African Journal of Microbiology Research Vol. 6(13), pp. 3092-3096, 9 April, 2012
Available online at http://www.academicjournals.org/AJMR
DOI: 10.5897/AJMR11.834
ISSN 1996-0808 ©2012 Academic Journals

Full Length Research Paper

Bacterial contamination of operating theatre and other specialized care unit in a tertiary hospital in Northeastern Nigeria

Okon K. O.[1]*, Osundi S.[1], Dibal J.[2], Ngbale T.[3], Bello M.[4], Akuhwa R.T.[4], Balogun S. T.[5] and Uba A.[6]

[1]Department of Medical Microbiology, College of Medical Sciences, University of Maiduguri, Nigeria.
[2]Intensive care Unit, University of Maiduguri Teaching Hospital, Maiduguri, Nigeria.
[3]School of Perioperative, University of Maiduguri Teaching Hospital, Maiduguri, Nigeria.
[4]Department of Peadiatrics, University of Maiduguri Teaching Hospital, Maiduguri, Nigeria.
[5]Department of Clinical Pharmacology and Therapeutics, College of Medical Sciences, University of Maiduguri, Nigeria.
[6]Department of Biological Sciences, Abubakar Tafawa Balewa University, Bauchi, Nigeria.

Accepted 15 December, 2011

Bacterial contamination in operating theatre and other specialized care units had contributed to nosocomial infections. The study examined the level of bacterial contamination in these specialized care units in University of Maiduguri Teaching Hospital. Of the 267 samples collected and analysed, 70.0% (n=186) were positive for bacterial growth, 14.1% (n=26) by open plate and 85.9% (n=160) by swabbing method, respectively. Coagulase-negative *Staphylococci* spp. accounted for 72.1% (n=134) of bacteria pathogens isolated, followed by *Proteus* spp. 8.6% (n=16), *E. coli* 8.0% (n=15), *Pseudomonas aeruginosa* 6.9% (n=13) *Coliforms* and *Klebsiella pneumoniae* were 2.2% (n=4) each, respectively. The degree of bacterial contamination showed that coagualse-negative *Staphylococci* predominate in all units sampled, with varied frequency of occurrence of other bacteria pathogens. Antibiotic susceptibility pattern of bacterial pathogens showed relative sensitivity to the drugs, particularly with cotrimoxazole, ampicillin, gentamycin and amiplicox. In conclusion, the relatively low level of bacterial contamination of the air compared to the high level with equipments and objects indicates the needs for periodic microbiological surveillance aimed at early detection of bacterial contamination level and subsequent effect on nosocomial infection.

Key words: Bacterial contamination, operating theatre, specialized units, antibiotic susceptibility, tertiary hospital.

INTRODUCTION

Microbial contamination of hospital environment, especially the operating theatre and other specialized units had continued to increase prevalence of nosocomial infection (Bonten et al., 1996; Boyce et al., 1997; Hayden et al., 2006; Bhalla et al., 2007). With resultant effect of high morbidity and mortality rate among patient on admission for post-operative surgery, those in intensive care units with multi-drug resistant strain like methicillin-resistant *Staphylococcus aureus* (MRSA) and difficulty in infection control (Zerr et al., 2005). In hospital setting, reduction of microbial contamination impact depends primarily on improved cleaning and proper disinfection of the hospital environment, especially high risk areas, as these measures are crucial to stemming down dissemination of these microbial contaminations (Frindkin and Jarvis, 1996).

Source of microbial contamination is diverse, from surgical/medical team, movement within the units, theatre gown, foot wares, gloves and hands, drainage of the wounds, transportation of patients and collection bags

*Corresponding author. E-mail: okonkenneth@gmail.com.

Table 1. Bacterial pathogens isolated and frequency of occurrence.

Organism	Frequency (%)
Coagulase-negative *Staphylococcus (CoNS)*	134(72.1)
Proteus spp.	16(8.6)
Escherichia coli	15(8.0)
Pseudomonas aeruginosa	13(6.9)
Coliform	4(2.2)
Klebsiella pneumoniae	4(2.2)
Total	186 (100)

(Emmerson, 1998). The impact of these sources on the degree of bacterial contamination differs, depending on the numbers of bacterial pathogens involved. Similarly, the level of contamination can be reduced, if high level of hospital hygiene is adhered to by health care worker. The type of ventilation used in operation theatre also helped to reduce the level of bacterial contamination (Mora, 2001).The clinical implication of bacterial contamination in operating theatre and specialized care units, and overall effect in infection control in hospital setting is enormous on both the patient and the caring medical team. Based on this observation, we decided to evaluate the level of bacterial contamination level in our hospital operating theatre and other specialized units.

MATERIALS AND METHODS

The study was conducted in University of Maiduguri Teaching Hospital (UMTH), between October and December 2009. UMTH is a tertiary hospital and major referral centre for other hospitals in the north eastern geographical zone of Nigeria and the neighbouring countries of Niger, Chad and Cameroon. It has a 500 bed capacity, with hospital with subspecialty in Medicine, Surgery, Paediatrics, and Pathology. The study sites were operating theatres, intensive care unit (ICU), special care baby unit (SCBU), Kidney centre, Central Sterile Service Department (CSSD). The criteria of selection of the study site were based on the fact that these units are expected to be sterile. The main operating theatre consists of 5 operating room, 1 recovery room, patient reception room, and staff changing room. The intensive care unit (ICU), made up of general ward, and one ward each designated for patient isolation and burn patients. The Special care baby unit (SCBU) consists of 3 wards for neonates on admission, nursing station and mother feeding room. The Kidney centre is made up of the nursing station, one dialysis room each for hepatitis – negative, hepatitis B-positive and hepatitis C-positive patients. The CSSD is responsible for sterilization of surgical materials, and has 1 packing room, 1 sterilizing area and washing room. Of these units identified for the study, the floors, walls, operating tables, windows, air vents/conditioners and the equipments present in the units were sampled for analysis. Information collected were type of room equipments, number of staff per each unit, and type of disinfectant used daily in cleaning.

Two sampling procedures used in the study were open plate and swabbing, as described by Javed et al. (2008). Sampling procedure was done in duplicate per each unit during the study period. In the open plate method, blood agar and MacConkey plates were placed horizontally about 1 meter above the ground and exposed for 15 min in the 6 designated locations per unit. Swabbing method, sterile swab sticks were used to swab the surface of equipments/materials used in operating theatre and specialized units the samples were transported in new transparent disposable bags to the laboratory for processing. A total of 267 microbiological samples were collected from five identified units of the hospital.

Microbiological procedures

The swab sticks were inoculated on sterile blood agar and MacConkey plates, and the open plates were incubated at 37℃ for 24 h. After incubation, bacterial colonies were identified by standard bacteriological procedures (Cowan and Steel, 2004). Antibiotic susceptibility testing of the bacterial isolates was determined by Kirby-Bauer disc- diffusion method using Mueller-Hilton agar, with the following antibiotic discs, ciprofloxacin, streptomycin, cotrimoxazole, chloramphenicol, erythromycin, amoxicillin, ampicillin, gentamycin and ampiclox. Afterwards the plates were read and microbial susceptibility was interpreted based on the zones of growth inhibition diameter.

RESULTS

Of the 267 samples examined, 70% (n=186) yielded positive bacterial growth, with 14.1% (n=26) from open plate methods and 85.9% (n=160) from swabbing respectively. The distribution of bacterial pathogens isolated is presented in Table 1, Coagulase-negative *Staphylococci* (CoNS) accounted for 72.1% (n=134), followed by *Proteus* spp. 8.6% (n=16), *Escherichia coli* 8.0% (n=15), *Pseudomonas aeruginosa* 6.9% (n=13), and the least were *Coliforms* 2.2% (n=4), *Klebsiella pneumonia* 2.2% (n=4).

The distribution of bacterial pathogens within the operating theatre and other specialized care units is presented in Table 2, Coagulase-negative *Staphylococci* (CoNS) predominate in all the units sampled, 26.1%(n=35) in the operating theatre, 2.9% (n=4) in Kidney centre, 26.1%(n=35) in intensive care unit, 32.8%(n=44) in special care baby unit and 11.9%(n=16) in CSSD. *K. pneumoniae* in the operating theatre was 25.0% (n=1) and 75% (n=3) in SCBU, *P. aeroginosa* isolates in operating theatre was 7.6% (n=1), 38.4% (n=5) in ICU, 38.4% (n=5) in SCBU 38.4% (n=5), and15.3% (n=2) *Coliforms* that were isolated, 75% (n=3) in ICU and 25% (n=1) in SCBU, and for *E. coli* isolates, 20% (n=3) where found in the Kidney centre, 6.6% (n=1), in ICU, 66.6% (n=10) in SCBU and 6.6% (n=1) in CSSD.

Table 2. Distribution of bacterial pathogens isolates from operating in theatre and other specialized care units sampled.

Location	Site	CoNS	Kleb	Pseudo	*Coliforms*	*E. coli*	*P. Proteus*
Theatres	OT1	6	-	1	-	-	-
	OT2	7	1	-	-	-	-
	OT3	7	-	-	-	-	-
	OT4	6	-	-	-	-	-
	OT5	7	-	-	-	-	-
	Rec	2	-	-	-	2	-
KIDCEN	HB rm	2	-	-	-	2	-
	HC rm	1	-	-	-	1	-
	H. free	1	-	-	-	-	1
ICU	Isolation	4	-	1	-	-	-
	Burns	4	-	1	-	-	2
	General	27	-	3	3	1	4
SCBU	Rm1	13	1	3	1	5	1
	Rm2	14	-	2	-	3	2
	Rm3	17	2	-	-	2	5
CSSD	PA	8	-	1	-	-	1
	SA	4	-	1	-	-	-
	WA	4	-	-	-	1	-
Total	186 (100%)	134 (72.1%)	4 (2.2%)	13 (6.9%)	4 (2.2%)	15 (8.0%)	16 (8.6%)

OT1=Operating theatre 1, OT2=Operating theatre 2, OT3=operating theatre 3, OT4= operating theatre 4, OT5 =Operating theatre 5, Rec=Recovery room, KIDCEN= Kidney centre, HB rm= Hepatitis B positive room, HC rm=Hepatitis C room, H. Free=hepatitis free room, ICU=Intensive care unit, SCBU=Special care baby unit, Rm1=room 1, Rm2=room 2, Rm3=room 3, CSSD=central sterile service department, PA=packing area, SA=sterile area, WA=washing area, CoNS- coagulase negative *staphylococci,* kleb-*klebsiella pneumoniae,* Pseudo- *Pseudomonas aeruginosa.*

For *Proteus* spp. that were isolated, 6.2% (n=1) were found in Kidney centre, 37.5% (n=6) in ICU and 56.2% (n=9) in SCBU.

The antibiotic resistance pattern as shown in Table 3 reveals that the isolates were highly resistance to commonly used antibiotic like cotrimoxazole, ampicillin and gentamycin, coagulase-negative *Staphylococci* showed highest resistance to ampiclox 75 (55.9%), *K. pneumoniae* showed the highest resistance to ampicillin 3 (75%), and the most resistance organism that was isolated was *Pseudomonas aeruginosa* which showed total resistance to three drugs; cotrimoxazole (100%), ampicillin (100%) and gentamycin (100%), *Coliforms*, *E. coli*, and *Proteus* spp. showed the highest resistance to cotrimoxazole.

DISCUSSION

Bacterial contamination of operating theatre and other specialized care units like intensive care units in hospital setting had contributed significantly to high prevalence of nosocomial infections (Weber et al., 1976). The resultant effect of bacterial contamination is much more pronounced in post-operative /or open wound that could occurs during dressing or contaminated air atmosphere in the operating theatre and other specialized units.

In our study, 14.1% (n=26) positive bacterial isolates were obtained from the open culture plate technique. This level of bacterial contamination simply revealed the quality of air within the sampled units. Primarily, the quality of indoor air depends on external and internal factors such as the type of ventilation system, cleaning procedures, surgical /medical team and degree of activity (Suzuki et al., 1984; Fleischer et al., 2005). The effect of external factor can be explained by the presence of coagulase-negative *staphylococci* isolates that pre-dominate in sampled units by open plate method. The primary ecology niche of *Staphylococci* is anterior nare, axilla and groin, and small numbers of individuals are

Table 3. Antibiotic resistance pattern of bacterial pathogens isolated.

Antimicrobial agent	CoNS (n=134)	Kleb (n=4)	Pseudo (n=13)	Coliforms (n=4)	*E. coli* (n=15)	Proteus (n=16)
Ciprofloxacin	17(12.6%)	NA	1(7.6%)	NA	NA	NA
Streptomycin	35(26.1%)	2(50%)	3(23.1%)	1(25%)	3(20%)	9(56.2%)
Cotrimoxazole	NT	2(50%)	13(100%)	2(50%)	14(93.3%)	16(100%)
Chloramphenicol	51(38.0%)	NT	NT	NT	NT	NT
Erythromycin	44(32.8%)	NT	NT	NT	NT	NT
Amoxicillin	45(33.5%)	NT	NT	NT	NT	NT
Ampicillin	NT	3(75%)	13(100%)	1(25%)	10(66.6%)	9(56.2%)
Gentamycin	NT	2(50%)	13(100%)	1(25%)	4(26.6%)	13(81.2%)
Ampiclox	75(55.9%)	NT	NT	NT	NT	NT

NT- not tested, NA- no activity, CoNS- coagulase negative *staphylococci,* kleb- *klebsiella pneumoniae,* Pseudo- *Pseudomonas aeruginosa*.

carriers in which relatively number of these *Staphylococci* could be shed in the air in high activity state (Hughes and Anderson, 1999).

In contrast, higher level of bacterial contamination, 85.9% (n=160) was recorded by swabbing method. This value might not be surprising, as high traffic density of personnel and students are involved in the day- to-day surgical /clinical procedures in the operating theatre/other care units, which could serve as source of bacterial contamination evident in our findings. Duguid and Wallace (1948) reported that increased activity enhanced the dispersion of bacteria. Also, movement can shed up to 10,000 skin scales per minutes of which 10% carry cluster of microorganism (Hughes and Anderson, 1999).

The breakdown of bacterial pathogens isolated showed the coagulase-negative *Staphylococci* predominate in all units, which is consistent with similar reported studies (Suzuki et al., 1984; Javed et al., 2008; Ensayel et al., 2009). Coagulase-negative *Staphylococci* are known exogenous organism, often referred to as contaminant (Ensayel et al., 2009). The source of CoNS in such study include normal skin flora of medical personnel, patients and fabrics (Chacko et al., 2003). However, clinical implication of CoNS is more pronounced in immunocompromised patients, as entry into systemic environment could initiates infection. Apart from CoNS, *P. aeruginosa* (6.9%), *E. coli* (8.0%), and *Proteus* spp. (8.6%), and the least *Coliform* spp. (2.2%) and *K. pneumoniae* (2.2%) are bacterial pathogens frequent encountered within hospital environment. Intrahospital 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.

Available information provided, these units are regularly disinfected on daily basis, despite the relative presence of these bacterial pathogens recorded. The high human population, especially the theatres staff and medical students, within these units might be responsible for bacterial contamination. The operating theatres have 5 operating beds, which could accommodate an average of 12 patients per operating days. However, on operating days, the numbers of staff/students within the theatre could increased from 13 to 100 medical personnel/ student in the units, this could leads to overcrowding, thereby leading to bacterial contamination. Lidwell et al. (1982) suggested that number of operating team should kept relatively low as 6 persons per operating theatre, as possibility of bacterial contamination is higher if the number is increased up to 15. In order to reduce such bacterial contamination in a teaching hospital environment, particularly in operating theatre, provision of a real time audio-visual facility could be provided. In addition, departmentalisation of surgical theatres, into different subspecialty units like orthopaedics, paediatrics, operating room would help decongest the central operating theatres.

Apart from coagulase-negative *Staphylococci*, certain gram negative bacteria *Klebsiella pneumonia* 1(25%) and *Pseudomonas* spp*.* 1 (7.6%) were isolated. Although, the frequency is relatively low but their clinical significance in nosocomial infection cannot be ruled out. The special care baby unit (SCBU) serves as nursery for neonates and high level of sterility is of high clinical importance, because of patient with low level of immunity. The bacterial contamination pattern in the unit showed high presence of coagulase-negative staphylococci compared to gram-negative bacteria, *E. coli* (66.6%), *Pseudomonas* spp. (56.2%) *Proteus* spp. (56.2%), *K. pneumoniae* (38.4%) and *Coliforms* (25%). However, in our study, the relatively high level of bacterial pathogens can be attributed high movement of medical staff and mother of the babies in the course of treatment and breast-feeding.

In the ICU, similar bacterial pathogens were observed; however, mixed growths were recovered from equipments such as the mechanical ventilators, ward gowns, syringe pumps, trolleys and beds. The presence of these bacterial pathogens on this resuscitating equipment could serve as means of transmission in critically ill patients.

The CSSD plays a critical role in the reduction of nosocomial infection especially those related to surgical infections. Bacterial pathogen isolated from CSSD were, CoNS, 16 (80%), *P. aeruginosa* 2 (10%) and *E. coli* 1 (5%). The presence of these pathogens in this units that is supposed to be sterile posed a serious clinical problem especially presence of *P. aeruginosa* isolated that may be difficult to control.

The antibiotic resistance pattern revealed relatively high susceptibility of the pathogens to drugs tested. However, some of pathogen exhibited mutli-resistant pattern especially *P. aeruginosa*, *E. coli* and *Proteus* spp. isolates. In such units, in which bacterial pathogens were isolated high level of disfecting procedures is required to be carried out. Similarly, staff and students should be trained on the need for high level of high hygiene in order to reduce further bacterial contamination.

In conclusion, the high level of bacterial contamination in the sampled units, particularly with the equipment and objects used calls for prompt attention and intervention measures. This measure be achieved by improvement in the cleaning and disinfection procedures and sometimes needs for periodic fumigation of the units.

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