A CASE STUDY ON ANTIMICROBIAL RESISTANCE OF BACTERIAL ISOLATES FROM HIGH-TOUCHED SURFACES IN HOSPITALS IN MADONNA CATHOLIC HOSPITAL, ABIA STATE

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When healthcare professionals handle infected materials with their hands and gloves or when patients come into contact with contaminated surfaces directly, environmental contamination enhances the transmission of bacteria. This study aimed to determine the antimicrobial resistance of bacteria isolated from high-touched surfaces in Madonna Catholic hospital, Abia State. Samples of the most commonly contacted surfaces were gathered by rubbing and spinning sterile swabs sticks with normal saline on the surfaces. Direct inoculation of the swab samples using the streak plate method was done on Blood agar and MacConkey agar plates. The serial dilution method enumerated the bacterial species associated with the contact surfaces. The bacterial isolates were subjected to an antibiotic susceptibility test using the Kirby Bauer disc diffusion technique. This study showed that thirty-six (36) bacteria isolates were obtained from fifty (50) swab samples collected from high-touched surfaces. It was also observed that *Staphylococcus aureus* is the most frequently occurring isolate with 12 (33.3%), followed by coagulase-negative *Staphylococci* 10 (27.8%). The least occurring isolate was recorded for *Pseudomonas* spp. 5 (13.9%). It was recorded in this study that door handles showed the highest distribution of bacterial isolates 14 (38.8%), whereas swab samples obtained from the benches showed a minor distribution 2 (5.5%). However, the antibiotics susceptibility profile of bacterial isolate from the sampled surfaces showed that Ciprofloxacin was the most effective antibiotic tested at a rate of 100%. It was revealed in this study that most of the bacterial isolates showed a highest level of resistance to Chloramphenicol, Tetracycline and Ampiclox (100%). An appreciable number of pathogenic bacteria isolates were detected in the frequently touched surfaces in the hospital. The presence of these organisms could be the leading cause of hospital-acquired infections. Suitable hygienic measures must be adopted at the hospital to reduce the level of contamination and spread of disease through these surfaces. It is also vital to promote excellent personal hygiene like hand washing. This study finding suggests that ciprofloxacin can be used for treatment and control bacterial infections.

Keywords: High-touched surfaces, Resistance, Antibiotics, Hospital, Bacteria

INTRODUCTION

Infections from the hospital are the leading cause of death, morbidity, higher treatment expenses, and prolonged hospitalization. A hospital setting is a crucial contributor to the development of numerous healthcare-related infections worldwide (1). The fast transmission of hospital germs from patient to patient, healthcare workers to patients, and inanimate surfaces to all bodies is aided by contamination of the inert surfaces of the hospital environment, healthcare workers (HCWs), and medical equipment (2). Inadequate sterilization, surface decontamination and poor hand hygiene practices among healthcare workers all contribute to the cross-transmission of pathogens like multidrug-resistant (MDR) bacteria, which cause many nosocomial admissions (3). Environmental contamination aids in the spread of bacteria when health professionals' hands or gloves get contaminated after handling infectious objects or when patients come into touch with contaminated

surfaces (4). Bacteria species can be transmitted from one person to the next, including healthcare personnel and patients (5). Studies have revealed the presence of bacteria species on high-touched surfaces in the hospital environment in a previous study in Ethiopia (6). These bacterial species include; *Klebsiella, E. coli, Enterococcus, Proteus, Acinetobacter, Salmonella, Shigella, S. aureus, Streptococcus*, and *Pseudomonas* species, which are found on hospital hand touch surfaces (6). Patients, visitors, and health care employees often touch high-touch surfaces. They might act as a nosocomial pathogen reservoir and a source of healthcare-associated pathogen transmission, leading to several outbreaks of healthcare-acquired diseases (7). Bacterial cross-contamination is crucial in healthcare-associated infections (HCAIs) and the spread of resistant strains (8). Although most HCAIs are thought to be transmitted directly from patient to patient, growing data suggests that medical workers and the clinical environment (i.e., surfaces and equipment) can also be

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sources of infection (9). Controlling nosocomial infections and resistant strains polluting air, hands, equipment, and surfaces have been a significant focus of hospital design and hygiene practices (10). More profound knowledge of bacterial cross-contamination can help researchers design evidence-based prevention strategies (11).

The prevalence of hospital-related infections in underdeveloped countries is not adequately recognized or reported (12). According to a systematic review, hospital-related infections affect 7.6% of high-income countries and 10.1% of low- and middle-income countries (13). On a variety of surfaces, including white coats, stethoscopes, mobile communication devices, computer keyboards, elevator buttons, sticky tape, and ultrasound transducers, bacteria have been seen to persist for varying lengths of time (14). Multidrug-resistant bacteria are bacterial species resistant to at least one antibiotic from a different spectrum of antibiotics. Despite broad antibiotic availability, multidrug-resistant (MDR) bacterial isolates are great concern for global infections by such bacteria (15). The rise of multidrug-resistant bacteria species in the hospital environment, particularly in developing countries, is becoming a problem, posing a challenge to nosocomial infection management (16). Multidrug resistance among bacterial isolates is increasingly crucial, with antimicrobial-resistant bacteria accounting for nearly 60% of nosocomial infections (17). This study aimed to investigate the diversity and distribution of bacterial strains that mostly contaminate the highly touched surfaces in the hospital. These sites are shared by patients, health workers and visitors and are mostly neglected for cleaning and disinfection procedures. Because limited data is available regarding bacterial colonization of highly touched surfaces in hospital settings in Umuahia, capital city of Abia State, this work was conducted to isolate and characterize the pathogenic microorganisms from high-touched surface of Madonna Catholic hospital in Abia State of Nigeria.

MATERIALS AND METHODS

Study Area. This study was conducted at Madonna Catholic Hospital located at Ohokobe Afaraukwu Aba Road Umuahia, Abia State. The hospital is about 10 km from Umuahia town, a health care institution designed for 200-bed spaces. The institution's services include pediatrics, laboratory analysis, cardiac clinic, ophthalmology, gynecology, outpatient rehabilitation, outpatient surgery and Laryngological services.

Study Period. The study was carried out from July to September 2021.

Sample Collection. A total of fifty (50) samples were obtained from various surfaces within the hospital. The contaminated surfaces include; door handles, staircase railings, chairs and benches. The swab method was used in collecting the samples (18). By rubbing and rotating sterile swabs wet with normal saline, samples of the most commonly contacted surfaces were obtained from target areas. The swab sticks were placed in their container to avoid contamination, labelled, and transported in ice packs to the Microbiology Laboratory of Michael Okpara University of Agriculture in Umudike for isolation and characterization of bacteria.

Sterilization Methods. All the glasswares were properly washed and sterilized in a hot air oven at 170°C for 2 hours. Distilled water was sterilized in the autoclave at 121°C for 15 minutes. Cork-borer and glass rods were sterilized by dipping them into 70% alcohol before flaming on the Bunsen burner. The workbench was swabbed with 75% alcohol before and after each experiment.

Media and Preparation. Blood and MacConkey agar (Oxoid, UK) was used to isolate the bacteria species from the touched surfaces. Nutrient agar media was used to sub-culture the isolates to obtain a pure culture. Mueller Hinton agar/broth was used for carrying out Agar Disc/well Diffusion method for diameter zone of inhibition and antimicrobial susceptibility assay. All the media used for this research work were prepared according to the manufacturer's instructions, autoclaved for 15 minutes at 121ºC at 15 psi and were aseptically poured into sterile Petri dishes.

Inoculation and Isolation. Direct inoculation by the streak plate technique was carried out (19). The swabs were streaked directly on the surface of the sterile culture material (Blood agar, Nutrient agar, and MacConkey agar) (Oxoid, UK). Plates were incubated after inoculation for 24 hours at 37°C for bacterial growth.

Purification of Isolates. The resulting colonies from the Blood agar, MacConkey agar, and Nutrient agar (Oxoid, UK) plates were purified by sub-culturing on freshly prepared nutrient agar. The plates were incubated for 24 hours at 37°C. After overnight incubation, the resulting discrete colonies were stored in an agar slant for further use.

Characterization of Bacterial Isolates. Morphological characteristics, gram staining, observation and growth on the medium were carried out with all isolates (19).

Gram Staining. A smear from the sample was made on a clean grease-free slide, air dried, and heat fixed. The glass slide was flooded with crystal violet for 1 minute and rinsed with water. Lugol's iodine (mordant) was applied for 60 seconds and rinsed. Acetone was used in decolorizing and washed immediately, then counterstained with neutral red for 1 minute. It was then rinsed with water, blotted carefully, and air dried. Finally, the slides were observed under the microscope using oil immersion objectives (x100) (19).

Motility Test. The test is useful in detecting motile and non-motile organisms. A 20-hour peptone medium culture drop of the test organism was placed on a clean, grease-free slide with a Pasteur pipette. The glass slide was then covered with a cover slip and viewed under the microscope using an x40 objective lens. The movement of small motile bacteria is distinguished from the on-the-spot vibratory movement (Brownian movement), which is shown by all microorganisms and particles when suspended in a fluid. True bacterial motility refers to an organism's ability to move in multiple or single directions (19).

Biochemical Tests. Isolated organisms were identified by standard microbiology identification techniques, including catalase, coagulase, citrate utilization, methyl-red, Voges-Proskauer, urease, starch utilization, hydrogen-sulphide and indole test (19).

Antimicrobial Susceptibility Testing by Disk Diffusion Method. The Kirby Bauer antibiotics disk method for susceptibility tests was used. Discrete colonies from 24-hour nutrient agar plates were suspended into sterile normal saline in a tube to achieve a bacteria suspension equivalent to 0.5 McFarland turbidity standards. A cotton swab was dipped in the bacterial mixture and rubbed against the tube's side to drain surplus fluid. The entire surface of the agar plates was then inoculated with the swab of inoculums, ensuring the confluent growth of bacteria. Antibiotic discs containing Ciprofloxacin (10μg), Gentamicin (10μg), Nitrofurantoin (20μg), Nalidixic acid (30μg), Ofloxacin (5μg), Amoxicillin (30μg), Streptomycin (30μg), Tetracycline (10μg), Erythromycin (30μg), Chloramphenicol (30μg), Ampiclox (20μg), and Levofloxacin (20μg) were placed onto the inoculated plates with a sterile flame forceps and the plates incubated at 37°C for 18-24 hours. After incubation, the diameter of zone of inhibition produced by each antibiotic against the isolates was measured in millimeter. The drugs were interpreted as sensitive, intermediates or resistant, following the guidelines of the Clinical and Laboratory Standard Institute (CLSI) (20).

RESULTS

Tables 1a and 1b show the bacterial isolates from the frequently touched surfaces. Morphological characteristics identified these isolates, pigmentation on media, microscopy, biochemical, sugar fermentation methods and colonial morphology on various culture media. The bacterial isolates obtained from this study include; *Staphylococcus aureus*, Coagulase Negative *Staphylococcus, Escherichia coli* and *Pseudomonas* species.

Table 2 shows the distribution and percentage occurrence of bacterial isolates from frequently touched surfaces. A total of thirty-six (36) bacterial strains were isolated from the frequently touched surfaces, which include; *Staphylococcus aureus* 12 (33.3%), coagulase negative *Staphylococcus* 10 (27.8%), *Escherichia coli* 9 (25.0%) and

Pseudomonas species 5 (13.8%). Among the frequently touched surfaces in the hospital investigated, door handles showed the highest numbers of bacteria isolates (n = 14, 38.8%), while the least number of isolates was recorded for benches (n =2, 5.5%).

Table 3 shows the drug sensitivity, and resistance pattern of bacteria isolates from the frequently touched surfaces with varying percentages of sensitivity, intermediate and resistance to the tested antibiotics. Ciprofloxacin (10μg), Gentamicin (10μg) and Levofloxacin (20μg) were the most effective antibiotics tested against bacterial isolates from all the sample sources. Meanwhile, *Escherichia coli* isolate was resistant against six (6) antibiotics which include; Nitrofurantoin, Nalidixic acid, Ofloxacin, Amoxicillin, Tetracycline, and Ampiclox. The most frequently occurring isolate, *Staphylococcus aureus,* was highly susceptible to Ciprofloxacin (91.7%) and

least susceptible to Chloramphenicol (16.7%). However, the least occurring isolate (*Pseudomonas* species) was highly resistant to Tetracycline (100%) and Ampiclox (100%). CoN *Staphylococcus* was 80% and 70% sensitive to Ciprofloxacin and Levofloxacin but was highly resistant to Chloramphenicol (100%) and Erythromycin (90%). The most predominant Gram-negative isolate (*Escherichia coli*) showed a high level of sensitivity to Ciprofloxacin (77.8%), Gentamicin (88.9%) and Levofloxacin (77.8%) but was resistant to Nalidixic Acid (88.9%), Tetracycline (100%) and Ampiclox (100%).

Table 4 shows the Multiple Antibiotics Resistance Index (MARI). This revealed that *Escherichia coli* isolated from frequently touched surfaces showed the highest level of multidrug resistance at 0.5. At the same time, the least index 0.3 was recorded for Coagulase-negative *Staphylococcus* (CoN)*, Staphylococcus aureus* and *Pseudomonas* species.

Table 1a: Identification and Characterization of Bacterial Isolates from the frequently touched surfaces.

S/N	Gram Reaction	Cell Arrangement	Catalase	Oxidase	Coagulase	Indole	Citrate	Motility	Methyl Red	Voges-proskauer	H_2S	Urease	Glucose	Lactose	Probable organisms
1	-	Short Rod	+	-	-	+	-	+	-	-	-	-	AG	AG	*Escherichia coli*
2	+	Cocci	+	-	-	-	+	-	+	-	-	+	AG	AG	CoN *Staphylococcus*
3	+	Cocci	+	+	+	+	-	-	+	+	+	+	AG	AG	*Staphylococcus aureus*
4	-	Short Rod	+	+	-	-	-	+	-	+	-	-	NAG	NAG	*Pseudomonas* species

Note: - = Negative, + = Positive, CoN = Coagulase Negative, H_2S = Hydrogen Sulphide, AG = Acid and Gas Production, NAG = No Acid and Gas Production.

Table 1b: Morphological identification of bacterial isolates from high-touched surfaces.

Isolates	Colonial Morphology
Escherichia coli	Pink coloured, circular, slightly raised, smooth colonies on MacConkey agar
CoN *Staphylococcus*	Light yellow colonies with slight elevation on Mannitol Salt agar
Staphylococcus aureus	Golden yellow colonies on Mannitol Salt agar
Pseudomonas species	Milky coloured colonies on MacConkey agar

Table 2: Distribution and percentage of occurrence of bacterial isolates from the high-touched surfaces.

Bacteria Isolates	Frequency Occurrence					Percentage (%)
	Tables	Stair case Railing	Benches	Hospital beds	Door Handles	
Escherichia coli	+++	++	+	+	++	9(25.0%)
CoN *Staphylococcus*	+	+++	-	++	++++	10(27.8%)
Staphylococcus aureus	+	+++	+	++	+++++	12(33.3%)
Pseudomonas species	-	+	-	+	+++	5(13.8%)
Total	6	9	2	6	14	36(100%)

Note: CoNS = Coagulase Negative *Staphylococci*, + = Present, - = Absent.

Table 3: Antibiotics sensitivity and resistance pattern of the bacterial isolates from the frequently touched surfaces.

Bacterial Isolates	Pattern	No. of Isolates	Number Resistant and Sensitivity To (%)											
			CPX	CN	NIF	NA	OFX	AU	S	TET	ERY	CLM	APX	LEV
Staphylococcus aureus	S	12	11(91.7)	8(66.7)	7(58.3)	3(25.0)	6(50.0)	4(33.3)	7(58.3)	7(58.3)	3(25.0)	2(16.7)	3(25.0)	9(75.0)
	R		1(.8.3)	3(25.0)	3(25.0)	9(75.0)	6(50.0)	8(66.7)	2(16.7)	5(41.7)	7(58.3)	9(75.0)	9(75.0)	3(25.0)
	I		0(0.0)	1(8.3)	2(16.7)	0(0.0)	0(0.0)	0(0.0)	3(25.0)	0(0.0)	2(16.7)	1(8.3)	0(0.0)	0(0.0)
CoN *Staphylococcus*	S	10	8(80.0)	6(60.0)	6(60.0)	2(20.0)	4(40.0)	3(30.0)	4(40.0)	5(50.0)	1(10.0)	0(0.0)	3(30.0)	7(70.0)
	R		1(10.0)	4(40.0)	4(40.0)	5(50.0)	6(60.0)	7(70.0)	6(60.0)	4(40.0)	9(90.0)	10(100)	6(60.0)	2(20.0)
	I		1(10.0)	0(0.0)	0(0.0)	3(30.0)	0(0.0)	0(0.0)	0(0.0)	1(10.0)	0(0.0)	0(0.0)	1(10.0)	0(0.0)
Escherichia coli	S	9	7(77.8)	8(88.9)	2(22.2)	1(11.1)	2(22.2)	2(22.2)	4(44.4)	0(0.0)	3(33.3)	4(44.4)	0(0.0)	7(77.8)
	R		1(11.1)	1(11.1)	7(77.8)	8(88.9)	7(77.8)	7(77.8)	5(55.6)	9(100)	3(33.3)	5(55.6)	9(100)	1(11.1)
	I		1(11.1)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(11.1)	0(0.0)	0(0.0)	1(11.1)
Pseudomonas species	S	5	5(100)	3(60.0)	3(60.0)	3(60.0)	3(60.0)	2(40.0)	1(20.0)	0(0.0)	2(40.0)	2(40.0)	0(0.0)	4(80.0)
	R		0(0.0)	2(40.0)	2(40.0)	2(40.0)	2(40.0)	3(60.0)	4(80.0)	5(100)	3(60.0)	3(60.0)	5(100)	1(20.0)
	I		0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)
TOTAL	S	36	31(86.1)	25(69.4)	18(50.0)	9(25.5)	15(41.6)	11(30.5)	16(44.4)	12(33.3)	9(25.5)	8(22.2)	6(16.6)	27(75.0)
	R		3(8.3)	10(27.7)	16(44.4)	24(66.6)	21(58.3)	25(69.4)	17(47.2)	23(63.8)	22(61.1)	27(75.0)	29(80.5)	7(19.4)
	I		2(5.5)	1(2.7)	2(5.5)	3(8.3)	0(0.0)	0(0.0)	3(8.3)	1(2.7)	3(8.3)	1(2.7)	1(2.7)	1(2.7)

Note: Ciprofloxacin (10µg) = CPX, Gentamicin (10µg) = CN, Nitrofurantoin (20µg) = NIF, Nalidixic acid (30µg) = NA, Ofloxacin (5µg) = OFX, Amoxicillin (30µg) = AU, Streptomycin (30µg) = S, Tetracycline (10µg) = TET, Erythromycin (30µg) = E, Chloramphenicol (30µg) = CLM, Ampiclox (20µg) = APX, and Levofloxacin 20µg = LEV, % = Percentage, No = Number, S = Sensitive, R = Resistant, I = Intermediate.

Table 4: Resistance pattern and MAR index of the isolates.

Bacterial Isolate	Resistivity Pattern	MARI
Escherichia coli	NIF, NA, OFX, AU, TET, APX	0.5
CoN *Staphylococcus*	AU, ERY, CLM	0.3
Staphylococcus aureus	NA, AU, CLM, APX	0.3
Pseudomonas species	S, TET, APX	0.3

Note: Ciprofloxacin (10µg) = CPX, Gentamicin (10µg) = CN, Nitrofurantoin (20µg) = NIF, Nalidixic acid (30µg) = NA, Ofloxacin (5µg) = OFX, Amoxicillin (30µg) = AU, Streptomycin (30µg) = S, Tetracycline (10µg) = TET, Erythromycin (30µg) = E, Chloramphenicol (30µg) = CLM, Ampiclox (20µg) = APX, and Levofloxacin (20µg) = LEV.

Multiple Antibiotics Resistance Index (MARI) = No. of antibiotics to which the organism is resistance
                                              Total No. of antibiotics tested

DISCUSSION

Since hospital-acquired illness has remained one of the most serious public health problems worldwide (21), the hospital environment has contributed to the emergence of nosocomial infections. The bacteria flora excreted by patients, visitors, and healthcare professionals frequently contaminate hospital surfaces, and microorganisms increase infection risk among vulnerable patients in the hospital environment (22). The antimicrobial resistance of bacterial isolates from high- touched surfaces in Madonna Catholic Hospital, was investigated in this study. The findings of this study demonstrated that all the frequently touched surfaces in the hospital under investigation were contaminated with bacteria species which include; *Staphylococcus aureus*, Coagulase Negative *Staphylococcus, Escherichia coli* and *Pseudomonas* species. It has been demonstrated that the issue of surface contamination by microorganisms contributes to the spread of nosocomial and community-acquired

illnesses through the inanimate transmission method (23). The result obtained here corroborates an investigation done by John and Anthony (2018), who isolated both Gram-positive and Gram-negative bacteria from contact surfaces in Uyo, Akwa Ibom State, Nigeria. A similar study conducted by Bhatta*et al*. (2018) in Nepal demonstrated that routinely used hospital items were home to a diverse range of pathogenic microorganisms, including *S. aureus, Acinetobacter* species, *Escherichia coli* and*Pseudomonas species,* as well as normal flora.
The prevalence of *Staphylococcus aureus* as part of the normal flora of human skin and hands, which frequently come into contact with things in the environment, may have contributed to its isolation. This also suggests the likelihood of oral or nasal contamination (aerosol discharge from the mouth and nose), implying that passengers' body flora may have been shed on those surfaces (26, 27). Opportunistic infections such as *Pseudomonas* spp. can also be found in soil. The presence of *Escherichia coli* on contact surfaces indicates fecal contamination, most likely from the hands of people who do not wash

their hands properly after using the restroom or submitting a specimen for testing.

This study also revealed that *Staphylococcus aureus* is the most frequently occurring isolates from the high-touched surfaces in the hospital 12 (33.3%), followed by Coagulase Negative *Staphylococcus, Escherichia coli* and *Pseudomonas* species at 10 (27.8%), 9 (25.0%), and 5 (13.8%), respectively. The current study shows lower rate of contamination by microorganisms compared to another study by Mohammed *et al.* (2017) on bacterial contamination of an operation theatre in Nigeria with a contamination rate of 78%. This study was conducted to evaluate bacterial contamination of inert hospital surfaces and equipment in critical and non-critical care units with a prevalence of 94.1% in Brazil (21); and the bacteriological study of electronic devices used by healthcare workers in Rwanda with contamination of 98.53% (28). Similar to our result, lower bacterial contaminations were also reported in studies conducted elsewhere; Sudan (29.7%) (30), Nigeria (39.4%) (31), Uganda (44.2%) (32) and Bahir Dar, Northwest Ethiopia (39.6%) (33).

The high reports from the previous study comparedto the present study may be due to the difference inthe study design (21), ineffective disinfectants during surface cleaning, migration of the organisms through airflow or other means, particularly in places where the ventilation system has not been working properly (34). However, differences in hand hygiene, ventilation system, sterilization and disinfection techniques could account for these discrepancies (8). This study also revealed that among the frequently touched surfaces in the hospital investigated for the presence of bacteria species, door handles had the highest numbers of bacterial contaminants (14), while the least contaminated surfaces were the benches. In a study by Augustine et al. (2017), *S. aureus, Pseudomonas* species and *E. coli* were reported as common isolates from door handles. In a recent study, *E. coli* has reported as the second-most common bacterial isolate from door handles (36). Isolation of *E. coli* from pediatric unit door handles could threaten serious infections among neonates. In a similar study (37), door handle contamination by *S. aureus* in a University hospital in Japan was 27% which is comparable with our study (16.2%). Courage *et al.* (2017) reported that *S. aureus* colonization rate of 39% (47/120) from door handles, staircase railings and other contact points in Teaching Hospitals. Bacterial contamination of other frequently touched places, such as stair railings, poses a danger of transmission, particularly among children fondling railings during hospital visits. From this study, hospital beds were the third most frequently contaminated surfaces having about 16.7% of the bacteria isolates. Similar outcomes on bed samples were attained in research from Iran (39) and Nigeria (31). Cross-contamination from a patient's flora,

healthcare staff' hands, contaminated storage carts, or contamination during the washing process, particularly for bed linens, are possible sources of such contaminations (39).

Indications from the antibiotic sensitivity test using the Modified Kirby Bauer disc diffusion test method revealed varying levels and patterns of susceptibility and resistance to the antibiotics tested. The result obtained from this study showed that Ciprofloxacin, Gentamicin and Levofloxacin were the most effective antibiotics tested against bacterial isolates from all the sample sources.

According to Sapkota *et al.* (2019), Gentamicin was the most effective antibiotic for *E. coli* isolates, and Amoxicillin was the least effective antibiotic, which agrees with the sensitivity pattern observed in this study. A similar resistance pattern of bacteria isolates from contact surfaces has been reported (41, 42). This result, however, contradicts the findings of Jombo *et al.* (2010), who found that commonly isolated organisms from contact surfaces were susceptible to Amoxicillin. The selection pressure that the antibiotics exert results in increased resistance to β-lactam antibiotics (44). Serious issues may arise when administering these tested antibiotics since they reflect the most commonly used antibiotics in practice (45). Creating prescription recommendations for antibiotics should be one strategy in the battle against this trend in resistance (46).

However, the Multiple Antibiotics Resistance Index (MARI) revealed from this study that *E. coli* showed the highest multidrug resistance at 0.5%. Previous investigations have indicated a lower prevalence of MDR in *E. coli* compared to the current study. This finding is lower compared to the reports from Tikur Anbesa (45.8 and 73.8%) (47) and Iran (47.8 and 83.1%) (48). The formation of MDR strains may be caused by the constant pressure of disinfectants and antibiotics on the bacteria prevalent in the hospital environment (49).

CONCLUSION

Based on the findings in this study, it can be concluded that the frequently touched surfaces in Madonna Catholic Hospital, Umuahia, Abia state, Nigeria, were contaminated with bacterial species such as *Staphylococcus aureus,* Coagulase Negative *Staphylococcus, Escherichia coli* and *Pseudomonas* specie. The isolation of organisms from these surfaces suggests that they could be used to spread disease in these vital public spaces (hospitals). In order to avoid or limit the contamination or spread of illnesses caused by these bacteria species, it is crucial to promote proper personal hygiene practices such as hand washing. The multidrug-resistant pattern from this study showed high varied percentage resistance of the isolates to the antibiotics tested. Even though the rate of multidrug resistance was low in this study, it is

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still a cause for concern because there is an antibiotic resistance gene pool and resistance genes and plasmid-encoded virulent genes are easily transmitted to other strains. Following the results of the sensitivity and resistance pattern of the isolates to different antibiotics, the study, therefore, suggests that Ciprofloxacin (10µg), Gentamicin (10µg) and Levofloxacin (20µg) are the drugs of choice in the treatment of health complications and infections caused by these bacteria species acquired through the contact with contaminated surfaces.

CONSENT AND ETHICAL APPROVAL

The authors declare that all experiments have been examined and approved by the appropriate ethics committee and informed consent was obtained from all relevant authorities.

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COMPETING INTERESTS

Authors declare that there are no competing interests exist.

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