BACTERIOLOGICAL ASSESSMENT OF AUTOMATED TELLER AND POINT OF SALES MACHINE USER INTERFACE IN UYO METROPOLIS, NIGERIA

ABSTRACT

The Automated Teller Machine (ATM) and Point of Sales (POS) machine user interface of different banks, schools, hospitals, restaurants/eateries, shopping malls and petrol/gas stations in Uyo metropolis were bacteriologically assessed in the dry and wet seasons using cultural technique. The result of fomites key pads indicate total heterotrophic bacteria counts (THBC) was in the order: Banks > Hospitals > Schools > Petrol/Gas stations > shopping malls > Restaurants/Eateries in both seasons. There was an increase in the bacterial counts of the fomites from all locations in the wet season compared to the dry season and the difference significant ($p = 0.05$). The THBC from ATMs in banks and schools ranged from 5.6 ± 0.1 to 7.8 ± 0.6 $Log_{10}CFU/cm^2$ and 3.4 ± 0.3 to 5.0 ± 0.2 $Log_{10}CFU/cm^2$) for Petrol/Gas stations and Restaurants/Eateries in the wet season. Organisms associated with the fomites were *Escherichia coli, Staphylococcus aureus, Staphylococcus epidermidis* and species of *Bacillus, Pseudomonas, Proteus, Streptococcus, Salmonella, Shigella, Micrococcus, Vibrio* and *Klebsiella.* The highest and least frequency of occurrence in the dry season indicated *Micrococcus* (17.2%) and *Vibrio* (1.4%**)** in relation to *Staphylococcus aureus* (18.2%) and *Proteus* sp. (2.8%) in the wet season. The Gram-positive organisms exhibited high and low susceptibility to Gentamycin and Augmentin compared to Ofloxacin and Amoxicillin respectively in Gram-negative bacteria. The results indicate ATM and POS machine user interface as possible sources of pathogenic organisms. Therefore, regular cleaning of ATM and POS user interface and public awareness on the need for adequate personal hygienic practice after the use of these machines is recommended to reduce associated risks.

KEY WORDS: Automated Teller Machine, Point of Sales Machine, User Interface, Metropolis, Pathogenic

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1. INTRODUCTION

Electronic banking, an offshoot of Information and Communication Technology (ICT) has provided the classic and associated transformation to the banking industry with benefits through ease of monetary transactions. It is rather becoming 'an essential to have' than 'a pleasure to have' service. E-banking systems evolved technologies include, Automated Teller Machines (ATMs), Point of Sales (POS) device, Electronic Funds Transfer and Telebanking with the ATMs and POS machine as the most frequently used technologies [1]. These services are provided within certain locations not only near or inside the premises of banks but places such as shopping centres /malls, airports, grocery stores, petrol/ gas stations, restaurants, hospitals or any place that large number of people gather [2,3]. Therefore, the development of e-banking services has

not only affected economic status of countries but has had several deep social and cultural effects on the quality of individual lives.

Studies indicate that increasing number of persons prefer to use the ATMs and POS machines than to queue at banking halls for financial transactions especially as most countries gravitate towards cashless economy [4,5].While enormous investment has been made in the acquisition, installation, maintenance and even the security of these e-banking facilities, little has been done in ensuring its sound environmental quality, health wise. Microorganisms are ubiquitous and their ability to contaminate environmental objects and their surfaces is not an unusual phenomenon [6,7].There are reports indicating the presence of viable organisms on inanimate objects causing contamination, colonization and the spread of microbial infections [8,9]. Human beings have a marked tendency to pick up microorganisms from environmental objects and the hands play a vital role in contact and transmission of organisms.

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Colonization of e-banking facilities by pathogenic organisms has been reported as a potential vehicle for their transmission [10,11,12]. Microorganisms found to contaminate fomites are known to persist on environmental surfaces for varying periods of time ranging from hours to months. Hence, cross infection of microorganisms between environmental surfaces and a host has equally been established [13].The current banking policies which aim at operating a cashless economy has made the use of ATM and POS machines at different locations in Uyo metropolis popular tools for banking transactions /marketing by companies, institutions, hospitals and individuals of different social, educational and health status. However, the paucity of information on the bacteriological status of these vital tools in respect to their location in Uyo metropolis has necessitated this study.

2. MATERIALS AND METHODS

2.1 Source / Collection of Samples

Samples (Six hundred swabs) were collected from Two hundred Automated Teller Machine (ATMs) (i.e., fifty each season) and Two hundred Point of Sales (POS) machine (i.e., fifty each season) user interface (key pads) at different banks, hospitals, shopping malls and petrol/gas stations located within Uyo metropolis, in Akwa Ibom state, Nigeria by surface swab technique [14] in the wet and dry seasons. The surface swabs from the ATM and POS device keypads were collected aseptically using sterile swab sticks moistened with normal saline. This was done by rubbing the swab sticks firmly over the predetermined surface area using parallel stroke line with slow rotation with respectively chosen template surface area to be swabbed. The moistened sterile swab sticks were used to swab 20cm² of the contact surfaces. The swab sticks were replaced into their packs, sealed, labelled and transported within one hour of collection to the University of Uyo Microbiology laboratory for bacteriological analysis. Sampling was done for two wet and two dry seasons.

2.2 Bacteriological Quality Assessment

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All samples collected were processed in the University of Uyo, Microbiology laboratory according to standard bacteriological methods under complete aseptic conditions. The swabs were inoculated on appropriate culture media (Nutrient agar, MacConkey agar, Mannitol salt agar, Blood agar, Salmonella-Shigella agar and Thiocitrate bile salt agar) by direct steak method [15] in triplicates and incubated at 37°C under aerobic conditions for 18 - 48 hours. The surface swabs were also processed using the swab-rinse method for enumeration of bacteria associated with the fomites. The swab sticks were agitated up and down in the tubes containing Peptone water to aid on rinsing of the swab sticks. Serial dilution of the swab-rinse was made to promote appropriate dilutions from which aliquots for inoculation unto sterile media were obtained. Aliquot (1ml) of swab-rinsed dilutions were used for inoculation unto Nutrient agar, MacConkey agar, Mannitol salt agar, Blood agar, Salmonella – Shigella agar and Thiocitrate bile salt agar using pour plate method [16]. Inoculated plates were incubated at 37 °C for 18-24 hours for enumeration of Total Heterotrophic Bacterial Counts. Discrete colonies which grew were picked using a sterile wire loop and inoculated on the freshly prepared media that were previously used for primary culturing respectively using streak plating method. Pure isolates were preserved in MacCartney bottles as stock cultures in the refrigerator at 4 to 8 °C for further analysis.

2.3 Antibiotic sensitivity test

The antibiotic test was carried out to detect organisms that were susceptible or resistant to standard antibiotics. Each inoculum of the bacterial isolate was suspended in 2ml of sterile water and subsequently diluted to the turbidity of the McFarland standard. Susceptibility testing was carried out according to Clinical and Laboratory Standard Institute [17] procedures using the commercially prepared antibiotic discs (Abtek Biologicals Ltd) with the following antibiotics; Amoxicillin (25 µg), Gentamicin (10 µg), Cotrimoxazole (25 µg), Nitrofurantoin (20 µg), Nalidixic acid (30 µ), Ofloxacin (5 µg), Augmentin (30µg), Tetracycline (10 µg), Cloxacillin (5 µg), Erythromycin (5 µg), Streptomycin (10 µg) and Chloramphenicol (10 µg).

2.4 Characterization and Identification of Bacterial Isolates

The bacterial isolates were characterized and identified by comparing to known taxa using Bergey's Manual of Determinative Bacteriology based on their morphology, microscope appearance and biochemical characteristics [18].

2.5 Statistical Analysis

Statistical package for the social sciences (SPSS) version 17. 0 was employed for the statistical analysis of data generated. This included percentage, mean and standard deviation,.

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3. RESULTS

3.1 Bacterial counts of assessed fomites

The bacterial load of the assessed ATM and POS user interface is as presented in Figures 1 and 2. ATMs of the different locations in both seasons showed a bacterial load range of 4.1 ± (0.6) $Log_{10}CFU/cm^2$ to 7.8 ± (0.6) $Log_{10}CFU/cm^2$ in the wet and dry seasons while the bacterial counts for the POS in both seasons ranged between 2.6 ± (0.8) $Log_{10}CFU/cm^2$ and 5.0 ± (0.2) $Log_{10}CFU/cm^2$.

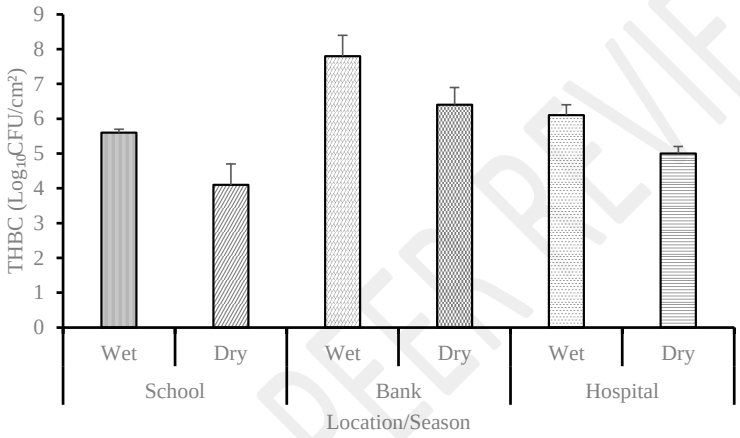

Figure 1 : Total heterotrophic bacterial count of ATM at different location

Figure 2 : Total heterotrophic bacterial count of POS at different locations

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3.2 Bacterial isolates associated with ATM and POS key pads

The bacteria associated with the assessed fomites included *Escherichia coli, Staphylococcus aureus, Staphylococcus epidermidis* and species of *Bacillus, Streptococcus, Salmonella, Shigella, Micrococcus, Proteus, Pseudomonas, Vibrio* and *Klebsiella.*

3.2 Percentage distribution of bacteria

The highest and least frequency of occurrence in the dry season indicated *Micrococcus* (17.2%) and *Vibrio* (1.4%**)** in relation to *Staphylococcus aureus* (18.2%) and *Proteus* sp. (2.8%) in the wet season. Figures 3 - 6 presents the percentage distribution of bacteria associated with the assessed fomites at the various locations in the wet and dry seasons.

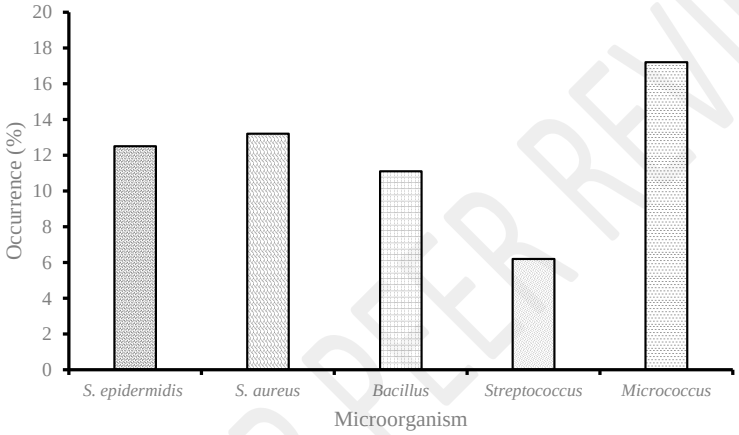

Figure 3 Percentage occurrence of Gram postive organisms in the dry season

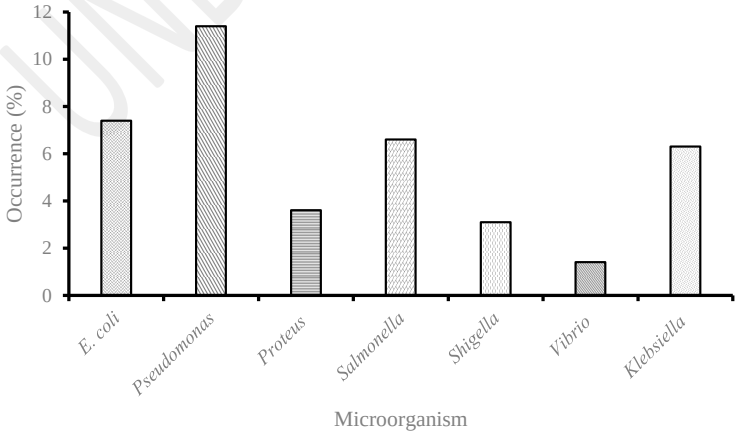

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Figure 4 Percentage occurrence of Gram negative organisms in the dry season

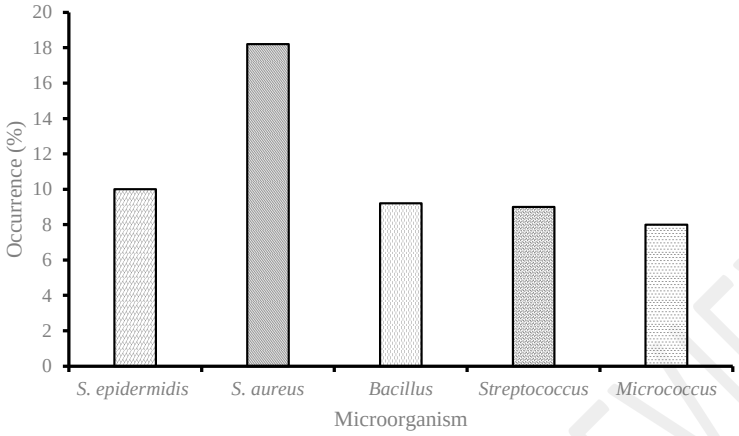

Figure 5 Percentage occurrence of Gram positive organisms in the wet season

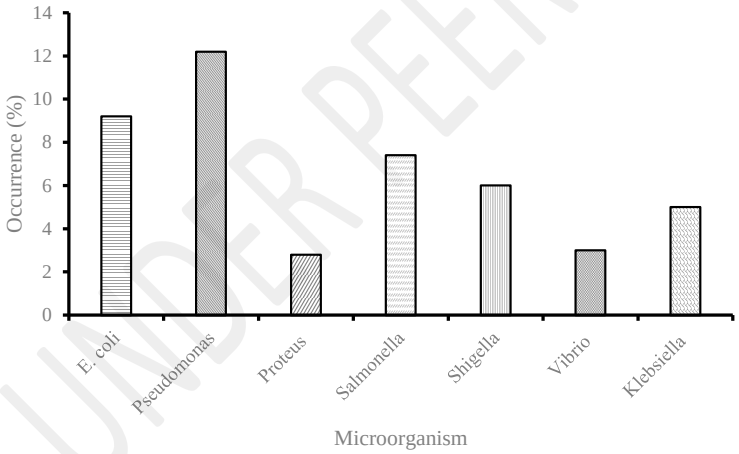

Figure 6 Percentage occurrence of Gram negative organisms in the wet season

3.3 Antimicrobial Suceptibility Profile of Bacterial Isolates Associated with ATM and POS

The Gram positive bacteria with the highest occurrence (*Staphylococcus aureus* - 18.2%) in the wet season revealed highest sensitivity (90%) to Gentamycin and highest (100%) resistance to Augmentin. *Streptococcus* (8%) with the least occurrence in the wet season also showed highest (100%) sensitivity to Gentamycin and highest (100 %) resistance to

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Erythromycin, Cotrimoxazole,Cloxacillin and Augmentin. The dry season for the Gram positive bacteria revealed *Micrococcus* (17.2%) with highest occurrence which showed highest sensitivity (90%) to Gentamycin and highest (100%) resistance to Tetracycline, Chloramphenicol and Augmentin. *Vibrio* (1.4%) with least occurrence among the Gram negative bacteria in the dry season exhibited highest (80%) sensitivity to Ofloxacin and highest resistance (100%) to Amoxicillin, Augmentin,Cotrimoxazole,Gentamycin, Nalidixic acid and Nitrofuratoin. *Pseudomonas* the Gram negative bacteria with highest occurence (12.2%) in the wet season showed highest(95%) sensitivity to Ofloxacin and highest (100%) resistance to Augmentin, Amoxicillin, Nalidixic acid and Tetracycline. *Proteus* with least occurrence (2.8%) in the wet season revealed highest sensitivity (100%) to Ofloxacin and Gentamycin and highest resistance (80%) to Augmentin and Amoxicillin. The antimicrobial profile of the bacterial isolates associated with ATM and POS are presented on Tables 1 and 2.

Table 1: Antibiotic resistance pattern of Gram positive bacteria associated with ATM and POS (n = 114)

Antibiotics	Percentage resistance				
	Bacillus sp	*S.aureus*	*S.epidermidis*	*Streptococcus* sp	*Micrococcus* sp
Augmentin	95	90	88	100	100
Cloxacillin	30	85	100	100	72
Cotrimazole	95	88	100	100	30
Chloramphenicol	36	60	55	50	100
Erythromycin	40	70	85	100	80
Gentamycin	20	10	5	0	10
Streptomycin	40	35	20	35	0
Tetracycline	80	65	82	55	100

Table 2: Antibiotic resistance pattern of Gram negative bacteria associated with ATM and POS (n=172)

Antibiotics	Percentage resistance						
	E. coli	***Klebsiella***	***Proteus***	***Pseudomonas***	***Salmonella***	***Shigella***	***Vibrio***
Amoxicillin	90	80	80	100	60	70	100
Augmentin	75	85	80	100	40	60	100
Cotrimoxazole	70	40	5	70	50	55	100
Gentamycin	30	20	100	10	0	0	100
Nalidixic acid	85	40	55	100	90	60	100
Nitrofuratoin	70	35	35	50	80	30	100
Ofloxacin	10	5	0	5	0	0	20
Tetracycline	80	25	60	100	80	10	30

4. DISCUSSION

Microorganisms are ubiquitous and their ability to cause contamination on environmental objects and their surfaces has been reported [7,9]. The results of this study showed the Total Heterotrophic Bacterial Counts for the machine user interface in the order: banks > Hospitals > Schools > Petrol/Gas stations > shopping malls > Restaurants/Eateries. The highest bacterial load at banks is attributed to the frequent and relative reliance of a large segment of the populace on use of the e-banking facilities, the hygienic status of the machine users and the environment where it is

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placed. The banking premises is not limited to people of certain class or status, compared to the hospitals, Schools, Petrol/gas stations, Restaurants/Eateries and shopping malls which is restricted to patients /individuals patronizing their services, individuals on visits to the hospitals or workers. This agrees with the reports indicating more contamination on keypads of e- banking facilities located in banks than those located elsewhere [19].

Furthermore, there was high contamination of the fomites in the wet season compared to the dry season. The difference in the bacterial load is attributed to the influence of varied environmental conditions on the growth of bacteria on surfaces [20]. The results indicate more favourable growth conditions in the wet season than dry season for the bacteria associated with the fomites. Generally, there was a high THBC on ATMs than the POS devices attributed to low patronage of the POS compared to the use of ATMs by individuals, companies and Institution.

The bacterial isolates associated with the fomites user interface in both seasons were more Gram-negative bacteria and a smaller number of Gram-positive bacteria. These included *Staphylococcus epidermidis Staphylococcus aureus, Escherichia coli and species of Bacillus, Pseudomonas, Proteus, Streptococcus, Salmonella, Shigella,Micrococcus,Vibrio and Klebsiella*. This results corroborates with the reports on the colonization of fomites by microbes via hand contact surfaces [9,21,22]. However, there was variations in the occurrence of bacterial isolates in the wet and dry seasons. And corroborates with the frequency of bacteria in winter and summer for ATM machines at Paducherry, India [21].

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The predominance of *Micrococcus* (17.2%) in the dry season was probably from abundance in air and thus easily contaminate the ATM/POS machine because they are located / exposed to open places and dust. It was observed as the fifth (9%) in the order of occurrence among isolates in the wet season, *Micrococcus* sp is an opportunistic pathogen in air often present in fine dust particles and may colonize the skin or mucus membrane of human, flora of the human skin and hands which often make contact with objects in the environment [23]. Species of *Vibrio* (1.4 %) were the least isolated bacteria in the dry season and attributed to the microbial pattern among users of the ATM and POS as well as the environmental condition hosting the facilities.

Vibro are organisms with high pathogenicity, causing even death in some major outbreaks and infections [24]. *Staphylococcus aureus* (18.2%) had high occurrence in the wet season with 13.2% in the dry season on the fomites. *Stapylococcus epidermidis* was also present in the wet and dry seasons on these facilities. The association of *Staphylococcus* species on the ATMs and POS keypads is attributed to their existence as part of the normal flora. The Coagulase – negative species have relatively low virulence but are increasingly recognized as agents of clinically significant infection of the blood stream and other sites and are frequently associated with nosocomial infections. They are known to be responsible for infections such as bacteraemia,

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endocarditis and urinary tract infections. *Staphylococcus aureus* is a common cause of skin infections, respiratory infections and food poisoning.

Pathogenic strains often promote infections by producing potent protein toxins and expressing cell surface proteins that bind and inactivate antibodies. A worldwide problem in clinical medicine is the emergence of antibiotic resistant strains of *Staphylococcus aureus* such as methicillin-resistant *Staphylococcus aureus* [20]. *Proteus* species was less frequent (2%) in the wet season and are commonly found in the human intestinal tract as part of normal human intestinal flora and also exist in multiple environmental habitats including long- term care facilities and hospitals. They are often regarded as indicators of fecal pollution, posing a threat of poisoning when it contaminates food or water. Species of *Proteus* are opportunistic pathogens and the most common cause of nosocomial infections [25].

The presence of *Bacillus* species on the ATM and POS user interface is attributed to its spore forming ability which probably cause it to be dispersed into the air and thus be able to settle on the surface of the key pads and its persistence on dry surfaces. It is a transient microflora of hands and adapts to varying environmental conditions. Species of *Bacillus* have been involved in food poisoning and food spoilage [20]. *Escherichia coli*, *Shigella* sp and *Salmonella* sp were also associated with the contact surfaces of these facilities. These organisms are enteric pathogens that are linked with gastroenteritis [26]. Their presence on the user interface indicates faecal contamination most likely from contaminated and unwashed hands and can easily be transferred from fingers to food surfaces and cause acute ailments. Virulent strains of *Escherichia coli* cause gastroenteritis, urinary tract infections, neonatal meningitis, septicemia, dysentery, vomiting, stomach cramps and flatulence [20]. Species of S*almonella* cause a range of illness including typhoid fever and gastroenteritis; food infections (salmonellosis) which is often fatal in patients with compromised immune systems [27].

Shigella species cause Shigellosis which is associated with diarrhea (sometimes bloody), fever, severe stomach cramps or tenderness and dehydration [28].The presence of *Streptococococcus* sp and *Klebsiella* sp indicate the possibility of mouth or nasal contamination from the aerosol discharge from mouth and nose that might have been shed to those surfaces by the users of the ATM and POS machine. These organisms have been implicated in respiratory infections. *Pseudomonas* species which are found in soil were also associated with the fomites. These organisms are opportunistic pathogens and presence on these facilities is a cause for concern, because they are known to cause infections, especially in hospital settings [20].

The findings of this study indicate that ATM and POS keypads can be considered a source of bacterial infections because most people with different levels of hygiene and health status use these items. They can therefore be widely involved in absorbing, harboring, and transferring infectious microorganisms. Contaminated hands touching

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an ATM or POS keypad can transfer pathogens, ultimately facilitating the spread of infectious diseases [10].

The antibiogram results suggest that some of the bacteria are resistant to standard antibiotics (Tables 1 and 2) Susceptibility of isolates indicate Gentamycin and Augmentin as the most and least effective antibiotics respectively against the Gram-positive bacterial isolates. Ofloxacin and Amoxicillin were the most and least effective antibiotics respectively against the Gram-negative bacterial isolates. This result corroborates with other reports [21,22] but contrast with the reports that indicate high susceptibility of bacterial isolates associated with contact surfaces to Augmentin [29]. In addition, the bacterial isolates were sensitive to rarely used antibiotics and resistant to commonly used ones. The variations in the antibiotic sensitivity pattern among the bacterial isolates is attributed to the emergence of resistant strains from the abuse of antibiotics for prophylaxis and treatment.

5. CONCLUSION

The Automated Teller Machine (ATM) and Point of Sales (POS) Machine user interface are contaminated with pathogenic bacteria species associated with possible health implications and were resistant to some commonly used antibiotics. The major contributing factor is poor hand hygiene practices exhibited by ATM and POS users and exposure of the facilities to dust. This indicates the interface as potential vehicles for the transmission of clinically important pathogens through human hands. Based on the results of this study, Strict adherence to basic rules of hand washing after ATM and POS use and proper cleaning / disinfection regimen of these facilities should be practiced regularly to reduce contamination. Public health awareness on the need for hand washing and proper hygienic use of these facilities by government and non-governmental organization is also recommended to reduce associated health risk through these vital banking / marketing tools.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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