaminating the surfaces in the operating rooms. This may be due to *Staphylococci* been of human origin. Microbiological surveillance of operating theatres can play an important role in reducing bacterial contamination consequently preoperative infectious episodes can be reduced considerably.

Keywords: Microbial contamination, operating Theatre, surfaces, antimicrobial resistance

INTRODUCTION

Contamination of operating theatres (OT) is one of the most life-threatening sources of nosocomial infection for patients, especially in transplant surgery, heart surgery, cystoscopy and transurethral resection of prostate and bladder tumours ; Okon *et al*., (2012) Multiple reservoirs have been reported as being responsible for the contamination of the OT, including unfiltered air, ventilation systems and antiseptic solutions, drainage of the wounds, transportation of patients and collection bags, surgical team, extent of indoor traffic, theatre gown, foot wares, gloves and hands, use of inadequately sterilized equipment, contaminated environment and grossly contaminated surfaces (Okon *et al*., 2012; Matinyi *et al.,* 2018). The impact of these sources on the degree of microbial contamination differs, depending on the numbers of pathogens involved. *Staphylococcus aureus* and coagulase negative *Staphylococci* (CoNS), for example, are the major pathogens associated with infection of implantable biomedical device (Hard,2018). The clinical implication of microbial contamination in OT is enormous on both the patient and the caring surgical team (Okon *et al*., 2012; Hard,2018). Approximately, 10 % of all infections can have serious consequences in terms of increased patient mortality, morbidity and length of hospital stay and overall costs (Soltanian *et al*., 2018).

However, it can be prevented through adequate application of infection control practices. Reduction of airborne bacteria in the OT by about 13-fold, for example, would reduce the wound contamination by about 50 % (Okon *et al*., 2012; Matinyi *et al.,* 2018). Reduction of microbial contamination depends primarily on improved cleaning and proper disinfection of OT (Okon *et al*., 2012; Matinyi *et al.,* 2018).

The risk of infection from OTs also needs to be viewed in light of current evidence-based practice. Evidence emanating from research of low methodological quality is more likely to over- or underestimates the risk of Nosocomial infection from OTs, giving an inaccurate description of the problem and making the risk of infection from OTs difficult to ascertain. A systematic review provides a standardized critical appraisal of all research in this area and allows recommendations for future research to be made based on shortcomings in the research design and methods of previous studies.

Total numbers of bacteria in an empty operating theatre should be < 35 CFU/m^3 with less than one colony of *Clostridium perfringens* or *S. Aureus***.** (Okon *et al*., 2012). During an operation total air count should be < 180 cfu/m^3 (Okon *et al*., 2012).

MATERIALS AND METHODS

The study was conducted in Kaduna State University (KASU), Microbiology Department between January and June 2018, after getting full approval from Barau Dikko Teaching Hospital, Health Research Ethics Committee (BDTH HREC) where the samples were obtained.

Swab sampling procedures was used, as described by Javed *et al.* (2008). To check the sterility of articles and surfaces in the major Operating Theatre, sterile swab moistened with sterile peptone water was used to collect samples. All the plates were labelled and the swab was immediately streaked on to 5% sheep blood agar (Oxoid, UK), MacConkey agar (Oxoid, UK) and Mannitol salt agar (Oxoid, UK). Upon inoculation, plates were sealed and transported to the Microbiology laboratory of Kaduna State University in sealed plastic bags and incubated at 37 °C under aerobic conditions for 24 hours. A total of 350 microbiological samples were collected from four operating

theatres.

Bacterial colonies were initially characterized by morphology and microscopic examination (Patwardhan *et al.,*2011). They were Gram-stained and sub-cultured onto appropriate medium based on the Gram-reaction; i.e. Gram-positive *Staphylococci* were cultured on to mannitol salt agar (Oxoid, UK) and 5 % Sheep's blood agar (Oxoid, UK), and Gram-negative rods onto mac Conkey agar (Oxoid, UK). Further identification was done by biochemical tests using the standard bacteriological techniques (Patwardhan *et al.,*2011). The antimicrobial susceptibility testing of the bacterial species was done on Mueller-Hinton agar (Oxoid, UK) against ten antibiotics by Kirby-Bauer disk diffusion method matching the test organism to 0.5 McFarland turbidity standards. The susceptibility result was interpreted according to the Clinical Laboratory Standards Institute (CLSI) methodology CLSI, (2013). *S. aureus* ATCC25923, and *Escherichia coli* ATCC 25922 were used as control bacterial strains to monitor the whole bacteriological procedures. Data obtained was subjected to statistical analysis using SPSS16.0 and Microsoft Office Excel 2007. A significant difference among the mean microbial air counts was tested using Kruskal-Wallis test.

RESULTS

Table 1: Shows the Biochemical characteristic of bacterial isolates from Operating Theatres. A total of 393 bacterial pathogens were recovered from all specimens processed during the study. Among these, 245(62.3 %) were Gram-positive and 148(37.7 %) were Gram-negative bacteria. Among the Gram-positive isolates, *Staphylococcus aureus* were predominant (69.4%) followed by Coagulase negative *staphylococci* (24.5 %). *Proteus* species were the dominant isolate of the Gram-negative rods (30.5 %) as shown in Table 2.

Table 3: shows the sources of contamination in the Obstetrics and Gynaecology theatre. The floor had the highest number (19.7 %) of isolates and mostly pathogens. The Coagulase negative *staphylococci (*CoNS) (23.9 %) was the most frequently isolated bacteria pathogens in the operating theatre.

Table 4: indicate the source of contamination in the ophthalmic theatre. The operating bed and cylinder had the highest number (18.9 %) of isolates and were mostly pathogens. The CoNS (36.3 %) were the most frequently isolated pathogen in the operating theatre.

Table 5: shows the sources of contamination in the Orthopaedic theatre and the spectrum of contaminants; *Staphylococcus aureus* (40 %) was the most frequently isolated followed by *CoNS* (25.7 %). The operating bed, floor, Anaesthetic machine and Trolley had the highest number (14.3 %) each of the isolates and were mostly pathogens.

Table 6: shows the source of contamination in the General Surgery Theatre. *Proteus* species (32.7 %) was the most frequently isolated pathogen followed by *CoNS* and *Staphylococcus aureus* (26.5 %) each. The infusion stand had the highest number (16.3 %) and were most pathogens.

The susceptibility patterns of isolates revealed varying degrees of susceptibility to the antibiotics tested. Gram positive isolated from different sample sources were effective to most of the antibiotics tested (Table 7). The predominant isolate, *CoNS* demonstrated high level of susceptibility to Rocephine, Perfloxacin, Zinacef, Ciprofloxacin, Amoxacillin, Streptomycin and Gentamycin. 57(95 %),52(86.7 %), 49(81.7 %), 48(80 %), 44(73.3 %), 43(71.7 %), 42(70 %) and Resistance to Ampiclox and Erythromycin 50(83.3 %) each.

As indicated in (Table- 7). 70(41.1%), 125(73.5 %), 115(67.6 %) of *Staphylococcus aureus* showed susceptibility to Ciprofloxacin, Perfloxacin and Gentamycin. 8(88.9 %) of *Bacillus* species each were effective to Zinacef, Amoxicillin and Ciprofloxacin. Also 7(77.8 %) each were effective to Ampiclox, Streptomycin. 6(66.7 %) and 5(55.6 %) were effective to Septrin and Erythromycin.

Similarly, 2(100 %) each of Zinacef, Amoxicillin, Rocephin, Ciprofloxacin, Streptomycin, Septrin, Erythromycin, Perfloxacin and Gentamycin were effective against *Enterobacter* species. 1(100 %) each of Rocephin, Ciprofloxacin, Perfloxacin and Gentamycin were effective against *Micrococcus* species while 1(100 %) each of Streptomycin, and Erythromycin were resistance. Also, 3(100 %) each of Rocephin, Ciprofloxacin and 2(66.7%) of Perfloxacin were effective against *Streptococcus* species. 3(100 %) each of Erythromycin and Gentamycin were resistance.

Similarly, the susceptibility patterns of Gram-negative rod isolates from different sample sources were effective to most of the antibiotics tested. As indicated in Table 8.1 Proteus species were effective to Perflaxacin, Ciprofloxacin, Sparfloxacin, Gentamycin, Ofloxacin, Amoxicillin, Septrin, and Chloramphenicol 115(95.8 %), 114(95 %), 113(94.2 %), 112(93.3 %), 110(91.7 %), 101(84.2 %), 100(83.3 %), 96(80.0 %). Also as showed in table 8 19(95.0 %) each of Amoxicillin-Clavulanic acid, Perfloxacin, Ofloxacin, Sparfloxacin, and Ciprofloxacin were effective against *E. coli.* Also 18(90.0 %) each of Amoxicillin, Streptomycin, Septrin and 17(85.0 %) each of Gentamycin, and chloramphenicol were effective against *E. coli. Salmonella* species were susceptible to Ciprofloxacin, Ofloxacin and Perfloxacin 7(87.5 %), 6(75.0 %), 5(62.5 %) and was resistance to Gentamycin 7(75.5 %). (Table 7.1)

Table 1: Biochemical characteristic of bacterial isolates from Operating Theatres of Barau Dikko Teaching Hospital Kaduna

Organisms	coagulaes	catalase	oxidase	urease	citrate	indole	methyl red	VP
S. aureaus	+	+	-	-	-	-	-	+
CoNS	-	+	-	-	-	-	-	-
B. species	-	+	-	-	+	-	-	+
E. species	-	+	+	-	+	_	-	+
M. species	-	+	-	-	-	-	-	+
S. species	-	-	-	-	-	-		
P. species	-	+	-	+	+	+	+	-
E. coli	-	-	-	-	-	+	+	-
Sa. species	-	+	+	-	+	-	+	-

Key.

S.species= *Streptococcus* species, P.species= *Proteus* species,Sa.species= *Salmonella* species, M.Species=*Micrococcus* species, E. species=*Enterobacter* species, B.species= *Bacillus* species, CoNS= Coagolase negative *staphylococ*i

Science World Journal Vol. 15(No 2) 2020
www.scienceworldjournal.org
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Table 2: Bacterial isolates from Operating Theatres of Barau Dikko Teaching Hospital Kaduna

Bacterial Isolates	Total	Percentage
Gram Positive	245	62.3
Staphylococcus aureaus	170	69.4
Coagulase Negative *Staphylococci*	60	24.5
Bacillus species	9	3.7
Enterococcus species	2	0.8
Micrococcus species	1	0.4
Streptococcus species	3	1.2
Gram Negative	148	37.7
Proteus species	120	30.5
E.coli	20	5.1
Salmonella species	8	2
Total	**393**	**100**

Table 3: Frequency and Distribution of Bacterial Isolated from Fomites in the Obstetrics and Gynaecology Theatre

Frequency of occurrence (%) of microbial isolates N = 40

Organisms	OPB	FC	FL	ANM	SC	OPL	ST	TL	WL	IFS
S. aureus	5(41.7%)	0	0	0	2(100%)	0	6(50%)	1(16.7%)	2(33.3%)	0
CoNS	0	0	4(28.6%)	2(40%)	0	0	0	1(16.7%)	4(66.7%)	6(100%)
B. species	0	2(66.7%)	4(28.6%)	2(40%)	0	5(100%)	0	0	0	0
*E.*species	0	0	0	0	0	0	2(16.7%)	0	0	0
M. species	0	0	3(21.4%)	0	0	0	0	0	0	0
S. species	2(16.7%)	1(33.3%)	3(21.4%)	0	0	0	2(16.7%)	2(35.5%)	0	0
*P.*species	4(33.3%)	0	0	1(20%)	0	0	0	2(-33.30%)	0	0
E. coli	1(8.3%)	0	0	0	0	0	1(8.3%)	0	0	0
Sa. species	0	0	0	0	0	0	1(8.3%)	0	0	0
Total	12	3	14	5	`2	5	12	6	6	6

Key:
OPB=Operating bed, FC=Forcep, FL=Floor, ANM=Anesthetics machine, SC=Scissor, OPL= Operating lamp, ST=Suction machine, TL=Trolley, WL=Wall, IFS=Infusion stand.

S.species= *Streptococcus* species, P.species= *Proteus* species,Sa.species= *Salmonella* species, M.Species=*Micrococcus* species, E. species=*Enterobacter* species, B.species= *Bacillus* species, CoNS= Coagolase negative *staphylococci*

Table 4: Frequency and Distribution of Bacterial Isolated from Fomites in the Ophthalmic

Frequency of occurrence (%) of microbial isolates N = 40

Organisms	OPB	FC	FL	ANM	SC	OPL	ST	TL	WL	IFS
S. aureus	2(50%)	1(100%)	0	1(33.3%)	0	2(66.7%)	1(25%)	1(33.3%)	0	0
CoNS	1(25%)	0	0	1(33.3%)	1(100%)	1(33.3%)	2(50%)	1(33.3%)	1(100%)	0
B. species	0	0	1(50%)	0	0	0	0	0	0	0
*E.*species	0	0	0	0	0	0	0	0	0	0
*M.*species	0	0	1(50%)	0	0	0	0	0	0	0
S. species	0	0	0	0	0	0	0	0	0	0
*P.*species	1(25%)	0	0	0	1(33.3%)	0	1(25%)	1(33.3%)	0	0
E. coli	0	0	0	0	0	0	0	0	0	0
Sa. species	0	0	0	0	0	0	0	0	0	0
Total	4	1	2	3	1	3	4	3	1	0

Key:
OPB=Operating bed, FC=Forcep, FL=Floor, ANM=Anesthetics machine, SC=Scissor,OPL= Operating lamp, CD=Cylinder, TL=Trolley, WL=Wall, IFS=Infusion

Table 5: Frequency and Distribution of Bacterial Isolated from Fomites in the Orthopaedic theatre

Frequency of occurrence (%) of microbial isolates N = 40

Organisms	OPB	FC	FL	ANM	SC	OPL	ST	TL	WL	IFS
S. aureus	3(60%)	2(100%)	2(40%)	3(60%)	1(50%)	0	3(60%)	0	3(100%)	0
CoNS	1(20%)	0	2(40%)	1(20%)	1(50%)	1(50%)	1(40%)	3(100%)	0	0
B. species	0	0	0	0	0	0	0	0	0	0
*E.*species	0	0	0	0	0	0	0	0	0	0
*M.*species	0	0	0	0	0	0	0	0	0	0
S. species	0	0	0	0	0	0	0	0	0	0
*P.*species	1(20%)	0	1(20%)	1(20%)	1(100%)	1(50%)	1(40%)	0	0	0
E. coli	0	0	0	0	0	0	0	0	0	0
Sa. species	0	0	0	0	0	0	0	0	0	0
Total	5	2	5	5	3	2	5	3	3	0

Key:
OPB=Operating bed, FC=Forcep, FL=Floor, ANM=Anesthetics machine, SA=Saw, OPL= Operating lamp, ST=Suction machine, TL=Trolley, WL=Wall, IFS=Infusion stand

Table 6: Frequency and Distribution of Bacterial Isolated from Fomites in the General Surgery Theatre.

Frequency of occurrence (%) of microbial isolates N = 40

Organisms	OPB	FC	FL	ANM	SC	OPL	ST	TL	WL	IFS
S. aureus	1(33.3%)	3(100%)	1(4.3%)	2(40%)	0	0	0	2(28.6%)	3(50%)	1(12.5%)
CoNS	1(33.3%)	0	3(42.9%)	2(40%)	3(100%)	0	0	0	0	4(50%)
B. species	0	0	0	0	0	0	0	0	1(16.7%)	0
*E.*species	0	0	0	0	0	0	1(20%)	0	0	0
*M.*species	0	0	0	0	0	0	1(20%)	0	1(16.7%)	0
S. species	0	0	1(4.3%)	0	0	0	0	1(4.3%)	0	0
*P.*species	1(33.3%)	0	2(28.6%)	1(20%)	0	2(100%)	2(40%)	4(57.1%)	1(16.7%)	3(37.5%)
E. coli	0	0	0	0	0	0	0	0	0	0
Sa. species	0	0	0	0	0	0	1(20%)	0	0	0
Total	3	3	7	5	3	2	5	7	6	8

Key:
OPB=Operating bed, FC=Forcep, FL=Floor, ANM=Anesthetics machine, SC=Scissor, OPL= Operating lamp, ST=Suction machine, TL=Trolley, WL=Wall, IFS=Infusion stand

Table 7: Antibiotics Susceptibility Profiles of Gram positive isolate from Operating Theatres.

Bacterial isolates	Pattern	APX	Z	AM	R	CPX	S	SXT	E	PEF	CN
CoNs	S	10	49	44	57	48	43	14	10	52	42
	%	16.7	81.7	73.3	95	80	71.7	23.3	16.7	86.7	70
	R	5.0	11	16	3	12	17	46	50	8	18
	%	83.3	18.3	26.7	5	20	28.3	76.7	83.3	13.3	30
Staphylococcu aureus	S	-	-	-	-	70	-	-	-	125	115
	%					41.2				73.5	67.6
	R	-	-	-	-	100	-	-	-	45	55
	%	-	-	-	-	58.8	-	-	-	26.5	32.4
Bacillus species	S	7	8	8	9	8	7	6	5	9	9
	%	77.8	88.9	88.9	100	88.9	77.8	66.7	55.6	100	100
	R	2	1	1	0	1	2	3	4	0	0
	%	22.2	11.1	11.1	0.0	11.1	22.2	33.3	44.4	0.0	0.0
Enterococcus species	S	-	2	2	2	2	2	2	2	2	2
	%		100	100	100	100	100	100	100	100	100
	R	-	0	0	0	0	0	0	0	0	0
	%		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Micrococcus species	S	-	-	-	1	1	0	-	0	1	1
	%				100	100	0.0		0.0	100	100
	R	-	-	-	0	0	1	-	1	0	0
	%				0.0	0.0	100		100	0.0	0.0
Streptococcus species	S	-	-	-	3	3	-	-	0	2	0
	%				100	100			0.0	66.7	0.0
	R	-	-	-	0	0	-	-	3	1	3
	%				0.0	0.0			100	33.3	100

Key:
S=Sensitivity, R=Resistant, %=Percent, PEF=Pefloxacin,

CN=Gentamycin, APX=Ampiclox, Z=Zinacef, AM=Amoxacillin, R=Rocephin, CPX=Ciprofloxacin, S=Streptomycin, SXT=Trimethoprim-Sulfamethoxazole, E=Erythromycin, CoNS= Coagulase negative *staphylococci.*

Table 7.1: Antibiotics Susceptibility pattern of Gram negative isolates from Operating Theatre of Barau Dikko Teaching Hospital, Kaduna

Bacterial isolates	Pattern	AM	AU	CN	PEF	OFX	S	SXT	CH	SP	CPX
***Proteus* species**	S	101	-	112	115	110	-	100	96	113	114
	%	84.2		93.3	95.8	91.7		83.3	8.0	94.2	95
	R	19	-	8	5	10	-	20	24	7	6
	%	15.8		6.7	4.2	8.3		16.7	20	5.8	5
E.coli	S	18	19	17	19	19	18	18	17	19	19
	%	90	95	85	95	95	90	90	85	95	95
	R	2	1	3	1	1	2	2	3	1	1
	%	10	5	15	5	5	10	10	15	5	5
***Salmonella* species**	S	-	-	1	5	6	-	-	-	-	7
	%			12.5	62.5	75					87.5
	R	-	-	7	3	2	-	-	-	-	1
	%			75.5	37.5	25					12.5

Key:
S=Sensitive, R=Resistant, %=Percent, AU=Augmentin, CN=Gentamycin, PEF=Pefloxacin, OFX=Ofloxacin, S=Streptomycin, SXT=Trimethoprim-sulfamethoxazole, CH=Chloramphenicol, SP=Sparfloxacin, CPX=Ciprofloxacin, AM=Amoxicillin

DISCUSSION

From the study, 205(58.6 %) of the total samples were variously contaminated by bacterial agents many of which are recognized pathogens. *Staphylococcus aureus* 170 (69.4 %) were the most frequently isolated from all the samples collected from the operating room followed by coagulase negative *staphylococci* 60(24.5 %) and *Proteus* species (30.5 %). The result of this study agrees with the report of Muhammad *et al.* (2013) which showed that *Staphylococcus aureus* was the predominant among the isolated bacteria in hospital environments. It also correlates with the report of Genet *et al*. (2011) who reported that *Staphylococcus aureus* was the most prevalent bacteria isolated in the operating room. On the other hand, the result of this study is inconsistent with the work of Okon (2012) and Gelaw (2014) which reported that coagulase negative *Staphylococci* is the most frequent bacteria isolated. Whether these microorganisms are originated from the patients (endogenous flora) or from the staff, instruments and consumers (exogenous flora) this is difficult to be determined as endogenous flora can be transformed exogenous one (Okon *et al.*, 2012). Clesham *et al*., (2018) have also shown that *Staphylococcus aureus*, coagulase negative *Staphylococci*, *Enterococcus* species., and *Escherichia coli*. *Staphylococcus aureus* was the common microorganism from this finding. *Staphylococcus aureus* is a normal skin flora of the patients and the staff working in the theatres. Droplet and nuclei contaminated with *Staphylococcus* can infect not only the wounds but also the ground, shelves, and lamps of the operating rooms. Dust is an important factor in aerosolization of the microorganisms settled on the ground (Qoreishi *et al*.,2019). Unnecessary mobility of the staff during the operation can create air stream around the open wound; therefore, continuous maintenance of laminar air flow-ventilated operating rooms offers high-quality air during surgery and the guidelines for environmental infection control in health-care facilities should be always implemented as reported by (Qoreishi *et al*.,2019). Also, Coagulase-negative Staphylococci *60*(24.5 %) was the second most isolated of the Gram-positive organism they are known exogenous organism, often referred to as contaminant as reported by Johnson *et al*. (2017). The source of *CoNS* in such study include normal skin flora of medical personnel, patients and fabrics (Alramli *et al*.,2019). However, clinical implication of *CoNS is* more pronounced in immunocom-promised patients, as entry into systemic environment could initiates infection. Apart from *CoNS, Proteus* species 120(30.5 %), and *E. coli* 20(5.1 %), are bacterial pathogens frequent encountered within hospital environment as confirmed in this research. Intra hospital transmission of these bacterial pathogens can occur from transportation of patient either from the wards to the operating theatre and the specialized units. The air in the ward/or beddings and covering fabrics of the patient may have been contaminated already, in the course of the patient movement within the hospital, it is possible that the contaminated bacterial pathogens might be released either during the patient clothing/or bedding being changed without observing proper hygienic hospital procedures.

Coliforms are faecal bacteria and their presence suggests that the food and water supply could be the source of contamination. Another possible contaminant source is the bowels of patients, from normal flora or from urinary tract infections, particularly in the delivery theatre as *Escherichia coli* is the most common infectious agent in pregnant women as reported by Christodoulidou and Pearce (2016).

. Although the role of formites in contributing to surgical site infections have been controversial, the fact that Onwubiko and Akande (2015) in the past confirmed the survival of unknown bacterial pathogens on inanimate objects for months and lends credence to the possibility of their causing nosocomial infections.

Operating table, trolley, oxygen cylinder, saw, infusion stand, anaesthetic machine, suction tip, light sources that are frequently used in the operating rooms during operation were found to be contaminated with *S. aureus* and coagulase negative *staphylococci*. This finding is in agreement with study by Osman *et al*. (2017). The scissor and the forceps that were supposed to be sterile were found to be contaminated with *Staphylococcus aureus, CoNs* and *Bacillus* species. This could be as a result of inadequate sterilization of the instruments.

The floor was the most contaminated of all the fomites in this study. This correlate with the study of Nwankwo and Azeez, (2015). This might be linked to the large influx of staff, students during operation and inadequate cleaning of the floor before and after operation.

The habit of leaving this equipment for long periods without cleaning and proper disinfection after use is possibly responsible for this contamination. Similarly, other immovable objects such as floor and wall, were heavily contaminated with Gram-positive bacteria of the genus *staphylococci* as compare to the report of Osman *et al.* (2017).

In this finding, Pefloxacin, Ciprofloxacin, Rocephin and Zinacef were found to be active against more than 80 % of coagulase negative *Staphylococci* and 70 % of S. *aureus* isolates. This is similar to the report of Genet *et al*. (2011). Which showed 90.4 % sensitivity of *S. aureus* to ciprofloxacin. It was also found that 50 % of ampiclox was resistant to *CoNS*. Furthermore, over 70 % were sensitive to ampiclox, zinacef, amoxicillin, rocephin, streptomycin pefloxacin and gentamycin. More than 80 % of the antibiotic tested isolates were sensitive. The antibiotic resistance

pattern revealed relatively high susceptibility to Pefloxacin, Ciprofloxacin, Rocephin and Zinacef. However, some of pathogen exhibited multi-resistant pattern especially *Staphylococcus aureau, CoNS and Proteus* species isolates. High level of disinfection procedures is required to be carried out in units were bacterial isolates were isolated. Similarly, staff and students should be trained on the need for high level of hygiene in order to reduce further bacterial contaminations in operating theatres.

Conclusion

The operating theatres were contaminated with various types of bacteria. *Staphyllococus aureus* were the predominant bacterial type isolated from operating rooms, followed by Coagulase negative *staphylococci.* The frequency of single drug resistance was high. This might be a reflection of inappropriate use of antibiotics, or unavailability of a guideline regarding the selection of drugs. Adherence to infection prevention practices may be paramount important. Additionally, government at all tiers should endeavour to sponsor researches on development of new antibiotics that could be relevant in the treatment of severe infections caused by antibiotic resistant bacteria.

Recommendation

The results indicate that 3 factors need to be considered.

i. Some bacterial strains such as *S. aureus*, *S. epidermidis*, and *E. coli* have a greater propensity to cause contamination, especially in operating theatres, so extensive infection control practices are necessary to prevent or contain these pathogens.
ii. The social level of incoming patients reflects the individual patient risk, which must be investigated and modified whenever possible.
iii. The patient should be prepared for operation and appropriate skin antiseptic should be used on the operation sites.
iv. The patient should also be considered for preoperative antibiotic prophylaxis. Bowel preparation, if appropriate, should be carried out.
v. There is need for hospitals to encourage periodic review of the microbial flora of their environment and the antibiotic sensitivity pattern.

It is also necessary that all professionals should take an active role in infection control within their organization and more resources should be provided to encourage good antibiotic Practice and good hygiene in hospitals

REFERENCES

Affe, F. C. D., Agbankpe, A. J., Johnson, R. C., Hoongbegnom, O. S. C., & Bankole, H. S,(2018). Hospital Acquired Infection: Bacteriological Profile of Species From Environmental Surfaces of Cotonou 5 Hospital in South Benin (West Africa). *International Journal of Current Microbiological Apply Science,* 7(4), 1503-1515.

Amare, B., Abdurrahman, Z., Moges, B., Ali, J., Muluken, L., Alemayehu, M. (2011). Postoperative Surgical Site Bacterial Infections and Drug Susceptibility Patterns at Gondar University Teaching Hospital, Northwest Ethiopia. *Journal of Bacteriology and Parasitology*; 2:126.

Andersson, A. E., Bergh, I., Karlsson, J., Eriksson, B. I., Nilsson, K., Traffic flow in the operating room: An explorative and descriptive study on air quality during orthopedic trauma implant surgery. *America Journal of Infection Control* 2

Attaway, H. H., Fairey, S., Steed, L. L., Salgado, C. D., Michels, H. T., Schmidt, M., G. (2012). Intrinsic bacterial burden associated with intensive care unit hospital beds: Effects of disinfection on population recovery and mitigation of potential infection risk. *America Journal of Infection Control,* 40(1):750-755.

Bonten, M. J. M., Hayden, M., K. & Nathan, C.(1996). Epidemiology of colonization of patient and environment with vancomycin-resistant enterococci, *Lancet*, 348(1):1615-1619..

Clinical Laboratory Standards Institute (CLSI). Performance Standards for Antimicrobial Susceptibility Testing; Twenty-Third Informational Supplement, 2013

Cheesbrough, A. E., Garvin, T., & Nykiforuk, C.I. (2019). Everyday wild. Urban national area, health, and well-being. *Health and place,* 56(1): 43-52.

Chacko, I., Jose, S., Isa, A. & Bhat, K., G.(2003). Survival of Nosocomial Bacteria in Hospital Fabrics, *Indian Journal of Medical Microbiology*, 21(4): 291.

Christodoulidou, M., and Pearce, I. (2016). Infection of penile prostheses in patients with diabetes mellitus. *Suegical Infection.* 17(1): 2-8.

De Oliveira, A.C., Damasceno, Q., S. (2010). Surfaces of the hospital environment as possible deposits of resistant bacteria: a review, Rev Esc Enferm USP, 44(4):1112-7.

Dharan, S., and Pittet, D. (2002). Environmental control in operating theatres, *Hospital Infection*, 51 (2): 79- 84.

Edmiston, C. E Jr., Seabrook, G. R., Cambria, R. A., Brown, K. R., Lewis, B. D., Sommers J., R. (2005). Molecular epidemiology of microbial contamination in the operating room environment: Is there a risk for infection? *Surgery* 138(1): 573-579.

Endalafer, N., Gebre-Selassie, S., Kotiso, B. (2011). Nosocomial bacterial infections in a tertiary hospital in Ethiopia. *Journal of Infection Prevention*; 12(1): 38-43. 33

Ensayel, S., Al-Shalchi, S., and Sabbar, M.(2009). Microbial contamination in the operating theatre: a study in a hospital in Baghdad, *Eastern Mediterranean Health Journal*, 15(1): 219-223.

Fleischer, M., Bober-Gheek, B., Bortkiewicz, O., Rusiecka-Ziólkowskaa,(2006).*Journal of Microbiological control of airborne contamination in hospitals.* Indoor Build Environment;15:53-56.

Genet, C., Kibru, G., Tsegaye, W. (2011). Indoor air bacterial load and antibiotic susceptibility pattern of isolates in operating rooms and surgical wards at Jimma university specialized hospital, southwest Ethiopia. *Ethiopia Journal of Health Science*. 21(1):9-17.

Gelaw, A., Gebre-Selassie, S., Tiruneh, M., Mathios, E., Yifru, S. (2014). Isolation of bacterial pathogens from patients with postoperative surgical site infection and possible sources of infection at university of Gondar hospital, northwest Ethiopia. *Journal of Environmental Occupational Science*; 3(2):103-108.

Habeeb, A.A. (2018). The Microbial contamination in Surgery Operating Theatre at Al-Zahraa General Teaching Hospital. *Al-Qadisiyah Journal of Pure Science,* 23(3): 22-29.

Hard, J. H.(2018). A clinical test to measure Airborne Microbial Contamination on the sterile file During Total Joint Replacement : Method, Reference Values, and Pilot Study.

Journal of Bone and Joint Surgery. Open Access 3, no.3.

Johnson, O. O., Adekule, G. F., Adnike, A., Elizebeth, T. S., Sylvia, M. E., and Olayinka, M. B. (2017). Indoor Airborne Microbial Burden of Operating Theatres in a Tertiary Hospital in South-Western Nigeria. *International Journal Current Microbiological Apply Science*, 6(9): 3335-3345.

Kiranmai, S., and Madhavi, K. (2016). Microbiological survallance of operating theatres, intensive care units and labor room of a tertiary hospital in Telangana, India. *International Journal of Research in Medical Sciences,* 4(12): 5256.

Knok, W, C., Elvis, K., Jalia, L., Ephraim, N., Emmanuel, O., Annet, T. and Stanley, I. J. (2018) The role of Hospital Surfaces and Theatre Environment in Transmission of Nosocomial Infections in a Rural District Hospital in Eastern Uganda. *Journal of Advances in Medicine and Medical Research,* 1-13

L. Cervantes, D., Weed, A., Keniston, C., S. Price, & R. K., Albert, (2011). "Newly cleaned physician uniforms and infrequently washed white coats have similar rates of bacterial contamination after an 8-hour workday: a randomized controlled trial*," Journal of Hospital Medicine,* 6(4): 177–182.

Manangan, L. P., Puglies, G., Jackson, M., Lynch, P., Sohn, A. H., Sinkowitz- Cochran, R., L.(2001) Infection control dogma: top ten suspects. *Infection Control Hospital Epidemiology*, 22(1): 243-247.

Mathur, P. (2019). Infection Control in Operating Rooms: Sterilization and Disinfection Practices. *In Textbook of Neuroanesthesia and Neucritical care* (pp. 351-358). Springer, Singapore.

Matinyi, S., Enock, M., Akia, D., Byaruhanga,V., Masereka, E., Ekeu, I., and Atuheire, C. (2018). Contamination of microbial Pathogens and their antimicrobial in operating theatre of peri- urban eastern Uganda: a cross- section study. *BMC infection diseases,* 18(1): 460.

Mishra, A. K., and Wadhai, V.S. (2016). Sterility Testing of Operating theatre in Hospital. *International Journal Current Microbiological Apply Science*, 5(5): 440-447.

Muhammad, U. K., Isa, MA., Aliyu, Z., M.(2013). Distribution of potential nosocomial pathogens isolated from environments of four selected hospital in Sokoto, North Western Nigeria*. Journal of Microbiology and Biotechnology Re*search, 3 (1):139-143.

Napoli, C., Marcotrigiano, V., and Montagna, M., T. (2012). Air sampling procedures to evaluate microbial contamination: A comparison between active and passive methods in operating theaters, *BMC Puplic health*, 12(1): 594.

Nwankwo, E.O., & Azeez, O.A. (2017). Microbial contamination in the operating theatre of a tertiary health institution in kano, Northwestern Nigeria. *Nigerian Journal of Microbiology*, 27(1): 2671-2679.

Ochie, K., Ohagwu, C.C. (2009). Contamination of X-Ray equipment and Accessories with Nosocomial Bacteria and the Effectiveness of Common Disinfecting Agents*. Africa Journal of Basic & Applied Science* , 1(1-2): 31-35

Odimayo, M.S., Nwabuisi C., Adegboro, B. (2008). Hospital acquired Infections in Nigeria. *Tropical Journal of Health Sciences,* 15(1): 49-54.

Onifade, E. O., Ogonna I. O., Ikwebe, J., and Aremu, S. O. (2019). Profiling of the bacterial pathogens associated with hospital within Makurdi metropolis, middle belt, Nigeria. *Bangladesh Journal of Medical Science,* 18(2), 368-378.

Onwubiko, N. E., and Akande, A. O.(2015). Microbial contamination in Operating Theatre of a tertiary health

Okon, K.O., Osundi, S., Diba,I. J., Ngbale, T., Bello, M., Akuhwa, R., T. (2012). Bacterial contamination of operating theatre and other specialized care unit in a tertiary hospital in North eastern Nigeria*. Africa Journal Microbiology Research,* 6(1): 3092-3096.

Osman,Y.A.E.M., El Aziz, A., Ahmed, Z., and El Tanyawy, A. F. A. E. (2017). Microbiogical Assessment of Surgical Operation Rooms' Clothes. *International Design Journal,* 26(5660): 1-12.

Patwardhan, N., Kelkar, U. (2011). Disinfection, sterilization and operation theater guidelines for dermatosurgical practitioners in India. *Indian Journal Dermatol Venereol Leprol*; 77(1): 83-93.

Patherick, E. S., Dalton, J., E.(2006). Methods for identifying surgical wound infections after discharging from Hospital: a systematic review. *BMC infection disease* 6(1): 170-178.

Pinon, A., Gachet, J., Alexandre, V., Decherf, S., Vialette, M. (2013). Microbiological Contamination of Bed Linen and Staff Uniforms in a Hospital. *Advances in Microbiology*; 3(1): 515-519.

Saadoun, I., Al Tayyar, IA., Elnasser, Z.(2008). Concentrations of airborne fungal contamination in the medical surgery operation theaters of different hospitals in Northern Jordan. *Jordan Journal of Biological Science*, 1(1): 181-4.

Sana, O.Y., Amani, E.,A. (, 2010). Isolation of potential pathogenic bacteria from the air of hospital delivery and nursing rooms. *Journal of Applied Sciences*; 10(11):1011-1014.

Segujja, F., Mwambi, B., Drago, C. K., Lubowa, N. M., Mugambwa, J., and Wabuyi, P. (2016). Characterization and antimicrobial susceptibility patterns of isolates from ward formites.

Sing-on, T., Wen-sen, L., Tisong-tih, OU., Yu-chia, H., Wan-chan, L., Yi-chun, L. (, 2009). Bacterial contamination of patients' medical chart in surgical ward and intensive care unit: impact on nosocomial *infection. Journal of Microbiology and Immunology Infectious Disease*; 42(1): 86-91.

Singh, K., Dar, F, A., Kishor, K. (2013). Bacterial contamination in operating theatres of district hospital Budgam in Kashmir division. *International Journal of Medical Health Science*; 3(2):62- 63.

Soltanian, M., Mohajeri, P., Najafi. F., Kazami, S., and Asadi. F.(2018). Study of Airborne Bacterial Density in Surgery and Infectious wards of Hospital Affiliated with Kermakshah University Medical Science and its Relationship with Environmental Factors. *Iranian Journal of Epidemiology,* 13(4): 308-317.

Sudharsanam, S., Srikanth, P., Sheela, M., Steinberg, R. (2008). Study of the Indoor Air Quality in Hospitals in South Chennai, India–Microbial Profile. Indoor Built Environment, 17(1): 435-441.

Tayh, G., A. (2011). Risk Factors and Antimicrobial Resistance of Pathogens Isolated from Burn Units at Local Hospitals in Gaza Strip, Palestine. Available at *http:// library.iugaza.edu.ps/thesis/96729.pdf* Accessed on December 12, 2013

Thomas, A. M., and M.J. Simmon. ''The effectiveness of ultra-clean air Operating Theatres in the Prevention of deep

Infection in Joint Orthroplasty Surgery''. *Bone Joint Journal* 100. 10 (2018): 1264-1269

Tucci, M., and Romanini, E., Zanoli, G., Pavan, L., Fantoni, M., and Venditti, M. (2019). Prevention of Surgery: a synthesis of current recommendations. *European review for Medical and Pharmacological Sciences,* 23(2): 224-239.

WHO. Bulletin of the World Health Organization. 2011; 89:757-765

Zerr, D.M., Garrision, M.M., Allpress, A.L., Heath, J., Christakin, D.A. (2005). Infection Control Policies and Hospital-Associated Infection among Surgical Patient; Variability or Association in a Multicentre Peadiatric Setting, *Peadiatrics*, 4(1): 387-392.