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Microbial Contamination of Sphygmomanometers in Healthcare Facilities in Benin City

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Abstract
Background: Nosocomial infections are infections that patients acquire while receiving treatment for other health conditions within a healthcare setting or facility. Sphygmomanometers measure the blood pressure of patients, the direct contact of the cuffs with patients' skin during use; makes them a potential source of transmission of infection. The aims of this study were to investigate the microbial contamination of blood pressure cuffs of sphygmomanometers used on patients in healthcare facilities and to determine the effectiveness of 70% isopropyl alcohol in reducing the microbial load on the blood pressure cuffs.
Materials and Method: The microbial isolation from the blood pressure cuffs was done following the standard microbiological isolation and identification techniques.Three sterile swab sticks were used for each sphygmomanometer and before being used, they were moistened with 0.9% normal saline to enable the sticks pick up the organisms from the surface of the blood pressure cuffs. The first two swab sticks were used to wipe the inner surface and the outer surface of the sphygmomanometer cuffs respectively. The third sterile swab stick was used to wipe the inner surface of the blood pressure cuff again, but this time, after disinfecting it with 70% isopropyl alcohol and left to stand for 10minutes.
Results: 89.1% (57 sphygmomanometers) showed microbial growth while 10.9% (7 sphygmomanometers) showed no growth. Though the blood pressure cuffs were contaminated by several bacteria and fungi, Staphylococcal aureus,41(20.5%) was the most isolated bacteria while Candida species 42 (21%) was the most frequent isolated fungi. Majority of the isolated bacteria subjected to antibiotic sensitivity test were resistant to the commonly used antibiotics tested. The most sensitive antibiotics tested was gentamicin, followed by ciprofloxacin and septrin while the least sensitive antibiotic was amoxicillin. This study revealed that most of the sphygmomanometers used in the investigated healthcare facilities were contaminated with pathogenic organisms that are implicated in healthcare-associated infections.
The 70% isopropyl alcohol was found to either eliminate or drastically reduce the microbial loads on the blood pressure cuffs of sphygmomanometers.
Keywords: sphygmomanometers, blood pressure cuffs, nosocomial infections, healthcare associated infections, hospital acquired infections.

I. INTRODUCTION

Nosocomial infections or healthcare associated infections are infections that patients acquire while they are receiving treatment for other health conditions within a healthcare setting or facility. They are usually not present in the patient at the time of admission to the healthcare facility. Azeez -Akande (2012) and Hassan *et al.* (2017)

Bacteria are responsible for most cases of nosocomial infections (often 80% of all cases) however, fungi, viruses and parasites are not spared. The transmission of nosocomial infections via blood pressure cuffs occurs when the contaminated blood pressure cuffs come in contact with the patients' skin where the organisms are then transferred to other sites of the body to cause harm. In medical facilities, sphygmomanometers are used on multiple patients daily and during use, they can become contaminated with microorganisms which can in turn be transferred from one patient to the other since their regular disinfection is not always done (Matsuo *et al*., 2013).

The objectives of this study were to investigate the microbial contamination of blood pressure cuffs of sphygmomanometers used in healthcare facilities and to determine the effectiveness of 70% isopropyl alcohol in reducing the microbial load on the blood pressure cuffs.

Quite a number of works have been done in this research area in the United States, Ethiopia, and India in the hospital setting, not much has been conducted in Nigeria. Also, no work has been done in community pharmacies in Nigeria. This research work covered both bacterial and fungal isolation of organisms from the sphygmomanometers in both hospital and community settings.

II. MATERIALS AND METHOD

Study Design

This was a cross-sectional study conducted in Central Hospital, University of Benin Teaching Hospital, and randomly selected and very busy Community Pharmacies from the four Local Government Areas in Benin City (Egor, Ovia, Oredo and Ikpoba-Okha). The sample size of the sphygmomanometers investigated was based on the number of sphygmomanometers available in the various units visited. This research was conducted between May and November 2019. Data generated were presented using descriptive statistics such as frequency and percentage distributionof the identified organisms. Ethical approval was obtained from Central Hospital Benin City (A732/T/1), University of Benin Teaching Hospital (ADM/E22/A/VOL II/14775) and administrative approval from the Community pharmacies.

The materials and media used in this study were cefoxitin disc (Becton, Dickinson and Company, USA), antibiotic multidisc (Maxi care Medical Laboratory, Nigeria),nutrient agar (by Titan Biotech Limited, India), potato dextrose agar (Titan Biotech Limited, India), Mueller Hinton agar (Titan Biotech Limited, India),Mannitol salt agar (Titan Biotech Limited, India).

Sample Collection

Three sterile swab sticks were used for each sphygmomanometer and before being used, they were moistened with 0.9% normal saline to enable the sticks pick up the organisms from the surface of the blood pressure cuffs. The first two swab sticks were used to wipe the inner surface (the part that comes in direct contact with the patients' upper arms) and the outer surface (i.e. the part that the healthcare provider touches while wrapping the cuff on the patient's arm) of the sphygmomanometer cuffs respectively. The third sterile swab stick was used to wipe the inner surface of the blood pressure cuff again, but this time, after disinfecting it with 70% isopropyl alcohol and left to stand for 10minutes, following a slightly modified method of Jeyakumari *et al*. (2016). All swabbed samples were immediately transported to the pharmaceutical microbiology laboratory for analysis.

Laboratory Investigation

Serial dilutions of the swabbed samples were carried out by transferring the swab sticks aseptically into 10ml diluent (sterile distilled water) and subsequently inoculated into 1: 10, 1: 100, and 1: 1000 diluents. For the bacterial isolation,after the serial dilutions, 1 drop (micropipette) of each dilution was inoculated onto already set nutrient agar using the well-known Miles and Misra method, allowed to diffuse and then incubated at 37 degrees Celsius for 48hours.

For the fungal isolation, 1ml of the 1:10 dilution was transferred into Petri dishes and molten potato dextrose agar was poured on each plate using the well-known pour plate method, allowed to set and then incubated at room temperature for 48 hours. After 48 hours, the plates were observed for growth, and the colonies were counted and the results recorded.

Gram staining was done and based on the Gram stain reaction, the following biochemical tests; catalase, slide and tube coagulase, oxidase, citrate, indole, sugar and hemolytic tests were performed to identify the bacteria isolates. The fungi isolated were identified using atlas (Bernward and Gabriele,1980).

Antibiotic sensitivity test

Multidisc antibiotics sensitivity tests were also carried out on all the bacterial isolates by inoculating the isolates on Muller Hinton agar plates. Antimicrobial sensitivity testing was done using Kirby Bauer disc diffusion method based on the Clinical Laboratory Standards Institute Guideline. In this method, pure cultures of the isolates were added to a sterile tube containing 5ml of 0.9% normal saline and mixed gently until a homogenous suspension equivalent to 0.5 McFarland standard was formed. Sterile swab sticks were dipped into the suspension and then streaked over the entire surface of the Mueller Hinton agar plates, left for 5 minutes to dry. Then the multidrug antimicrobial discs were carefully placed at the center of the plates and thereafter incubated at 37 degrees Celsius for 24hours, Fitsum *et al* (2019). The zones of inhibition were measured using a ruler calibrated in millimeter and the results recorded. The zones of inhibition were compared to the Clinical Laboratory Standard Institute (CLSI) values to know whether they were resistant or sensitive to the antibiotics used.

Cefoxitinsensitivity test

The isolated staphylococcus aureus species were further `subjected to cefoxitin disc diffusion test to know if they were methicillin-resistantor not.

A suspension of the organisms adjusted to 0.5x McFarland standard was diluted 1:100 and inoculated onto Mueller Hinton agar plates by streaking over the entire agar surface and thereafter the Cefoxitin antibiotic discs were placed centrally on each plate and tightly secured with the aid of a flamed forceps. The plates were inverted and then incubated at 37 degrees Celsius for 24 hours. The zones of inhibition were measured using a ruler calibrated in millimeter and the results recorded. The organism was considered methicillin-resistant *Staphylococcus aureus* (MRSA) if the zone of inhibition was ≤20mm.

III. RESULTS

A total of 192 swabbed samples were collected from 64 cuffs in the three healthcare facilities, 200 microbial strains were isolated consisting of 46.5% bacteria and 53.5% fungi. 57 (89.1%) sphygmomanometers showed microbial growth while 7 (10.9%) sphygmomanometers showed no growth. *Staphylococcusaureus*,41(20.5%) was the most commonly isolated bacteria followed by *Bacillus* species 18 (9.0%), *Coagulase negativeStaphylococcus* species 14 (7.0%), *Bacteriodes* species 8 (4.0%), *Pseudomonas* species 7 (3.5%), *Citrobacte*r species 3 (1.5%), *Klebsiella* and *Escherichia coli* species 1 (0.5%) each. *Candida* species 42 (21.0%) was the most commonly isolated fungi, followed by *Mucor* 34(17.0%) and *Aspergillus* species 23(11.5%), *Penicillium* species 5 (2.5%), *Trichophyton* species 2 (1.0%) and *Cryptococcus* species (table 1). The isolates from each healthcare facility are shown in tables 2, 3 and 4 below.

Table 1:Shows theoverallfrequency of microbial isolates in the three healthcare facilities

Organisms isolated	Frequency	Percentage
Staphylococcalaureus	41	20.5
Bacillus species	18	9.0
Coagulase negative *Staphylococcal* species	14	7.0
Bacteriodes species	8	4.0
Pseudomonas species	7	3.5
Citrobacter species	3	1.5
Klebsiella species	1	0.5
Escherichia coli	1	0.5
Candida species	42	21
Mucor	34	17
Aspergillus species	23	11.5
*Penicillum*species	5	2.5
Trichophyton species	2	1.0
Cryptococcus species	1	0.5
Total	200	100

Table 2: Organisms isolated from University of Benin Teaching Hospital

Organisms isolated	Frequency	Percentage
Staphylococcalaureus	6	6.9
Coagulase negativeStaphylococcal species	4	4.5
Bacillus species	6	6.9
Bacteriodes species	6	6.9
Pseudomonas species	4	4.5
Citrobacter species	1	1.1
Klebsiella species	1	1.1
Candida species	23	26.4
Aspergillus species	15	17.2
Mucor	14	16.1
Penicillum species	5	5.7
Trichophyton species	1	1.1
Cryptococcus species	1	1.1
Total	87	100

Table 3: Organisms isolated from Central hospital.

Organisms isolated	Frequency	Percentage
Staphylococcal species	6	20
Coagulase negativeStaphylococcal species	5	16.7
Bacillus species	7	23.3
Citrobacter species	1	3.3
Escherichia coli	1	3.3
Candida species	7	23.3
Aspergillus species	2	6.7
Mucor	1	3.3
Total	30	100

Table 4: Organisms isolated from Community pharmacies.

Organisms isolated	Frequency	Percentage
Staphylococcal aureus	29	34.9
Coagulase negativeStaphylococcal species	5	6.0
Bacillus species	5	6.0
Bacteriodes species	2	2.4
Pseudomonas species	3	3.6
Citrobacter species	1	1.2
Candida species	12	14.5
Aspergillus species	6	7.2
Mucor	19	22.9
Trichophyton species	1	1.2
Total	83	100

As can be observed from the tables, in UBTH, *Candida* species (26.4%), *Aspergillus* species (17.2%) and *Mucor* (16.1%) accounted for the highest occurring organisms. *Staphylococcus aureus*, *Bacillus* species and bacteriodes species accounted for 20.7%, (6.9%) each of all isolates. *Pseudomonas* species constituted 4.5%.

In Central hospital, *Candida* species (23.3%), *Bacillus* species (23.3%) and *Staphylococcal aureus* (20.0%) were the most isolated organisms.

In community pharmacies, *Staphylococcal aureus* (34.9%), *Mucor* (22.9%) and *Candida* species (14.5%) contributed to the highest isolated organisms.

Microbial load

The microbial load on the sphygmomanometers varied from unit to unit within the hospital settings and from one health care facility to the other. The hospital settings were found to have more microbial loads than the community setting as observed by their colony forming unit per ml.

In the three healthcare facilities, the inner surfaces of the blood pressure cuffs of sphygmomanometers were more contaminated than the outer surfaces except in the dermatology unit where the contamination was excessively high in both surfaces as seen in their colony forming unit per ml. Also, the bacterial load on the sphygmomanometers from consultant outpatient department (COPD), intensive care unit (ICU) and accident and emergency (A& E) was completely cleared after disinfecting with 70% isopropyl alcohol while the bacterial load of the sphygmomanometers from general practice clinic (GPC) and dermatology units was reduced after disinfecting. The fungi load on the sphygmomanometers from ICU and GPC was completely cleared while that on the sphygmomanometers from COPD, A & E, and Dermatology showed reduced fungi load.

For Central hospital, the microbial load on the sphygmomanometers from the various units investigated was completely cleared after disinfecting with the 70% isopropyl alcohol except in the tuberculosis ward which showed reduced bacterial load.

For the community pharmacies, there was no microbial growth on the sphygmomanometers from Ikpoba okha and Egor local government areas after disinfecting but there was a reduction in microbial load on the sphygmomanometers from Oredo and Ovia north east local government areas. These are shown in tables 5,6 and 7.

Table 5: Microbial load of evaluated sphygmomanometers from various units in UBTH

UNITS	MEAN BACTERIAL LOAD FROM SPHYG SURFACES(CFU/ML)			MEAN FUNGAL LOAD FROM SPHYG SURFACES(CFU/ML)		
	O	IB	IA	O	IB	IA
CONSULTANT OUTPATIENT DEPT	$4X10^2$	$7.3X10^3$	-	$7.1X10^1$	$7.07X10^2$	$1.05X10^2$
INTENSIVE CARE UNIT	$8x10^2$	$3.8x10^4$	-	$8.7x10^2$	$2.485x10^3$	-
GENERAL PRACTICE CLINIC	$8X10^2$	$8.67X10^4$	$1.8x10^3$	$5.5x10^2$	$4.8x10^2$	-
ACCIDENT&EMERGENCY	$1.4x10^3$	$5x10^2$	-	$5.68x10^2$	$5.25x10^2$	$3.0x10^1$
DERMATOLOGY	$1.885x10^5$	$2.820x10^5$	$7.25x10^4$	TNTC	TNTC	$4.15X10^2$

O- Outer surface of the blood pressure cuffs
IB- Inner surface of the blood pressure cuffs before disinfection
IA- Inner surface of the blood pressure cuffs after disinfection
TNTC- Too numerous to count.

UBTH- University of Benin Teaching Hospital

Table 6: Microbial load of evaluated sphygmomanometers from various units in Central hospital

UNITS	MEAN BACTERIAL LOAD FROM SPHYG SURFACES(CFU/ML)			MEAN FUNGAL LOAD FROM SPHYG SURFACES(CFU/ML)		
	O	IB	IA	O	IB	IA
LABOUR WARD	-	-	-	-	-	-
ANTENATAL CLINIC	-	-	-	-	-	-
FEMALE MEDICAL WARD	-	$3.6X10^3$	-	-	$1.8X10^3$	-
MATERNITY WARD	-	$2X10^2$	-	-	-	-
EMERGENCY OUT PATIENT	$6X10^2$	$2X10^2$	-	-	$2X10^2$	-
ORTHOPAEDIC OUT PATIENT DEPARTMENT	-	$4X10^2$	-	-	-	-
PAEDIATRIC WARD	$7X10^2$	$2X10^2$	-	$2X10^2$	-	-
MEDICAL OUT PATIENT	$8X10^2$	$8X10^2$	-	-	-	-
MALE MEDICAL WARD	$1.6X10^4$	$4.2X10^4$	-	$1X10^4$	$4.8X10^4$	-
MATERNITY SURGICAL WARD	$5.6X10^5$	-	-	-	-	-
MALE ORTHOPAEDIC WARD	-	$4X10^3$	-	$1X10^4$	$2.6X10^3$	-
FEMALE ORTHOPAEDIC WARD	-	-	-	-	$8.8X10^4$	
TUBERCULOSIS CLINIC	-	$5.6X10^3$	$3.2X10^3$	$6X10^3$	-	-

Table 7: Microbial load of evaluated sphygmomanometers from different pharmacies in the 4 local government areas in Benin City

LGA	MEAN BACTERIAL LOAD FROM SPHYG SURFACES(CFU/ML)			MEAN FUNGAL LOAD FROM SPHYG SURFACES(CFU/ML)		
	O	IB	IA	O	IB	IA
IKPOBA OKHA	$1X10^3$	$4.8X10^2$	-	$2.5X10^1$	-	-
OREDO	$2X10^2$	$3.67X10^2$	$2\ X10^2$	$2\ X10^1$	$0.83X10^1$	$0.5X10^1$
EGOR	$1.4X10^3$	$3.3X10^3$	-	$4.25X10^2$	$2.25X10^2$	-
OVIA NORTH EAST	$4.54X10^4$	$6.02X10^4$	$1.21X10^4$	$6.57X10^2$	$8.4\ X10^2$	$1.21X0^1$

Antimicrobial susceptibility pattern

Ninety-three (93)bacterial isolates from the 3 healthcare facilities were tested against 7 different antibiotics commonly used in treating bacterial infections. They all showed varied sensitivity to the antibiotics tested. However, 23 out of the 93 bacteria isolated (24.7%) were completely resistant to all the antibiotics. None of the bacteria was 100% sensitive to all the antibiotics tested. Hence the need to always do culture and sensitivity test prior to the treatment of any bacterial infection. This can be seen in tables 8,9 and 10.

Table 8: Antimicrobial Susceptibility pattern of isolates (UBTH)

Bacterial Isolates	Antimicrobial susceptibility Pattern							
		CN (10µg) S≥15mm	AM (30 µg) S≥18mm	Z (20 µg) S≥23mm	R (30 µg) S≥23mm	CIP (10µg) S≥21mm	SXT (30 µg) S≥16mm	E (10µg) S≥23mm
Staphylococcus aureus (6)	S	1(16.7%)	-	-	-	2(33.3%)	2(33.3%)	-
	R	5(83.3%)	6(100%)	6(100%)	6(100%)	4(66.7%)	4(66.7%)	6(100%)
Coagulase negative *Staphylococcus aureus* (4)	S	1(25%)	-	-	1(25%)	1(25%)	2(50%) 2(50%)	1(25%)
	R	3(75%)	4(100%)	4(100%)	3(75%)	3(75%)		3(75%)
Bacillus species (6)	S	6(100%)	1(16.7%)	3(50%)	3(50%)	5(83.3%)	6(100%)	4(66.7%)
	R	-	5(83.3%)	3(50%)	3(50%)	1(16.7%)	-	2(33.3%)
Pseudomonas species (4)	S	1(25%)	4(100%)	-	-	4(100%)	2(50%)	-
	R	3(75%)	-	4(100%)	4(100%)	-	2(50%)	4(100%)
Citrobacter species (1)	S	1(100%)	-	-	-	1(100%)	1(100%)	-
	R	-	1(100%)	1(100%)	1(100%)	-	-	1(100%)
Bacteriodes species (6)	S	5(83.3%)	3(50%)	4(66.7%)	4(66.6%)	6(100%)	5(83.3%)	4(66.7%)
	R	1(16.7%)	3(50%)	2(33.3%)	2(33.3%)	-	1(16.7%)	2(33.3%)
Klebsiella species (1)	S	1(100%)	-	1(100%)	-	1(100%)	1(100%)	1(100%)
	R	-	1(100%)	-	1(100%)	-	-	-

CN- gentamycin, AM- amoxicillin, Z-zinnacef(cefuroxime), R-rocephin(ceftriaxone), CIP- ciprofloxacin, SXT-septrin, E-erythromycin

Table 9: Antimicrobial susceptibility pattern (Central Hospital)

Bacterial Isolates	Antimicrobial susceptibility Pattern							
		CN (10µg) S≥15mm	AM (30 µg) S≥18mm	Z (20 µg) S≥23mm	R (30 µg) S≥23mm	CIP (10µg) S≥21mm	SXT (30 µg) S≥16mm	E (10µg) S≥23mm
Staphylococcus aureus (6)	S	6(100%)	-	4(66.7%)	2(33.3%)	4(66.7%)	5(83.3%)	1(16.7%)
	R	-	6(100%)	2(33.3%)	4(66.7%)	2(33.3%)	1(16.7%)	5(83.3%)
Coagulase negative *Staphylococcus aureus* (5)	S	2(40%)	-	1(20%)	1(20%) 4(80%)	3(60%)	2(40%)	2(40%)
	R	3(60%)	5(100%)	4(80%)		2(40%)	3(60%)	3(60%)
Bacillus species (7)	S	6(85.7%)	2(28.6%)	6(85.7%)	3(42.9%)	7(100%)	7(100%)	7(100%)
	R	1(14.3%)	5(71.4%)	1(14.3%)	4(57.1%)	-	-	-
Escherichia coli	S	-	-	-	1(100%)	1(100%)	1(100%)	1(100%)
	R	1(100%)	1(100%)	1(100%)	-	-	-	-
Citrobacter species (1)	S	1(100%)	-	-	-	1(100%)	1(100%)	- 1(100%)
	R	-	1(100%)	1(100%)	1(100%)	-	-	

Table 10: Antimicrobial susceptibility pattern (Community Pharmacies)

LGA	Bacterial isolates	Antimicrobial susceptibility Pattern							
			CN (10µg) S≥15mm	AM (30 µg) S≥18mm	Z (20 µg) S≥23mm	R (30 µg) S≥23mm	CIP (10µg) S≥21mm	SXT (30 µg) S≥16mm	E (10µg) S≥23mm	E
Ikpoba okha	*Staphylococcus aureus* (7)	S	7(85.7%)	-	5(71.4%)	5(71.4%)	5(71.4%)	5(71.4%)	2(28.6%)	
		R	1(14.3%)	7(100%)	2(28.6%)	2(28.6%)	2(28.6%)	2(28.6%)	5(71.4%)	
	Bacillus species (1)	S	1(100%)	1(100%)	1(100%)	-	1(100%)	1(100%)	-	
		R	-	-	-	1(100%)	-	-	1(100%)	
	Coagulase negative *Staphylococcus* species (2)	S	2(100%)	1(50%)	1(50%)	1(50%)	2(100%)	2(100%)	2(100%)	
		R	-	1(50%)	1(50%)	1(50%)	-	-	-	
Oredo	*Staphylococcus aureus* (5)	S	-	-	-	-	-	-	-	
		R	5(100%)	5(100%)	5(100%)	5(100%)	5(100%)	5(100%)	5(100%)	
	Coagulase negative *Staphylococcus* species (3)	S	1(33.3%)	-	1(33.3%)	1(33.3%)	1(33.3%)	1(33.3%)	1(33.3%)	
		R	2(66.7%)	3(100%)	2(66.7%)	2(66.7%)	2(66.7%)	2(66.7%)	2(66.7%)	
	Bacillus species (2)	S	1(50%)	-	-	-	-	-	-	
	Pseudomonas species (1)	R	1(50%)	2(100%)	2(100%)	2(100%)	2(100%)	2(100%)	2(100%)	
		S	1(100%)	1(100%)	-	1(100%)	1(100%)	1(100%)	-	

		R	-	-	1(100%)	-	-	-	1(100%)	

LGA	Bacterial isolates	Antimicrobial susceptibility								
		Pattern	CN	AM	Z	R	CIP	SXT	E	E
Egor	Staphylococcus aureus (9)	S	1(11.1%)	1(11.1%)	2(22.2%)	1(11.1%)	1(11.1%)	1(11.1%)	-	
		R	8(88.9%)	8(88.9%)	7(77.8%)	8(88.9%)	8(88.9%)	8(88.9%)	9(100%)	
	Bacillus species (2)									
		S	1(50%)	-	-	1(50%)	1(50%)	1(50%)	1(50%)	
		R	1(50%)	2(100%)	2(100%)	1(50%)	1(50%)	1(50%)	1(50%)	
	Bacteriodes species (2)									
		S	2(100%)	-	1(50%)	-	1(50%)	-	-	
	Citrobacter species (1)	R	-	2(100%)	1(50%)	2(100%)	1(50%)	2(100%)	2(100%)	
		S	-	-	-	-	-	-	-	
		R	1(100%)	1(100%)	1(100%)	1(100%)	1(100%)	1(100%)	1(100%)	
Ovia North East	Staphylococcus aureus (7)	S	5(71.4%)	2(28.6%)	2(28.6%)	1(14.3%)	4(57.1%)	2(28.6%)	-	
		R	2(28.6%)	5(71.4%)	5(71.4%)	6(85.7%)	3(48.3%)	5(71.4%)	7(100%)	
	Pseudomonas species (2)									
		S	1(50%)	-	-	-	-	2(100%)	-	
		R	1(50%)	2(100%)	2(100%)	2(100%)	2(100%)	-	2(100%)	

Cefoxitin disc diffusion susceptibility test

All the *staphylococcus aureus* speciesisolated (41 out of the 93 bacterial isolates) from the three healthcare facilities were subjected to cefoxitin disc diffusion test to know whether they were methicillin resistant or not. The *Staphylococcus aureus* was said to be resistant if the zone of inhibition was ≤ 20mm (based on the Clinical and Laboratory Standard Institute values 2013). All the 6 (100%) *Staphylococcus aureus* isolated in UBTH were methicillin resistant, 5 out of 6 (83.3%) of those isolated fromCentral hospital were methicillin resistant while 16 out of 29 (55.2%) species of *staphylococcus aureus* isolated from community pharmacies were methicillin resistant.

Antimicrobial susceptibility testing is thus very important in healthcare facilities as it enables the healthcare practitioners to accurately choose the most appropriate antibiotics for tackling any bacterial infection.

IV. DISCUSSION

Bacteria, fungi, parasites, and viruses have been implicated as the cause of nosocomial infections with bacteria being the most implicated organisms. In most studies conducted to isolate microorganisms from the blood pressure cuffs of sphygmomanometers, bacteria have always been the most isolated organisms but in this study, fungi were the most isolated 107 (53.5%) as against bacteria 93 (46.5%). In this study, *Staphylococcus aureus* was the most isolated bacteriumaccounting for 44.1% (41 out of 93 bacterial isolates). This was consistent with studies conducted by Fitsum *et al.,* (2019),Uneke and Ijeoma (2011),and Giallul*yet al*(2006), with *Staphylococcus aureus* accounting for 35%, 73.9%, and 74.0%,respectively.In a study by Baruah *et al.,*

(2008) the majority (67%) were contaminated with*Coagulase Negative Staphylococci*, but 30% were contaminated with

Staphylococcus aureus of which 5% were methicillin resistant. However, the organisms isolated from the different studies cited above varied from one healthcare facility to another as this could be attributed to the variation in geographical location, the environment of the particular healthcare facilities investigated, and the way the sphygmomanometers are being handled by the healthcare practitioners who use them.

In this study, the inner surfaces of the cuffs were more contaminated than the outer surfaces except in dermatology unit where both surfaces were heavily contaminated as seen in their colony forming unit per milliliter. The inner surfaces of the blood pressure cuffs usually have larger surface areas than the outer surfaces and the fact that these are the parts that come in direct contact with the patients' skin make them more likely to harbour more microorganisms than the outer surfaces. This was similar to a study done by Baruah *etal*, (2008)in which the inner surfaces were more contaminated than the outer surfaces and highest contamination was in the intensive care unit. Also, a studyby Umegbolu (2019)revealed that the inner surface was more contaminated than the outer surface but the most contamination was from the outpatient departments with *Pseudomonas aeruginosa* being the most isolated bacteria. However, in this particular study the highest contamination was in the dermatology unit. This could be attributed to the fact that the sphygmomanometers available in this unit are shared among many patients with obvious skin infections over a long period of time without adequate routine disinfection of the sphygmomanometers.

Disinfection of the inner surfaces of the blood pressure cuffs was found to drastically reduce the microbial loads in only few of the sphygmomanometerswhile eliminating the microorganisms in majority of the sphygmomanometer cuffs.This shows that the 70% isopropyl alcohol is an effective disinfectant and its routine use on the blood pressure cuffs could minimize the contamination of the sphygmomanometer cuffs and ultimately reduce the transmission of healthcare associated infections among patients in our healthcare facilities. This disinfectant at such concentration of 70% is safe for routine use on non-critical medical instruments such as the sphygmomanometers and stethoscopes. This was similar to other studies where the use of 70% isopropyl alcohol was able to reduce or eliminate the microorganismsJeyakumari *et al* (2016)and Umegbolu (2019).

Antimicrobial resistance is a major problem affecting the healthcare system as it's not only detrimental to the patients but also pose a great challenge to the healthcare practitioners who find it difficult to treat infections that have developed multidrug-resistance. Methicillin resistant *Staphylococcus aureus* infections are multidrug resistant and sometimes very difficult to treat.

In this study, the most sensitive antibiotics tested was gentamicin, followed by ciprofloxacin and septrin while the least sensitive antibiotic was amoxicillin. This was in line with the study done by Uneke and Ijeoma (2011) in which many of the isolated organisms were resistant to most of the antibiotics tested however, the most sensitive antibiotics in their study were ciprofloxacin and streptomycin.

V. CONCLUSION

This study confirmed the presence of potentially pathogenic organisms which are implicated in healthcare-associated infections on the surfaces of sphygmomanometer cuffs used in the investigated healthcare facilities, as the isolated organisms are found to cause serious systemic infections that require patients' hospitalization for effective treatment. The 70% isopropyl alcohol was found to be effective either in killing the organisms completely or reducing the microbial loads.Thus, there is the need to constantly disinfect the BP cuffs of sphygmomanometers to reduce the spread of microorganisms from one patient to another.

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Competing interest

The authors declare that they have no competing interests.

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