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Bacterial Contamination of Intensive Care Units at a Federal Medical Centre in Abia State, Nigeria

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Bacterial contamination in the Intensive Care Unit (ICU) is of public health concern because it is one of the leading causes of nosocomial infections and a breeding ground for multi drug resistant (MDR) pathogens. This study evaluated the bacterial contamination in ICU in Federal Medical Centre (FMC), Umuahia. The units sampled were adult ICU, and Newborn special care unit. Samples were processed in the microbiology laboratory by standard methods. The antibiotic sensitivity pattern was done by disc diffusion method. Identification of bacteria was done by Gram stain, Motility and biochemical methods. A total of 166 samples from fomites and air were collected, of which 27 (16.3%) yeided bacterial growth. Thirteen (15.9%) were detected from fomites in adult ICU, and 8 (11.1%) were detected from fomites in newborn special care. Six (50%) were detected from air in both units. The common bacterial isolates were *Staphylococcus aureus*, 8 (29.6%), *Escherichia coli*, 6 (22.2%), Coagulase negative Staphylococci, 6 (22.2%), *Pseudomonas* spp., 1 (3.7%), was the least common bacterial isolate. Antibiotic sensitivity of the bacterial isolates was carried out using disc diffusion method. Gram negative bacterial isolates were more sensitive to Ofloxacin, Peflacine, Ciprofloxacin, and Streptomycin. Gram positive bacterial isolates were more sensitive to Ciprofloxacin, Gentamicin, Rifampicin, Erythromycin, Levofloxacin. However, Coagulase negative Staphylococci was highly resistant to the drugs. This study revealed the presence of bacterial pathogens on fomites in the ICU.

Keywords: Bacterial contamination, Intensive care unit, Antibiotic sensitivity pattern

1. Introduction

Intensive care unit (ICU) is a relevant aspect of an effective health care service that provides care of resuscitating, management and monitoring of life-threatening cases. Some clinical cases in the hospital involve high anti-toxin use, long hospitalization favoring rise of multidrug resistant bacterial strains and rapid dissemination, high morbidity and mortality rate (Blot, 2008; Vincent et al., 2009). Microbes that contaminate inanimate surfaces, equipment and indoor environment are capable of surviving on these surfaces and air for a long time (Kramer, Schwebke, & Kampf, 2006) . Contamination occur by means of cross-transmission and dissemination, occupancy density, use of therapeutic hardware for numerous patient like stethoscope, outfits and dress (Galvin, Dolan, Cahill, Daniels, & Humphreys, 2012; Gupta, Anand, Chumber, Sashindran, & Patrikar, 2007). Health care worker and patient, their accessories and clinical specimen that are contaminated can also cause contamination (Dancer, 2008; Huang, Datta, & Platt, 2006; Ulger et al., 2009) . Non adherence of health care workers to basic standard method of hand washing, contribute to the spread of pathogens, and cross-transmission amid contact with patient or contaminated inanimate surfaces (Hayden, Blom, Lyle, Moore, & Weinstein, 2008; Nseir et al., 2011) . Bacteria that are shed constantly during clinical procedures are harbored by the human skin (Bonten et al. , 1996) . Pathogens can be shed and recouped from the immediate environment of the patient from infected health care worker and patient (Bonten et al., 1996; Pittet et al., 2006; Rohr et al., 2009). The type of organism, source and contamination with the surface, humidity level and size of the inoculum contribute to the spread of infection (Nasser, Abbas, & Hamed, 2013). Wide range of bacterial pathogens have been discovered in ICU contamination. However potentially clinically

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relevant ones include *Staphylococcus aureus*, Coagulase negative *Staphylococcus*, Enterobacteriaceae, and enterococci. These clinically relevant organisms are major causative agents of nosocomial infections, developed as multidrug resistant (MDR) pathogens (Damaceno, Iquiapaza, & Oliveira, 2014; Saka et al., 2016) . These MDR pathogens like Methicillin resistant *Staphylococcus aureus* (MRSA), Vancomycin resistant *Staphylococcus aureus* (VRSA), Extended spectrum Beta lactamase (ESBL) producing Enterobacteriaceae are used as indicator organisms for assessing the level of adherence to fundamental standard procedure in Intensive care units (Hayden et al., 2008; Javed et al., 2008) . Failure in these essential technique tends to build the dissemination of these pathogens within the units and hospital environment. The main objective of this study was to investigate the bacterial contamination of the Intensive Care Unit in FMC, Umuahia by evaluating the presence of potential pathogens.

2. Materials and Methods

2.1 Study location

This study was carried out in the Adult ICU and the Newborn Special Care Unit of Federal Medical Centre, Umuahia, Abia State, Nigeria. The study was approved by the ethical committee of FMC, Umuahia before the commencement of Sampling and analysis.

2.2 Sample collection and processing

Settle plate method and swabbing method were used as described (Cheesbrough, 2006). The fomites in each unit were pre-identified and the point for settle plate spots was pre-designated accordingly. For the swabbing method, sterile swab sticks moistened with sterile water were used to swab the surfaces of the fomites. To ensure maximal coverage of a surface area, the swab was rolled back and forth over each surface before carefully capped and labeled appropriately. The samples were sent for analysis to the laboratory. The swab samples were inoculated onto suitable media (Blood agar, MacConkey agar) which were incubated for 24 hours at 37ºC.

For the Settle plate method, petri dishes containing culture media that are standard were exposed on some tables for 30 minutes at different areas in the rooms and removed before the health care workers came in and were also exposed when there was activity in the units for the same duration of time before it was sent for analysis to the laboratory. Suspected bacterial growths were identified and confirmed by standard bacteriological methods.

2.3 Antibiotic susceptibility test

Antibiotic susceptibility testing was performed using the disk diffusion method and was interpreted by Clinical and Laboratory Standards Institute (2011) on Mueller Hinton agar (Hardy Diagnostics, USA). Mueller Hinton culture plates were inoculated by dipping a sterile cotton wool swab into the overnight growth of the organism in suspension prepared to the density of a McFarland no 0.5 opacity standard; spread plate method was used to express excess liquid from the swab before inoculation.

Antibiotic discs that were used have the following concentrations: Streptomycin 30 µg; Ofloxacin 10 µg; Norfloxacin 10 µg; Gentamicin 10 µg; Amoxil 20 µg; Ciprofloxacin 10 µg; Erythromycin 30 µg; Rifampicin 10 µg; Amoxycillin/Clavulanic acid 30 µg; Cefalexin 10 µg; Nalidixic acid 30 µg; Septrin 30 µg.

After overnight incubation, examination of the control and test plates were carried out to ensure the growth is confluent or near confluent**.** The diameter of each zone of inhibition was measured in mm using a ruler on the plate**'**s buttom**.** Growth starts at the endpoint of inhibition. The control strain used was *Escherichia coli* ATCC 25922.

3. Results

There were a total of 166 samples collected and analyzed from both Adult Intensive Care Unit and Newborn Special Care Unit. The bacterial growth observed that were positive was 16.3%. The bacterial contamination as detected from fomites showed 15.9% from Adult ICU while 11.1% from Newborn Special Care unit. 50% were from air in both Adult ICU and Newborn Special Care unit.

Seven different bacterial isolates were identified. *Staphylococcus aureus*, 29.6%, *Escherichia coli*, 22.2%, Coagulase negative Staphylococci, 22.2% were the majority bacterial isolates while other bacterial isolates were *Enterobacter* spp., 7.4%, *Klebsiella pneumoniae*, 7.4%, *Bacillus* spp., 7.4%, and *Pseudomonas* spp.,

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3.7%. In Table 1, *Staphylococcus aureus*, 8 (29.6%) was the highest isolated bacteria followed by *Escherichia coli*, 6 (22.2%) while *Pseudomonas* spp., 1 (3.7%) was the least isolated bacteria. In Table 2, mattress, 4 (30.8%) and mobile phone, 4 (30.8%) had the highest number of bacterial isolates while clinical coat and monitor had no bacterial isolates. In Table 3, mattress, 3 (37.5%) and mobile phone, 3 (37.5%) had the highest bacterial isolates. There was no bacterial isolate isolated from incubator, measuring tape, clinical coat. In Table 4, *Staphylococcus aureus*, 3 (50.0%) was the highest isolated bacteria in both units. In Table 5, the antibiotic susceptibility pattern of bacterial isolates is seen.

Table 1. Diversity and percentage of bacterial isolates in the study.

ISOLATES	NO OF ISOLATES	PERCENTAGE (%)
Staphylococococcus aureus	8	29.6
Escherichia coli	6	22.2
CoNS	6	22.2
Enterobacter spp.	2	7.4
Klebsiella pneumoniae	2	7.4
Bacillus spp.	2	7.4
Pseudomonas spp.	1	3.7
Total	27	100

KEY: CoNS- Coagulase negative Staphylococci, NO: Number

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Table 2. Distribution of bacterial isolates from fomites in the Adult ICU at FMC, Umuahia.

ITEMS	NO EXAMINED	NO OF BACTERIAL ISOLATES							
		Staph aureus	***E. coli***	***Entero* spp.**	***Kleb pneu***	***Bacil* spp.**	**CoNS**	***Pseudomonas* spp.**	**Total**
Mattress	11	0	2	2	0	0	0	0	4
Bedsheet	13	2	0	0	0	0	0	0	2
Stethoscope	20	1	1	0	0	0	1	0	3
Mobile phone	15	1	1	0	0	0	1	1	4
Clinical coat	15	0	0	0	0	0	0	0	0
Monitor	8	0	0	0	0	0	0	0	0
Total		4	4	2	0	0	2	1	13
Percentage (%)		30.8	30.8	15.4	0	0	5.4	7.6	100

KEY: *Staphylococcus aureus*, *Enterobacter* spp., *Escherichia coli*, *Klebsiella pneumoniae*, *Bacillus* spp., Coagulase Negative Staphylococci, NO: Number

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Table 3. Distribution of bacterial isolates from fomites in Newborn Special Care Unit at FMC, Umuahia.

ITEMS	NO EXAMINED	NO OF BACTERIAL ISOLATES							
		Staph aureus	***E. coli***	***Entero* spp.**	***Kleb pneu***	***Bacil* spp.**	**CoNS**	***Pseudomonas* spp.**	**Total**
Mattress	16	1	0	0	1	0	1	0	3
Stethoscope	15	0	1	0	0	0	0	0	1
Mobile phone	15	0	0	0	0	1	2	0	3
Weighing balance	2	0	0	0	0	0	1	0	1
Incubator	4	0	0	0	0	0	0	0	0
Measuring tape	5	0	0	0	0	0	0	0	0
Clinical cloth	15	0	0	0	0	0	0	0	0
Total		1	1	0	1	1	4	0	8
Percentage (%)		12.5	12.5	0	12.5	12.5	50	0	100

Table 4. Distribution of bacterial isolates from air using settle plate method.

ISOLATES	AICU	NB	TOTAL	PERCENTAGE (%)
Staphylococcus aureus	2	1	3	50
Escherichia coli	1	0	1	16.7
Enterobacter spp.	0	0	0	0
Klebsiella pneumoniae	1	0	1	16.7
Bacillu spp.	1	0	1	16.7
CoNS	0	0	0	0
Pseudomonas spp.	0	0	0	0
Total	5	1	6	100

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Table 5. Antibiotic sensitivity pattern of isolates.

		NO (%) SENSITIVE TO									
Isolates GNB	**No of isolates**	**OFX**	**PEF**	**CPX**	**AU**	**CN**	**S**	**CEP**	**NA**	**SXT**	**PN**
Klebsiella pneumoniae	2	2 (100)	1 (50)	2 (100)	0	1 (50)	2 (100)	0	1 (59)	1 (50)	0
Escherichia coli	6	4 (66.7)	3 (50)	2 (33.3)	2 (33.3)	3 (50)	3 (50)	0	0	3 (50)	3 (50)
Pseudomonas spp.	1	1 (100)	1 (100)	1 (100)	0	1 (100)	1 (100)	0	0	0	1 (100)
Enterobacter spp.	2	2 (100)	2 (100)	2 (100)	2 (100)	2 (100)	2 (100)	0	0	0	0
GPB		**CPX**	**NB**	**CN**	**AML**	**S**	**RD**	**E**	**CH**	**APX**	**LEV**
CoNS	6	1 (16.7)	0	1 (16.7)	0	0	2 (33.3)	1 (16.7)	2 (33.3)	0	2 (33.3)
Staphylococcus aureus	8	3 (37.5)	2 (25)	4 (50)	1 (12.5)	4 (50)	4 (50)	4 (50)	2 (25)	1 (12.5)	4 (50)

KEY: OFX-Ofloxacin, PEF-Peflacine, CPX-Ciprofloxacin, AU-Amoxycillin-Clavulanic acid, CN-Gentamycin, S-Streptomycin, CEP-Cefalexin, NA-Nalidixic acid, SXT-Septrin, PN-Ampicillin, CPX-Ciprofloxacin, NB-Norfloxacin, CN-Gentamicin, AML-Amoxil, RD-Rifampicin, E-Erythromycin, CH-Chloramphenicol, APX-Ampiclox, LEV-Levofloxa

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4. Discussion

Bacterial contamination of ICU is the major factor responsible for increased incidence of nosocomial infections, with attendant consequential effect on patient and healthcare workers (Huang *et al*., 2006; Vincent et al., 2009). Overall, the bacterial contamination rate recorded in the units was 16.3%. Adult Intensive Care Unit has 15.9% while 11.1% was recorded from fomites in Newborn Special Care Unit. The two units recorded 22.2% from air. The breakdown of bacterial contamination rate as detected from the area of collection showed 15.9% in Adult ICU, and 11.1% in Newborn special care unit. This is in contrast to the study by Yusuf et al. (2017) where the overall bacterial contamination recorded in the ICU's was 62.8%. Differemt contamination rate had been reported in other similar studies. In Maiduguri, Nigeria, 62.5% was reported in adult ICU and 38% in neonatal ICU (Abubakar et al., 2014) while 26.9% was reported in adult ICU by Montero et al. (2015). In Ilorin, 67.8% was reported in newborn ICU (Damaceno et al., 2014), 17.8% in Iraq (Saka et al., 2016), while 81% contamination rate from unused nonsterile gloves in ICU (Mojtahedi, Khoshrang, Taromsari, KazemnezhadLeili, & Hoorvash, 2014), and no bacterial contamination rate recorded in ICU in Labhore, Pakistan (Hall, Trivedi, Rumbaugh, & Dissanaike, 2014). The bacterial isolates from fomites in both Adult ICU and Newborn Special Care Unit were low. This is similar to the findings of Yusuf et al. (2017) in adult ICU but in contrast with his findings in Newborn ICU. The air contamination assessment by settle plate method had 83.3% recorded in Adult ICU, and 16.7% recorded in Newborn special care unit with *Staphylococcus aureus* as the predominant isolates. This compares favourably with the studies carried out by Sapkota et al. (2016), Gizaw, Gebrehiwot, & Yenew (2016) and Nwankwo, Nwachukwu, & Nwankwo (2014) where *Staphylococcus aureus* was the most commonly detected organism. These pathogens are mostly normal flora of human skin, and clothing fabrics that are continuously shed during routine activity and clothing fabrics (Gupta et al., 2007; Pittet et al., 2006; Rohr et al., 2009) of the 7 different isolates of bacterial pathogens. *Staphylococcus aureus*, *Escherichia coli*, and Coagulase negative Staphylococci were predominant in the study. Other studies have reported the predominance of *Staphylococcus* spp. and *Bacillus* spp. (Abubakar et al., 2014; Carlet et al., 2007; Galvin et al., 2012; Gupta et al., 2007; Montero et al., 2015; Saka et al., 2016). The recovery of potentially clinically relevant *Staphylococcus aureus*, Coagulase negative Staphylococci, *Escherichia coli*, and *Klebsiella pneumoniae*, from frequently used fomites, and vital areas within the unit is of Infection control and prevention concern.

In this study, we observed a high resistance pattern with the commonly used antibiotics; Amoxycillin/Clavulanic acid, Ampicilin, Cephalexin, Amoxil, Norfloxacin. Similar pattern was reported in other studies (Abubakar et al., 2014; Montero et al., 2015). The same pattern was seen in Yusuf et al. (2017) work with amoxicillin, ampicillin-cloxacillin and cotrimoxazole being highly resistant. The bacterial pathogens did not exhibit multidrug resistance pattern.

The outcome of this study has provided a data to start with on degree of contamination within the units. There are limitations in this study as the duration was short, and the sampling procedure was not comprehensive enough to capture the pre and post cleaning activities that may give a good epidermiological picture of contamination rate.

5. Conclusion

The outcome of this study is of ultimate importance to the hospital infection control and prevention unit. This study has given an overview of the degree of hygiene/cleanliness, indoor air quality and evaluation of units personnel to adherence to method for infection control. It has formed the template to formulate intervention measures. Apart from the bacterial contamination rate, the recovery of pathogens with clinical significance from frequently used fomites and crucial area is of serious concern because of their clinical implication. The hospital infection control and prevention units should adopt periodic surveillance, effective cleaning of fomites before and after use, and adhere to simple basic standard infection procedure, especially hand washing.

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Conflict of Interest

The authors do not report any financial or personal connections with anyone.

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Ethical approval

The study was approved by the Health Research Ethical Committee of Federal Medical Centre, Umuahia, Abia state, Nigeria (Date; 6th November, 2017). Number of ethics:
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