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BACTRERIAL CONTAMINATION OF OPERATING THEATRES AT A TERTIARY HOSPITAL IN BAUCHI, NORTHATSERN NIGERIA

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ABSTRACT

Bacterial contamination of operating theater is a major risk factor for increased incidence of surgical site and nosocomial infections in hospitals. Surveillance study allows for minimizing incidence and implements effective control and preventive measures. This study assessed the bacterial contamination level, bacterial pathogens and their resistance pattern in the two operating theaters in our hospitals.150 specimens were collected from two operating theaters, Main (MOT)(n=80) and Obsteristic and Gyneacology (O&G OT)(n=70) based on pre-identified inanimate items/surfaces and designated points and analyzed using standard microbiological methods. Overall bacterial contamination rate was 56.7%, 40% in MOT and 75.7% in O&G OT. High contamination rate of Staphylococcus aureus, coagulase negative staphylococci and Bacillius spp were recorded in both units. Clinically relevant pathogens, Klebsiella spp, Enterobacter spp, Enterococcus spp, Pseudomonas aeruginosa were recovered from routinely used equipments, with more pathogens from the O&G OT. High resistant to cotrimoxazole, amoxicillin, ampicillin-clauvanic acid, streptomycin, gentamycin, and erythromycin, observed with bacterial isolates from O/G OT. While the findings portray the level of bacterial contamination within the units, the high rate within the O&G OT posses greater risk for postoperative infections, necessitating need for effective cleaning and disinfection practices and adherence to basic standard infection procedures.

KEYWORDS: Bacterial contamination, operating theater, antibiotic resistance, Nigeria.

INTRODUCTION

Operating theater is one of the most important clinical units in hospital setting where surgical procedures are carried out under relatively sterile ecosystem. The operating ecosystem depends on the structure of the theaters, design layout, ventilation system and adherence to basic standard infection control procedures by health care workers [1-4]. Bacterial contamination of the operating theaters remains one of the major risk factors responsible for increasing incidence of surgical sites infections worldwide, and high morbidity and mortality rate associated with nosocomial infections[5-9l].Surgical site infections accounts for serious complications in hospital associated infections and 38% of nosocomial infection observed in surgical patients[5,9, 10], while nocosomial infections in developed countries varies between 5% and 10% compared to 25% in developing countries[11,12].Patients undergoing either stabilization or life threatening procedures are often exposed to high level of contamination from the environment and hands of health care workers resulting in postoperative infections[13, 14]. Factors responsible for bacterial contamination in OT units can be classified into two, external and internal. The external factors includes the air quality system/ventilation, design of the units, occupancy density, traffic and activities within the units and door opening rate[2,3 11], while the internal factors includes, colonization/infection of the health care personnel/patient, contaminated surface and equipment used routinely, and air quality within the units[16,17].similarly, the rate of surgical site infections have been linked with the level of microbial load(microbial colony unit)[4]. To reduce intraoperative bacterial contamination, proper design and ventilation system and behavioral measure needs to be adopted within the units, particularly the use of appropriate protective attire and limited medical activists [1, 17, 18]

Indoor air quality within the units plays a crucial role in the contamination level, because the airborne microbial concentration and particle mass is directly related to human activity, number of people and type of clothing worn by the health care personnel and patients within the units. The frequency at which people enter and exit the

units increase the quality of microorganisms in the units.[2, 3, 11, 19]

Microbial contamination of the OT includes bacteria, viruses and fungi. These pathogens possess potential of prolonged survival on the surface of inanimate items/ equipments and air, capable of initiating infections, acquiring resistant genes and disseminating within the units and hospital environment [20, 21]. Wide range of bacterial pathogens associated contamination have been documented, which includes staphylococci aureus (S. aureus) and coagulase negative staphylococc (CoNS), E.coli, Proteus spp, Pseudomonas aeroginosa (P. aeroginosa), Enterococcus spp and Enterobacter spp[22-25], potentially able to emerge as multidrug resistant strain, and also used as indicators of assessing the level of cleanliness of the units[26].

As antibiotic resistance has assumed a global phenomenon with its attendant consequential effect, the operating theatre is a reservoir and centre point for emergence of multidrug resistance (MDR) pathogens and dissemination into the hospital environment. Despite the high level of relative hygiene and cleanliness and basic knowledge of infection control and prevention procedures, incidence of nosocomial infections directly or indirectly related to bacterial contamination continued to increase in both developed and developing countries[5,9]. Surveillance within the unit to generate the much necessary epidemiological information becomes imperative, as template for infection control and prevention policy formulation. Based on this information, we decided to assess the bacterial contamination level in the two operating theaters' in our hospital

MATERIALS AND METHODS

This descriptive study was conducted in two operating theaters, Main (GOT) and Obstetrics and Gynecology (O&GOT) units of Abubakar Tafawa Balewa University Teaching Hospital (ATBUTH), Bauchi Nigeria between October and December 2015. It is a 650 bed capacity tertiary hospital that provides multi specialized services and a major referral centre in the north eastern geographical zone of Nigeria. The study protocol was approved by the institutional review board, before commencement. A standard study questionnaire was applied with the pre-identified inanimate items/equipments and pre-designated points within the units for open-plates methods. The two sampling methods employed were swabbing and open -plate as described by Javed et al[27].

For swabbing method, a sterile swab stick was moistened in sterile normal saline, and rolled severally on the pre-designated items/equipments, and labeled properly before transporting to the Laboratory for processing. In the open-plate method, Blood and MacConkey agar plates were placed at 1 meter above the ground, exposed for 15minute. After the exposure, the plates were covered and labeled properly and transported to the laboratory for processing. The swabs were inoculated onto Blood and MacConkey agar plates, incubated at 37^0C for 24 hours, alongside with the plates collected from the open-plates methods. Presumptive bacterial isolates were identified by colonial morphology, gram reaction and standard biochemical tests. Further evaluations of the bacterial isolates were carried on Vitek-2 equipment [manufactured by BioMerieux, Durham, USA]

Antibiotic Susceptibility testing was carried by disc diffusion technique according to CSLI guideline on Mueller Hinton agar. The antibiotic discs tested, were ampicillin, ciprofloxacin, gentamicin, trimethoprim-sulfamethoxazole, erythromycin, ofloxacin, streptomycin, amoxicllin, amoxicline-clavunalic acid. The bacterial isolates zone of growth inhibition diameter was measured and interpreted according to the guidelines.

The SPSS version 17.0 statistical package was used to analyze data, values expressed in frequency and percentages.

RESULTS AND DISCUSSIONS

Results

Of the 150 specimens collected and analyzed (80 from GOT and 70 from O/G OT), overall, 85(56.7%) yielded positive bacterial growth, 32 (37.6%) recovered from the GOT(n= 16 each by swabbing and open-plate), and 53(75.7%) from O&G OT, swabbing accounted for 25(47.2%) and open-plate 28(52.8%) respectively. Seventeen different bacterial species were isolated. Coagulase negative staphylococci (CoNS) 38.8%(n=33) and S.aureus 28.2% (n=24) predominate in both units, followed by Bacillus spp 9.4% (n=8). The clinically relevant pathogens identified in both units include, Klebciella pneumonia (K. pneumonia) 4.7%(4), Klebsiela oxytoca 1.2%(1), Acineobacter baumanii (A.baumanii) 1.2%(1), Enterobacter spp 1.2%(1) and Enterococcus spp 4.7%(4) respectively.

Table 1: Frequency of bacterial pathogens isolated in both units and methods employed

Bacterial pathogens	General operating theatre		O&G Operating theatre		Total
	Swabbing	Open -plate	Swabbing	Open-plate	No (%)
S.aureus	3	1	9	11	24(28.2)
CoNS	8	8	7	10	33(38.8)
Bacillus spp	1		3	4	8(9.4)
K.pneumoniae		2	1	1	4(4.7)

K. oxytoca				1	1(1.2)
P.aeruginosa				1	1(1.2)
A.baumannii			1		1(1.2)
Enterobacterspp		2			2(2.4)
Enterococcus gallinarium			1		1(1.2)
Enterococcus malodrium			1		1(1.2)
Enterococcus hirae			1		1(1.2)
Enterococcus muinditis			1		1(1.2)
Citrobacterspp	2				2(2.4)
Serratiaspp		2			2(2.4)
Corynebacteriumspp	1				1(1.2)
Lactobacillus spp	1				1(1.2)
Arcanobacillusspp		1			1(1.2)
Total	**16(18.8%)**	**16(18.8)**	**25(29.4%)**	**28(32.9)**	**85(100)**

Table 2: Bacterial contamination of inaminate surface and air quality in General OT

Bacterial pathogens	**General operating theatre**		**O&G Operating theatre**		**Total**
	Swabbing	**Open -plate**	**Swabbing**	**Open-plate**	**No (%)**
S.aureus	3	1	9	11	24(28.2)
CoNS	8	8	7	10	33(38.8)
Bacillus spp	1		3	4	8(9.4)
K. pneumoniae		2	1	1	4(4.7)
K. oxytoca				1	1(1.2)
P. aeruginosa				1	1(1.2)
Acineobacter baumannii			1		1(1.2)
Enterobacterspp		2			2(2.4)
Enterococcus gallinarium			1		1(1.2)
Enterococcus malodrium			1		1(1.2)
Enterococcus hirae			1		1(1.2)
Enterococcus muinditis			1		1(1.2)
Citrobacterspp	2				2(2.4)
Serratiaspp		2			2(2.4)
Corynebacteriumspp	1				1(1.2)
Lactobacillus spp	1				1(1.2)
Arcanobacillusspp		1			1(1.2)
Total	**16(18.8%)**	**16(18.8)**	**25(29.4%)**	**28(32.9)**	**85(100)**

Bacterial contamination of inanimate items/equipment and air quality in the general OT as presented in table 3, showed high contamination of CoNS 50%, (n=16) and S.aureus 12.5%, (n=4) isolates from items/ equipments, while air quality was 25%(n=8), in O&G OT, S.aureus 37.7%(n=20), CoNS 32.1%(n=17) and air quality of 41.5%(n=22)(table 3). High contamination was recorded with the floors in both units,18.7%(n=6) and 18.9%(n=10) ,from the following pathogens, S.aureus, CoNs, Enterococcus gallirum and Bacillius spp while no pathogens was recovered from door handle and sterile equipment sampled.

Table 3; Bacterial contamination of inanimate surface and air quality in O and G theater

	SA	**CoNS**	**EG**	**EM**	**EH**	**EM**	**KO**	**KP**	**AB**	**PA**	**CIT**	**BAC**	**Total(%)**
Open plate	**11**	**10**									**1**	**4**	**26(49.1)**
Bed surface	**3**												**3(5.6)**
Door handle	**1**								**1**				**2(3.8)**
Wall	**2**												**2(3.8)**
Floor	**2**	**5**	**1**									**2**	**10(18.5)**
Trollies		**1**											**1(1.9)**
Cylinder				**1**	**1**	**1**							**3(5.6)**
Oxygen concentrator													
Sterile equipment													
Anesthesia												**1**	**1(1.9)**

machine													
Stool													
Ampo bag													
Scrubbing area	**1**												**1(1.9)**
Suction machine		**1**					**1**	**1**		**1**			**4(7.5)**
Total	**20()**	**17()**	**1()**	**1()**	**1()**	**1()**	**1()**	**1()**	**1()**	**1()**	**1()**	**7()**	**53(100)**

SA-S.aureus, CoNS-cogulase negative staphylococcus , EG-Enterococcus gallinarium, EM-Enterococcus malodrium, EH-Enterococcus hirae, EM-Enterococcus muinditis, KO-Klebsiella oxytoca, KP-Klebsiella pneumoniae, AB-Acineobacter baumanii, PA-Pseudomonas aeruginosa, CIT-Citrobacterspp, BAC-Bacillius spp.

Clinically relevant pathogens recovered from inanimate item/equipments were CoNS, K. pneumonaie, K.oxytoca and P. aeriginosa from the suction machine, A. baumanii from the door handle, S. aureus from the stool and Enterococcus spp from floor and cylinder.

Moderate to high resistance pattern was observed (table 4) to cotrimoxazole, amoxicillin and ampicillin. In the GOT, S.aureus resistance percentage range between 25%-75%, CoNS (38-69%), while Bacillus spp, Enterobacter spp and K. pneumoniae demonstrated high sensitivity pattern. In O/G OT, S.aureus and CoNS demonstrated similar pattern, while Enterococcus spp, Klebsiela. .pneumoniae, Klebsiela oxytoca, A.baumanii and Pseudomonas aerugonsa depicited high resistance pattern to cotrimoxazole, amoxicillin, ampicillin while resistance to gentamycin erythomycin and streptomycin was limited to A.baumanii and Pseudomonas aeroginosa.

Table 4: Antimicrobial resistant pattern of bacterial pathogens isolated from both units sampled (%)

Bacterial isolates/unit	CIP	OFX	S	SXT	AMOX	AMP	CN	AU	ERY
GOT									
S.aureus				25	76	75	25	NT	25
CoNS	6			44	38	69	44		
Bacillus spp									
Enterococcus spp									
Kleb.pneumoniae								50	
O&G OT									
S.aureus			10	30	80	70	10		10
CoNS	25		40	18	66	77	24		6
Enterococcus spp				100	100	100			50
Klebpneumoniae			50	50	100	100			
Kleboxytoca				100	100	100			
Acineobacterbaumanii				100	100	100	100		100
Pseudomonas aeruginosa			100	100	100	100	100		100
Citrobacterspp									
Bacillus spp			14	14	14	14	30		14

CoNS-coagulase negative staphylococci spp, SXT-cotrimoxazole, AMOX-amoxicillin, AMP-ampicillin, CN-gentamycin, AU-Augmentin, ERY-erythromycin.

DISCUSSION

Bacterial contamination of inanimate items/equipment and air quality in the operating theater remains major contributory factor to increasing incidence of surgical site infections and nosocomial infections, with attendant negative impact of prolonged hospitalization, increased medical expenses, difficulty in patient management and high morbidity and mortality rate[,5,9, 13, 28]. Therefore, the findings of this study has provided the necessary baseline information to the hospital infection control and prevention unit as template for policy formulation and intervention measure to minimize the possible spread and dissemination within the unit and hospital environment.

In this study, overall bacterial contamination rate recorded in both units was 56.7% 37.6% in the general operating threatre and 62.4% in the Obsterisitic and gyneacology operating threatre. Similar studies has reported different rate, 70% and 62.8% in Maiduguri[23,24], 62.5%[27] and 24.7% in Gaza Paletine[29], The observed difference in contamination rate, simply highlight the effect of the external and internal factors on microbial load level attributable to occupancy density, traffic and movement, human activities, ventilation system and level of cleanliness as

well as adherence to basic infection control (hand washing).[2,3,11,19]

Air quality assessment by the open plate method, 48.5 %(n=16) contamination rate was recorded in the general OT and 53.8% (n=19) in O/G OT, in which staphylococci predominate in both units, 48.5% and 49.1% respectively. Similar pattern have been recorded in other studies.[23, 24, 25,30] This is a reflection of air quality within the units which is dependent on ventilation system, cleaning procedures, and degree of activity[28]. Staphyloccci is a normal flora of human skin and mucosa memberane that are continuously shed due to human activity and aerolised[31]. However, high contamination rate recorded from the O&G OT, which may be due to higher surgical procedures, occupancy density and human activities. An average of 31 surgical procedures is performed per week compared to 24 in the GOT. The source of Klebsiella pneumoniae, Enterobacter spp and Serratia spp, isolated in the study, may have emanated from clinical specimens, or contamination of equipment and items routinely used[24].

Of the 33 bacterial pathogens recovered from GOT by swabbing method, coagulase negative staphylococci were recovered from routinely used equipment and crucial areas in the units, such as suction machine, anaethesia machine and scrubbing area. On the other hand in the O&GOT, S.aureus from scrubbing, coagluase negative staphylococci, Klebsiella spp and Pseudomonas aerugibosa from the suction machine and A.baumanii from the door handle were isolated. While this findings posed serious clinical problem in patient management likewise these pathogens possess the potential of emerging as multidrug resistant upon exposure to excessive antibiotic usage further corroborate the contributory role of health care and patient as vehicle of pathogen transmission[26].

With 17 different bacterial species identified in the study, 6 can be classified as clinically relevant pathogens namely, S.aureus, coagulase negative staphylococci, Klebsiella spp, Acineobacter baumanii, Pseudomonas aeruginosa and Enterococcus spp, because of their potential to initiate infection in postoperative cases, acquire resistance gene upon exposure to excessive antibiotic usage and rapid dissemination in hospital environment. Coagulase negative staphylococci and S.aureus isolates predominate in both unit, a pattern reported in previous studies [23-25,30]. Other studies had reported Bacillus spp[32], and Pseudomonas aerugionsa [29] as the leading pathogens. Apart from the human skin of heatlh care worker and patient, clothing contribute significantly to the Bacillus spp and staphylococci contamination [33] The clinical implication of the pathogens is that , staphylococci spp can acquire the mecA gene to emerged as methicillin resistant strains while E.coli, lebsiella spp, Pseudomonas aerugionsa and A.baumanii are known ESBL -producing isolates.[26]

As the trend of antibitoic resistance continued to evolve, bacterial contamination responsible for postoperative infection tends to fuel the emergence of MDR pathogenesis[15,20]. Therefore, assessment of the contamination rate and antibiogram of the pathogens tends to serve as early warning signal for prompt actions. In this study, we observed high resistance to cotrimoxazole, amoxicillin and ampicillin, similar to pattern recorded in studies conducted in developing countries[23,24], but isolates from O/G OT exhibited resistance to two other drugs -, gentamycin, and erythomycin. Incidentally these are among the cheapest and most commonly used antibiotic and therefore should be a cause for concern. The reason for difference in resistance pattern may be related to antibiotic usage, and thus highlight the need for antimicrobial stewardship programme.

Though this study has provided valuable information in infection control and prevention assessment in both units, nevertheless there are limitations, such as the duration of the study was relatively short, to consider the contamination over a longer period and present a more comprehensive picture, pre-and post-fumigation procedure was not included in the scope of the study.

CONCLUSION

The finding has presented the bacterial contamination rate within the units, and factors responsible for the rate need to be addressed promptly. Efficient and effective cleaning procedure, especially the surface of inanimate item/equipment with the use of 70% alcohol for cleaning routinely used equipment before and after use. Infection control and prevention measures needs to be implemented against clinically relevant pathogens like Acineobacter baumannii, Enterococcus spp, as they posed a serious problem considering their clinical implication because of capability of emerging as multidrug resistant pathogens and dissemination within hospital environment.

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