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Bacterial Contamination of Intensive Care Units at a Tertiary Hospital in Bauchi, Northeastern Nigeria

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Abstract: Bacterial contamination of intensive care units is of clinical concern because it is one of the major risk factors of ICU -acquired infections and centre point of multidrug resistant (MDR) pathogens. Periodic surveillance is an early warning signal to non-adherence of basic standard infection control procedures and emergence of MDR pathogens. This study evaluated the bacterial contamination, bacterial pathogens isolated and their antimicrobial susceptibility pattern in the ICU units. The units sampled were adult and neonatal intensive care units, accordingly to previously described methods and analyzed by standard microbiological methods. A total of 113 samples were collected, overall, 71(62.8%) yielded positive bacterial growth, 15(21.1%) detected by open-plate and 14(19.7%) by swabbing in adult intensive care unit and 20(28.2%) and 22(31.0%) in neonatal care unit. Bacillus spp,Staphylococcus aureus and coagulase negative staphylococci spp predominated in both units 24(33.8%), 19(26.8%), 14(19.7%), Other pathogens 19%, clinically relevant pathogens isolated were Eschericia coli (1%), Klebsiella pneumonia(4%) and Streptococcus pneumonia (3%) respectively. High indoor contamination was recorded in both units, 51.7% (n=15) in AICU and 47.6% (n=20) in NICU and inanimate items/equipments. Clinically relevant pathogens were recovered from routinely used equipment and critical sites. High resistance to commonly prescribed and administered agents, cotrimoxazole, amoxicillin and ampicillin was observed. Though the findings has provided a baseline information for furthered surveillance, but the high indoor contamination within both units signify increased traffic, ventilation system problem and inadequate cleaning procedures.

Keywords: Bacterial Contamination, Intensive Care Units, Bacterial Pathogens, Antibiotic Susceptibility

1. Introduction

Intensive care unit is an integral part of effective health care service that provides care of resuscitating, management and monitoring of life-threatening cases. Clinical activities in the unit involved high antibiotic exposure/ usage, surgical and mechanical manipulation, long hospitalization favoring emergence of multidrug resistant bacterial strains and rapid dissemination, and high morbidity and mortality rate [1, 2]. Bacterial contamination of the unit is one of the major factors responsible for high incidence of ICU associated infection which accounts increased incidence of nosocomial infections, responsible for approximately 40% of ICU admission [3] In neonatal intensive units, diverse neonatal clinical conditions, ranging from low-birth weight to more complex and life-threading ones, requires high clinical care and attention.

Microbial contamination of inanimate surfaces, equipment and indoor environment are bacterial, viruses and fungi, capable of surviving on inanimate surfaces and air for a long time [4]. Contamination occurs via cross-transmission and dissemination, occupancy density, usage of medical equipment for multiple patient like stethoscope, gowns and clothing [5-8], colonized/ infected health care worker/patient, their accessories and clinical specimens [9-11]. Non-adherence of health care worker to simple standard procedure of hand washing, contribute significantly to the spread of pathogens, and cross-transmission during contact with patient or contaminated inanimate surfaces [12, 13]. Human skin is known to harbour significant proportion of bacteria-staphylococci, gram-negative that are shed continuously during clinical activities [14]. Another source of contamination is colonised and infected health care worker and patients in which the pathogens can be shed and recovered from the immediate environment of the patient[14-16], while the dispersion depends on type of organism, source and contamination with the surface, humidity level and size of the inoculum [11, 17]

Wide range of bacterial pathogens have been implicated in ICU contamination, but potentially clinically relevant ones includes S.aureus, coagulase negative staphylococci, Enterobactericiae, Enterococci, as major causative agent of nosocomial infection, emerged as multidrug resistant pathogens(MDR) and compound infection control [5, 18-21]. These MDR pathogens like MRSA, VRSA, ESBL producing Enterobacteriae and Acineobacter baumanii, are used as indicators organism for evaluating the level of adherence to basic standard procedures in intensive care units [11, 13, 24], as failure in these basic procedure tends to increase the dissemination these pathogens within the units and hospital environment. Therefore, periodic Surveillance of ICU is important, firstly to ascertain the level of hygiene and cleanliness, and secondly, the level of bacterial contamination, which might act as early warning signal of potentially pathogenic organism. Epidemiological information generated from such surveillance forms the working template for the hospital infection control and prevention unit to formulate policy and intervention measures. This is first surveillance study to be carried in these units, which is of ultimate clinical importance to the IPC unit. Therefore, considering the importance of the possible findings of the study, we evaluated the bacterial contamination rate of the inanimate surfaces/equipment and air quality within the unit.

2. Methodology

The descriptive cross-sectional study was conducted in the 2 intensive care units, (adult and neonatal) of Abubakar Tafawa Balewa University Teaching Hospital (ATBUTH) Bauchi, Nigeria between Novembers to December, 2015. The study protocol was approved by the institutional review board before the commencement of sampling and analysis. The hospital is a 650 bed size, that provides multimedical specialties and training of health care professional. Sampling was carried out immediately after the daily routine activities. Swabbing and Open plate methods was employed as previously described [25]. The inanimate items/equipments in each units were pre- identified, and the point for open-plate spots were pre-designated accordingly and documented in the study questionnaire.

For the swabbing method, sterile swab stick was moistened in sterile normal saline, and rolled over the pre identified inanimate surfaces /equipments severally before carefully capped and labeled appropriately. The samples were transported to the laboratory for analysis. The swab samples were incubated on Blood and MacConkey plates, and incubated at 37°C for 24 hours. For the open plate method, Blood and MacConkey agar plates were plate at 1 meter above the ground and exposed for 15 minute, before transported to the laboratory for analysis. Suspected bacterial growth were identified by standard bacteriological methods, furthered confirmed by Vitek-2 [manufactured by BioMerieux, Durham, USA]. Antibiotic susceptibility testing was determined by disc diffusion method using Mueller Hinton agar. The following antibiotic discs were tested, ciprofloxacin, ofloxacin, streptomycin, cotrimoxazole, amoxicillin, ampicillin, gentamycin, erythromycin, and cefuroxime. Data analysis-the data was analysed using SPSS version 20.0, values expressed in frequency and percentages.

3. Result

Of 113 specimens were collected and analysed from both intensive care units (adult ICU, n=63 neonatal ICU=50), overall, 62.8%(n=71) yielded positive bacterial growth, 40.8%(n=29) bacterial pathogens were recovered from adult ICU, 21.1%(n=15)) detected by open plate method and 19.7%(n=14) by swabbing method, while 59.2%(n=42) from neonatal ICU, 28.2%(n=20) by open plate and 31.0%(n=22) by swabbing. method respectively Ten different bacterial pathogens were identified, Bacillus spp, S.aureus and coagulase negative staphylococci spp accounted for majority of the bacterial pathogens identified, 33.1%(n=24), 26.8%(n=19) and 19.7%(n=14), while other pathogens are as follows, Klebsiella spp 4.2%(n=3) Corynebacterium spp 4.2%(n=3), Streptococcus pneumonia 2.8%(n=2), E.coli 1.4%(n=1), Micrococcus spp 1.4%(n=1) Diptheroids and Lactobacillius spp, 2.8%(n=2) each respectively (figure 1),

Bacterial contamination of inanimate items and air quality in the adult and neonatal ICUs. as presented in Table 2 and 3, showed that Bacillus spp S.aureus and CoNs accounted for the high contamination rate recorded in both units sampled, 51.7%(n=15) and 47.6%(n=20) respectively.

High contamination rate was recorded with some of the inanimate surfaces, in AICU, suction machine (Klebsiella spp, E.coli, and Corynbacterium spp), trolley (S.aureus, Bacillius spp, and Micrococcus). Floor and oxygen cylinder (Bacillius spp, CoNs) and S.aureus from resuscitation equipment. In NICU, isolation unit (S.aureus, Bacillius spp, Klebsiella spp and Lactobacillius), floor and wall of the

Pretem unit (S.aureus, Bacilllius spp and Diptheriods), Floor (mother room (CoNs, Streptococcus pneumoniae). S.aureus and CoNs contamination were recorded with suction machine, door handle (in-born room), incubator, while streptococcus pneumoniae recovered from the incubator (out-born room). No bacterial contamination was detected on the following items in adult ICU, sterile equipment, table, sphygonometer, and in neonatal ICU, trolley, weighing scale, oxygen concentrator, resuscitator, phototherapy machine and wall of mother's waiting room.

The antimicrobial susceptibility pattern of clinically relevant pathogens tested as presented in table 4 and 5, showed similar pattern with high resistant level to amoxicillin, ampicillin and cotrimoxazole, moderate resistance to erythromycin, and streptomycin and high sensitivity to ciprofloxacin, ofloxacin and gentamycin.

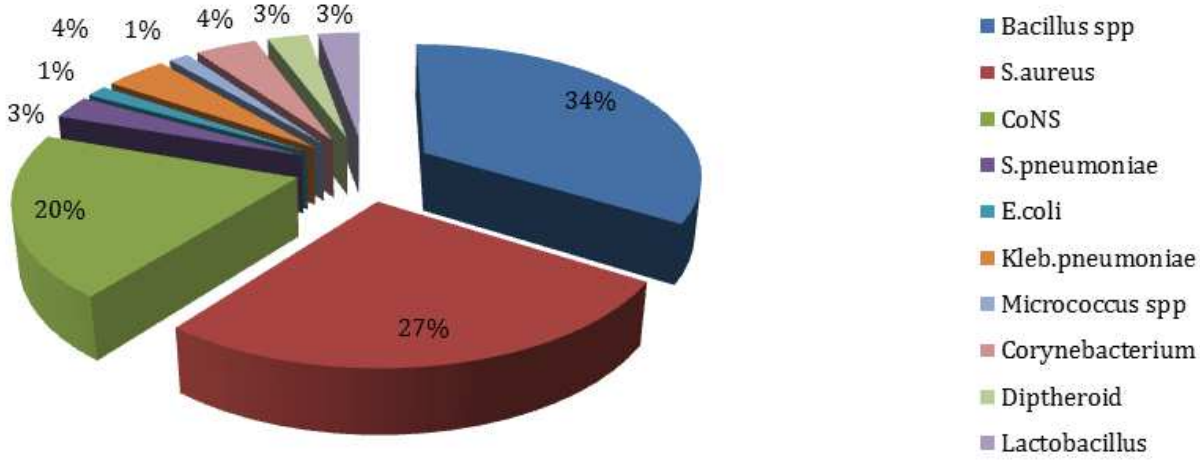

Figure 1. *Distibution of bacterial pathogen isolated from both units.*

Table 1. *Frequency and distribution of bacterial pathogens isolated.*

	Adult ICU		Neonatal ICU		Total
Bacterial pathogens	**open**	**swabbing**	**open**	**swabbing**	
S.aureus	5	3	6	5	19(26.8)
CoNS	3	1	3	7	14(19.7)
Bacillus spp	6	5	9	4	24(33.0)
Strep.pneumoniae				2	2(2.8)
E.coli		1			1(1.4)
Klebsiella spp		1		2	3(4.2)
Micrococcus spp		1			1(1.4)
Corynebacterium spp	1	2			3(4.2)
Diphtheroid			1	1	2(2.8)
Lactobacillus spp			1	1	2(2.8)
	15(21.1)	14(19.7)	20(28.2)	22(31.0)	71(100)

Table 2. *Bacterial Pathogens versus inaniminate surfaces items/equipment and air quality sampled in adult ICU(%).*

Site	***S.aureus***	***CoNS***	***Micrococcus***	***Bacillus spp***	***Corynecbacterium***	***E.coli***	***Kleb.pneumoniae***	**Total**
Open plate	5	3		6	1			15(51.7)
Bed surfaces								3(10.3)
Trolley	1		1	1				
Door handles								
Walls				1				1(3.4)
Floors				2				2(6.9)
Res-Equipments	1							
Oxygen cylinder		1		1				2(6.9)
Sterile equipment								
Tables								
Stools	1							1(3.4)
Sphygonometer								
Suction machine					2	1	1	4(13.8)
Total	8(27.5)	4(13.8)	1(3.4)	11(37.9)	3(10.3)	1(3.4)	1(3.4)	29(100)

CoNS-coagulase negative staphylococci.

Table 3. *Bacterial Pathogens versus inaniminate surfaces items/equipment and air quality sampled in neonatal ICU(%).*

	S.aureus	CoNS	S.pneumoniae	Bacillus spp	Diphtheriod	Lactobacillius	Kleb.pneumoniae	
Open plate	6	3		9	1	1		20(47.6)
Exam table	1							2(4.8)
Trolley								
Weighing scale								
Suctions machine		1						1(2.4)
Incubators(outborn)			1					1(2.4)
Oxygen concentration								
Re-sustainer								
Phototherapy unit								
Baby coat	2							2(4.8)
Door handle(in born)		1						1(2.4)
Sterile equipment								
Floor (mother room)		1	1					2(4.8)
Wall(mother room)								
Door handles(out born)		2				1		3(7.1)
Incubators(inborn)	1			1				2(4.8)
Preterm unit(floor & wall)	1			1	1			3(7.1)
Isolation unit		1		2		1	1	5(11.9)
Total	11(26.2)	10(23.8)	2(4.8)	13(31.0)	2(4.8)	2(4.8)	2(4.8)	42(100)

Table 4. *Antibiotic sensitivity pattern of bacterial pathogens isolated from adult ICU.*

Antibiotics	S.aureus(n=8)	CoNS(n=4)	Bacillius spp(n=11)	E.coli(n-1)	Kleb. pneumonia(n=1)
CIP	8(100)	4(100)	1(100)	1(100)	1(100)
OFX	8(100)	4(100)	1(100)	1(100)	1(100)
S	5(62.5)	3(75)	7(63.6)	1(100)	1(100)
GEN	8(100)	4(100)	11(100)	1(100)	1(100)
ERY	5(62.5)	2(50)	9(81.8)	NT	NT
SXT	3(37.5)	2(50)	4(36.3)	0(0)	0(0)
AMO	0(0)	2(50)	7(63.6)	0(0)	0(0)
AMP	4(50)	3(75)	1(100)	10(90)	2(66.6)

Table 5. *Antibiotic sensitivity pattern of bacterial pathogens isolated from neonatal ICU.*

	S.aureus(n=8)	CoNS(n=4)	Bacillus spp(n=11)	Strep pneumoniae(n-2)	Kleb.pneumoniae(n=2)
CIP	11(100)	9(90)	12(92.3)	2(100)	2(100)
OFX	11(100)	10(100)	13(100)	2(100)	2(100)
S	11(100)	10(100)	13(100)	1(50)	2(100)
GEN	11(100)	10(100)	10(76.9)	0(0)	1(50)
ERY	11(100)	9(90)	6(46.2)	2(100)	NT
SXT	3(27.3)	8(80)	12(92.3)	1(50)	0(0)
AMO	0(0)	4(40)	9(69.2)	2(100)	2(100)
AMP	0(0)	5(50)	7(53.8)	2(100)	2(100)

CIP-ciprofloxacin, OFX-ofloxacin, S-streptomycin, GEN-gentamycin, ERY-erythromycin, SXT-cotrimoxazole, AMO-amoxicillin, AMP-ampicillin.

4. Discussion

Bacterial contamination of ICU is the major factor responsible for increased incidence of nosocomial infections, with attendant consequential effect on patient and hospital management [2, 8]. The findings of this study is of ultimate importance to the hospital infection control and prevention unit as it had given overview of the degree of hygiene/cleanliness, indoor air quality and evaluation of units personnel to adherence to standard infection control procedures and formed the template to formulate intervention measures. Apart the bacterial contamination rate, the recovery of clinically relevant pathogens from routinely used equipments and crucial area is of serious concern because of their clinical implication.

Overall, the bacterial contamination rate recorded in both units was 62.8%, 40.8% in the adult ICU and 59.2% in NICU respectively. The breakdown of bacterial contamination rate as detected by the method employed, showed that in adult ICU 21.1% contamination rate was detected by open plate and 19.7% by swabbing, as compared to 28.2% and 31,0% in NICU. The high contamination rate recorded in NICU may be due to some obvious reasons, as high number of neonates with different clinical conditions are admitted frequently for clinical attention and evaluation. This clinical practice requires the frequent presence and attention of the mothers for breastfeeding and health care worker, thus increasing the unit occupancy density, traffic and human activities [15, 24]. Different contamination rate had been reported in other similar studies, in Maiduguri, Nigeria, 62.5% and 26.9% was reported adult ICU [22, 23] and 38% in neonatal ICU [22], 67.8% in NICU in Ilorin [19], 17.8%in Iraq [18], while 81% contamination rate from unused nonsterile gloves in ICU [26], and no bacterial contamination rate recorded in ICU in

Labhore, Pakistan [25].

The indoor contamination assessment by open plate method, 51.7%(n=15) recorded in adult ICU and 47.6%(n=20) in NICU, with S.aureus, coagulase negative staphylococci, and Bacillus spp predominate pathogens. These pathogens are normal flora of human skin, and clothing fabrics that are continuously shed during routine activity and clothing fabrics [5, 15, 16l], also structural design that allows frequency in the entry and exist and ventilation system [6, 9, 24]. In contrast, 48.3%(n=14) and 35.7%(n=15) contamination rate was recovered from inanimate surfaces in AICU and NICU respectively. Reasons for this contamination rate may be attributable to several factors, firstly the hand of health care workers and strict adherence to simple hand hygiene, as it acts as vector for cross-transmission, colonised/infected patients, and ineffective cleaning procedure of contaminated inanimate surfaces [11, 13, 16, 27, 28]. Studies have documented that hands of HCW accounts for between 20 to 40% infection due to cross-transmission within the units [8, 29], that may be emanated from clinical specimens [23, 30]. Evaluating the exogenous effect to bacterial contamination in ICU, Gupta et al study on the impact of footwear as protective measure against contamination, the study recorded no significance difference between the contamination rate and the footwear [6]

In this study, we isolated 10 different bacterial pathogens, Bacillus spp, 33.8%(n=24), S.aureus, 26.8% (n=19) and CoNS 19.7%(n=14), and predominate in both units, indoor contamination 51.7%(n=15)in AICU,and 47.6%(n=20) in NICU and surface items/equipments contamination 48.3%(n=14) and 35.7%(n=15) respectively. Other studies have reported the predominance of staphylococci and Bacillus spp [5, 6, 18, 22, 23, 31]. The recovery of potentially clinically relevant S.aureus CoNs, E.coli,. Klebsiella pneumoniae, and Strep. pneumoniae from routinely used equipment and vital area within the units is of infection control and prevention concern. As observed in adult ICU, S.aureus was recovered from resituating equipment, and E.coli and Kleb.pneumoniae from suction machine. These pathogens, E.coli and Kleb pneumoniae are known ESBL producing pathogens, associated with multidrug resistant pathogens, with potential of rapid dissemination and source of hospital associated infections [32]. Considering the clinical status of patients admitted in NICU, the isolation of S.aureus, CoNs, Streptococcus pneumoniae and Kleb pneumoniae posed a serious clinical concern. Firstly, these pathogens are known as major causative agent of superficial and systemic infections associated with high morbidity and mortality rate, while the two pathogens isolated in NICUs are principal pathogens responsible systemic infections in cases like meningitis bacteremia, septicemia, acute respiratory tract infections [33].

The clinical activities within the intensive care units which involves excessive antimicrobial usage/exposure, through surgical and mechanical manipulation on critically ill patients, predisposes the patient to increase incidence of nosocomial infection, and emergence of MDR pathogens in hospital setting [20]. The consequential effect of such scenario is that it compounds patient management and infection control within hospital environment.. Furthered worsen in low resource countries with no alternate chemotherapeutic option in treatment and management of MDR related infection.

In this study, we observed a high resistance pattern with the commonly used antibiotics, amoxicillin, ampicillin-cloxacillin and cotrimoxazole. Similar pattern was reported in other studies [22, 23], but none of the bacterial pathogens exhibited multidrug resistance pattern.

The findings of this study has provided a baseline information on degree of contamination within the units, nevertheless, there are limitation in this study, as the number of samples collected were few and duration was short, the sampling procedure employed was not comprehensive enough to capture the pre and post-cleaning activities that may give a good epidemiological picture of contamination rate.

5. Conclusion

The rate of bacterial contamination in the Intensive Care Unit of ATBUTH is high and mostly resistance to commonly prescribed and administered antibacterial agents. The hospital infection control and prevention units should adopt periodic surveillance, effective cleaning of inanimate surfaces before and after use, and adhere to basic standard infection procedure, especially hand washing.

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