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Original Research Article

Role of Automated Teller Machine Keypads in the Proliferation of Bacteria: A Public Health Concern

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ABSTRACT

The role of automated teller machine (ATM) keypads in the proliferation of bacteria was investigated in this research. Isolates and their prevalence in bank ATMs in Benin City were: Klebsiella sp. *(8.16%), Pseudomonas aeruginosa (7.28%), Proteus vulgaris (8.83%), Escherichia coli (12.58%), Micrococcus luteus (3.75%), Bacillus subtilis (10.15%), Staphylococcus aureus (13.46%), Corynebacteria* sp. *(8.60%), Staphylococcus epidermidis (19.42%) and Streptococcus pyogenes (11.58%). Total heterotrophic bacterial count (THBC) by banks ranged from 1.16±0.43 × 10^2 cfu/cm^2 (Bank I) to 2.22± 0.58×10^2 cfu/cm^2 (Bank K). Total coliform count (TCC) ranged from Nil (Bank B and G) to 1.37 ± 2.11×10^2 cfu/cm^2 (Bank I). By location and time, THBC ranged from 1.27 ± 0.63×10^2 cfu/cm^2 (UUC) to 1.60 ± 0.43×10^2 cfu/cm^2 (ER/RR) and 1.38 ± 0.57×10^2 cfu/cm^2 (UUC) to 1.93 ± 0.61×10^2 cfu/cm^2 (UR) for morning and afternoon respectively. TCC ranged from 0.52 ± 0.41×10^2 cfu/cm^2 (UR) to 1.15 ± 0.57×10^2 cfu/cm^2 (UUC) and 0.31 ± 0.50×10^2 cfu/cm^2 (ER/RR) to 1.46 ± 1.49×10^2 cfu/cm^2 (UUC) for morning and afternoon respectively. From the foregoing, it is pertinent to adopt measures aimed at preventing outbreak of diseases from ATM use.*

1. INTRODUCTION

Microorganisms such as bacteria are ubiquitous minute/microscopic organisms that make up a major part of every ecosystem and they exist either freely or as parasites. They are found all around us and within each one of us either as pathogens or commensals and are able to persist or even grow on any surface. These microorganisms live as transient contaminants in fomites/surfaces or hands where they constitute a major health hazard in the community (Pittet *et al.*, 1999). Though majority of these microorganisms are harmless to humans and animals, few are harmful and can lead to death of infected individuals, especially in immune-compromized individuals (Hooper 2001). Fomites, when in constant contact with humans or natural habitats of pathogenic organism constitute a major source of spread of infectious diseases (Osterholm *et al.*, 1995). Beside the day to day interaction of people, which constitute one way of spreading disease, the major source of spread of community acquired infections are fomites (Prescott *et al.*, 1993). The contamination of various

fomites by potential pathogenic microorganisms is of public health significance as these items can be likely sources of transmission of such pathogens. Fomites serve as vehicles for cross-infections and recontamination of washed hands (Monarca *et al*., 2000; Otter and French, 2009; Bright *et al*., 2010). Several of the bio-contaminants can bepathogenic and can be transferred from one individual to the next or may bringabout auto-inoculation (Kennedy *et al*., 2005; Li *et al*., 2009).

People tend not to be aware that microbes are found on many regular objects outdoors, in their workplace, comfortable offices and even in their homes. Such objects contaminated by microorganisms include; playground equipment, kitchen sinks, work desks, PC keyboards, handrails, elevator buttons and Automated Teller Machine (ATM) keypads (Al-Ghamdi *et al*., 2011). The entire above mentioned are objects/places that come in contact mostly with the hands of people who are in various hygienic conditions. It is a general belief amongst the populace that microbes are only present in research laboratories or in hospitals and clinics and thus they have a misleading feeling of safety or security in other places (Malik and Naeem, 2014). However, this lack information on where germs prowls could be the cause of health problems.

Due to the ongoing development and expansion of urbanization, as well as the increasing population, people do not have enough time to use traditional banking systems and have accepted new technological advances in e-banking, such as the use of Automated Teller Machines (ATMs) (Adepoju and Alhassan, 2010). Today, the wide use of electronic technologies is considered a source of bacterial contamination (Saroja *et al.,* 2013). Airborne transmission is one of the routes of spreading diseases responsible for a number of nosocomial infections (Ekhaise and Ogboghodo, 2011). Microorganisms constitute a major part of every ecosystem. In these environments, they live either freely or as parasites (Sleigh and Timbury, 1998). Various bacteria have been isolated from public surfaces which provided information on the relative hygiene of frequently encountered public surface whilst identifying the environments which are contaminated with exposure risk (Reynolds *et al.*, 2005). Human carriers are the principal reservoir host of infections according to Saroja *et al.* (2013). Both the faeces and the urine may find their way on the contact surfaces of the door handles via a hand touch as the hand is the major vehicle of transmission of common human disease to a susceptible host (Rusin *et al*., 2002).

Automated Teller Machine, a computerized device enables its users or clients of a financial institution to preform financial transactions without the mediation of a human clerk/bank teller or cashier. These machines function as a data terminal and communicate through a host processor which connects all other such machines operated by a bank across a wide area network; it makes services like cash withdrawal easily available to the account-holder with more convenience. Due to their vast dermal contact by multiple users, the ATM is likely to be contaminated with manifold microorganisms. There is no restriction as to who has access to the facility, and no guidelines to ensure hygienic usage. In view of these, it is imperative therefore, to examine the extent of bacterial contamination on ATM surfaces used by different people under everyday conditions and in various types of institutions or organizations and to investigate probable sources of high contamination rates. This study was aimed at assessing the role of ATM keypads in the proliferation of bacteria within Benin metropolis and the associated public health risk of cross-contamination.

2. MATERIALS AND METHODS

2.1. Sample Collection

Samples were collected from ATM keypads in bank premises and open access areas, shared by an array of users and open to the general public in Benin Metropolis, Edo State, Nigeria. Stratified random sampling method was used in the collection of samples, at five different locations – Uniben Ugbowo Campus (UUC), Akpapava Road (AR), New Benin/Mission Road (NB/MR), Ekehuan Road/Ring Road (ER/RR), and Ugbowo Road (UR), in 14 banks - First Bank (A), Keystone (B), UBA (C), Skye Bank (D), Zenith Bank (E), Access Bank (F), Unity Bank (G), FCMB (H), Union Bank (I), Fidelity Bank (J), Diamond Bank (K),

GTB (L), EcoBank (M) and Stanbic IBTC (N), totalling a hundred samples. Sterile swabs were methodically moved several times over the surfaces of the frequently used keys on the ATM keypad between the hours of 06:00 am to 08:00 am and 14:00 pm and 16:00 pm. Sample swabs were taken to the laboratory for immediate analysis in order to maintain the viability of the organisms to be isolated. The swabs were immediately dipped into labelled tubes of nutrient broth immediately on arrival at the laboratory. Control preparations were made by dipping unused sterile swabs in labelled broth tubes.

2.2. Cross-Contamination Simulations

Cross contamination trials were carried out according to the method described by Abban and Tano-Debrah (2011). All the fingers of a volunteer's hands were thoroughly wiped with sterile cotton wool dipped in disinfectant (Dettol). A finger of choice was then used to punch the command keys of an ATM, simulating the act of withdrawing cash. Five to eight keys were touched in each simulation. After the operation, the contaminated finger was used to touch the surface of a nutrient agar plate, at several spots, to transfer contaminants from the keys. Another disinfected finger of choice (which was not used to touch the keypads) was then used to touch the surface of another labelled nutrient agar plate as control for evaluating the effectiveness of disinfection. These operations were carried out on different but similar days from the previous swabbing operations at similar frequency. The choice finger used each time was changed randomly to minimize any bias that may be associated with a particular finger. All the inoculated plates and broths were immediately transported to the laboratory and incubated for 24 hrs at 28 ^{o}C.

2.3. Isolation and Enumeration of Bacterial Isolates

Serial dilution of the sample was aseptically carried out by pipetting 1ml from the inoculated nutrient broth into a test tube (10^{-1}) containing 9 ml of sterile distilled water. The process was repeated until a dilution of 10^{-3} was obtained. Aliquot of the 10^{-3} dilution was plated in nutrient agar and MacConkey agar amended with nystatin to prevent fungal growth. The inoculated nutrient agar plates and MacConkey agar plates were incubated at 28 ^{o}C and 37 ^{o}C respectively for 24 hrs. After incubation, the colonies were counted and expressed in cfu/cm^2. Isolated colonies were further purified by sub-culturing and identified using biochemical tests (Holt, 1994; Cheesbrough, 2000).

2.4. Characterisation of Bacterial Isolates

Characterisation of bacterial isolates were carried out according to Holt *et al.* (1994) and Cheesbrough (2000) using their cultural and morphological characteristics, as well as biochemical properties.

2.5. Statistical Analysis

All data were analysed using the IBM Statistical Package for Social Science (SPSS) software, version 22 for windows. Data were expressed as mean ± Standard Deviation. One-Way ANOVA was used to determine if the variation observed between variables was significant. The p-value < 0.05 were considered statistically significant (Ogbeibu, 2015).

3. RESULTS AND DISCUSSION

3.1. Characterization and Microbial Counts

The results of this study showed high level of bacterial contamination of the surfaces of banks' ATM keypads. This study found that all the ATMs tested were positive for bacterial contamination and most of the isolates recovered were skin flora in addition to other organisms. The diversity of organisms included Gram-positive bacilli, Gram-negative bacilli and Gram-positive cocci revealing a general level of

contamination of this widely used banking equipment. The isolation of bacterial contaminants in work place/public setting as seen in the present study is not unexpected as it had been reported by workers such as Bright *et al.* (2010) who reported that frequent or heavily used fomites were most likely contaminated and thus carried higher bacteria load. All swabs (100%) were positive for bacterial growth, while the control showed no growth. Ten different bacteria were found associated with ATM keypads in Benin metropolis (Table 1). They were: *Klebsiella* sp. *Pseudomonas aeruginosa, Proteus vulgaris, Escherichia coli, Micrococcus luteus, Bacillus subtilis, Staphylococcus aureus, Corynebacterium* sp., *Staphylococcus epidermidis* and *Streptococcus pyogenes*. This study revealed that potentially pathogenic bacteria were present and this agreed with Schultz *et al.* (2003), who observed the presence of bacterial isolates on keyboards.

Table 1: Cultural, morphological and biochemical characteristics

	1	2	3	4	5	6	7	8	9	10
Cultural										
Shape	Circular	Circular	Circular	Irregular	Circular	Circular	Circular	Irregular	Circular	Circular
Elevation	Convex	Convex	Low convex	Flat	Convex	Convex	Convex	Flat	Convex	Convex
Margin	Entire	Entire	Entire	Undulate	Entire	Entire	Entire	Serrated	Entire	Entire
Wetness/dryness	Wet	Wet	Wet	Dry	Wet	Wet	Wet	Wet	Wet	Wet
Transparency	Opaque	Opaque	Opaque	Opaque	Opaque	Opaque	Opaque	Opaque	Opaque	Opaque
Colour	Yellow	Cream	Green	Cream	Yellow	Dull cream	Whitish	Cream	Cream-white	Cream
Size	Medium	Medium	Medium	Large	Small	Medium	Small	Large	Medium	Small
Morphological										
Gram staining	+	-	-	+	+	+	+	-	+	-
Cell type	Cocci	Rod	Rod	Rod	Cocci	Rod	Cocci	Rod	Cocci	Rod
Cell arrangement	Single	Single	Single	Chain	Cluster	Single	Chain	Single	Cluster	Single
Biochemical										
Catalase	+	+	+	+	+	+	-	+	+	+
Oxidase	-	-	+	-	-	-	-	-	-	-
Coagulase	-	-	-	-	+	-	-	-	-	-
Urease	+	+	-	+	+	+	+	+	+	-
Indole	-	-	-	-	-	-	-	+	-	+
Citrate	+	+	+	+	+	+	+	+	+	-
Sugar fermentation										
Glucose	A	AG	A	A	A	A	A	A	A	AG
Lactose	-	+	-	-	-	-	-	-	-	+
Possible isolates	*Micrococcus luteus*	*Klebsiella* sp.	*Pseudomonas aeruginosa*	*Bacillus subtilis*	*Staphylococcus aureus*	*Corynebacterium* sp.	*Streptococcus pyogenes*	*Proteus vulgaris*	*Staphylococcus epidermidis*	*Escherichia coli*

Table 2 shows the prevalence of the bacterial isolates i.e. *Bacillus subtilis* (10.15 %), *Micrococcus luteus* (3.75 %), *Escherichia coli* (12.58 %), *Pseudomonas aeruginosa* (7.28 %), *Streptococcus pyogenes* (11.58 %), *Corynebacterium* sp (8.60 %), *Klebsiella* sp (8.16 %), *Staphylococcus aureus* (13.46 %), *Proteus vulgaris* (8.83), and *Staphylococcus epidermidis* (19.42 %). These results were in line with that of Rutala *et*

al. (2006) who isolated *Staphylococcus epidermidis, Micrococcus* sp. and *Bacillus* sp. from computer keyboards. *Staphylococcus epidermidis* followed by *Staphylococcus aureus* showed the highest prevalence among other isolates. This observation agrees with that of Anastasiades *et al.* (2009) and Anderson and Palombo (2009), who showed that *Staphylococcus aureus* was more prevalent on computer keypad and mouse. *S. aureus* is the major component of the normal flora of the skin and nostril, which probably explains its high prevalence as contaminant, and can be easily be discharged by several human activities, like sneezing, talking and contact with moist skin (Itah and Ben, 2004). The result of this study showed that the surfaces routinely touched with hands harboured high bacteria load. One could definitely accept this to be true as most cross-contamination happens through this route. This is also in line with the findings of Anderson *et al*. (2008), who documented that students and other members of the public are not always the most diligent of hand-washers. This suggests that the contamination rate of these devices is not a function of the bank in question.

Table 2: Prevalence of bacterial isolates

Isolates	Prevalence (%)
Escherichia coli	12.58
Pseudomonas aeruginosa	7.28
Streptococcus pyogenes	11.58
Corynebacterium sp.	8.60
Klebsiella sp.	8.16
Staphylococcus aureus	13.46
Proteus vulgaris	8.83
Micrococcus luteus	3.75
Bacillus subtilis	10.15
Staphylococcus epidermidis	19.42

Table 3 shows the mean THBC according to banks, and this ranged from $1.16 \pm 0.43 \times 10^2$ cfu/cm^2 (Bank I) to $2.22 \pm 0.58 \times 10^2$ cfu/cm^2 (Bank K). Coliform count ranged from Nil (Bank B and G) to $1.37 \pm 2.11 \times 10^2$ cfu/cm^2 (Bank I). The high level of bacterial contamination seen in this study is in line with the study of Oluduro *et al.* (2011), who reported that keypads of ATMs harboured more bacteria than computer keyboards and this may be due to the fact that ATMs are usually located in the open, exposed to wind and rain. The findings of this study are also in agreement with the study of Abban and Tano-Debrah (2011) who reported the presence of *Staphylococcus* sp, *Escherichia* sp and *Klebsiella* sp on the keypads of ATM machines. The result of this study is of public health concern as potential pathogenic bacterial isolates characterised in this research could be a source of a disease outbreak.

Table 4 showed the mean THBC according to location and time, which ranged from $1.27 \pm 0.63 \times 10^2$ cfu/cm^2 (UUC) to $1.60 \pm 0.43 \times 10^2$ cfu/cm^2 (ER/RR) and $1.38 \pm 0.57 \times 10^2$ cfu/cm^2 (UUC) to $1.93 \pm 0.61 \times 10^2$ cfu/cm^2 (UR) for morning and afternoon respectively. Table 5 shows the mean TCC according to location and time, which ranged from $0.52 \pm 0.41 \times 10^2$ cfu/cm^2 (UR) to $1.15 \pm 0.57 \times 10^2$ cfu/cm^2 (UUC) and $0.31 \pm 0.50 \times 10^2$ cfu/cm^2 (ER/RR) to $1.46 \pm 1.49 \times 10^2$ cfu/cm^2 (UUC) for morning and afternoon respectively. The high isolation of diverse bacteria can be due to the population, frequency of ATM use by its users and the close proximity of ATMs in a particular location, the proximity of these ATMs to the roads may also be a contributing factor as passing vehicles raise dust which settle on the ATM keypads (Oluduro *et al*., 2011). The difference in bacterial count, however, observed for the sampled locations was not significant ($p > 0.05$). The frequency of occurrence of bacterial species varied from morning (40.17%) to afternoon (59.82%). More bacterial species were isolated in the afternoon and this might be as a result of peak usage of the machine at this period coupled with the tendency of users to have picked up microbes from other places during their daily schedule.

These results highlight the importance of hand hygiene after using public ATMs for transactions as the keypad surfaces could also be potential vehicles for the transmission bacterial pathogens. The number of microorganisms present on a surface is amongst the microbe-associated factors that determine whether an infection will occur or not (Neely and Sittig, 2002). Apart from the quantity of bacteria, the type and quality of microorganism present on a surface is also an important determinant of whether an infection will occur or not (Oluduro *et al*., 2011).

Table 3: Total Heterotrophic bacterial count and coliform count by banks

Banks	THBC ± SD x 10^2(cfu/cm^2)	TCC ± SD x 10^2(cfu/cm^2)
A	1.55 ± 0.48	0.58 ± 0.45
B	1.34 ± 1.21	Nil
C	1.79 ± 0.76	0.46 ± 0.44
D	1.58 ± 0.49	1.04 ± 0.56
E	1.30 ± 0.72	0.76 ± 0.45
F	1.43 ± 0.42	1.32 ± 1.36
G	1.17 ± 0.22	Nil
H	1.63 ± 0.42	0.68 ± 0.64
I	1.16 ± 0.43	1.37 ± 2.11
J	1.42 ± 0.57	1.16 ± 0.96
K	2.22 ± 0.58	0.54 ± 0.38
L	1.53 ± 0.50	0.72 ± 0.81
M	1.78 ± 0.41	1.28 ± 0.59
N	1.21 ± 0.78	0.82 ± 0.92

Table 4: Total heterotrophic bacterial count by time and location

Location	THBC x 10^2 (cfu/cm^2)		THBC ± SD x 10^2 (cfu/cm^2)	*P*-value
	Morning	Afternoon		
UUC	1.27 ± 0.63	1.38 ± 0.57	1.32 ± 0.59	0.691
AR	1.33 ± 0.75	1.71 ± 0.54	1.52 ± 0.66	0.205
NB/MR	1.56 ± 0.71	1.56 ± 0.58	1.56 ± 0.63	0.995
ER/RR	1.60 ± 0.43	1.56 ± 0.62	1.58 ± 0.52	0.877
UR	1.36 ± 0.53	1.93 ± 0.61	1.64 ± 0.62	0.039*

*P-value is significant at the 0.05 level (2-tailed); UUC = Uniben Ugbowo Campus, AR = Akpapava Road, NB/MR = New Benin/Mission Road, ER/RR = Ekehuan Road/Ring Road, UR = Ugbowo Road

Table 5: Total coliform count by time and location

Location	TCC ± SD x 10^2 (cfu/cm^2)		TCC ± SD x 10^2 (cfu/cm^2)	*P*-value
	Morning	Afternoon		
UUC	1.15 ± 0.57	1.46 ± 1.49	1.30 ± 1.11	0.558
AR	0.96 ± 1.07	0.97 ± 0.77	0.97 ± 0.91	0.993
NB/MR	0.62 ± 0.61	0.75 ± 0.48	0.69 ± 0.54	0.613
ER/RR	0.73 ± 0.63	0.31 ± 0.50	0.52 ± 0.60	0.118
UR	0.52 ± 0.41	0.56 ± 0.61	0.54 ± 0.51	0.856

UUC = Uniben Ugbowo Campus, AR = Akpapava Road, NB/MR = New Benin/Mission Road, ER/RR = Ekehuan Road/Ring Road, UR = Ugbowo Road

3.2. Bacterial Contamination by Banks

Figure 1 highlights the occurrence/incidence of bacteria by banks. However, there is no significant difference (p> 0.05) in the variations observed amongst banks (F = 1.320; df = 13; p-value = 0.217). This study also showed the frequency of the isolated bacteria (Figure 1) to be highest in Bank J's ATMs (13.68%) than the other banks probably because most of the bank's ATM sampled were located in densely populated and accessible areas of the University of Benin, Ugbowo Campus (UUC).

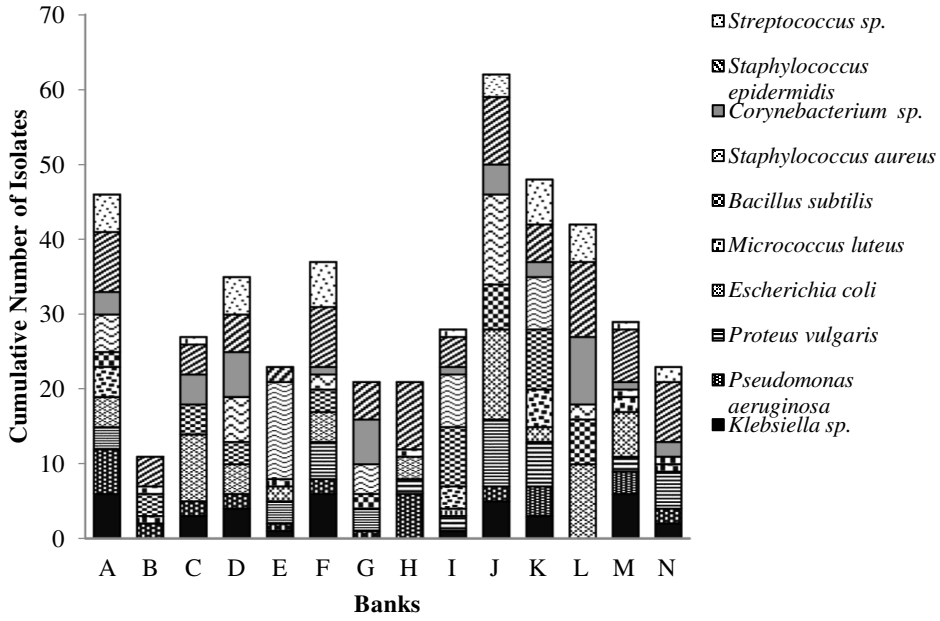

Figure 1: Bacterial distribution by Banks

3.3. Bacterial Contamination by Location

*Staphylococcus epidermidis*had the highest occurrence in all locations sampled (Figure 2). However, there was no significant difference (p> 0.05) between distributions of the bacterial isolates according to location (F =1.458; df = 4; p-value = 0.221). This indicates that bacterial contamination is not a function of the locale or banks in Benin City metropolis.

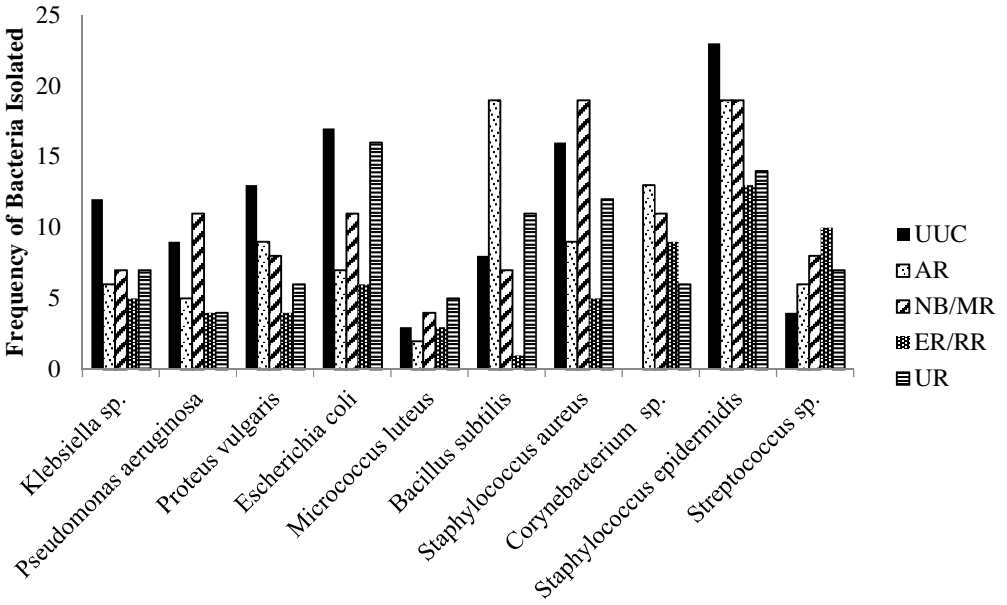

Figure 2: Bacterial distribution by location

3.4. Bacterial Contamination by Time

Twenty ATMs were sampled daily per location with ten ATMs each in the morning and in the afternoon. Bacteria (40.17 % and 59.82 %) were isolated in the morning and afternoon respectively. *Staphylococcus epidermidis* had the highest occurrence in the morning and afternoon while *Micrococcus luteus* had the lowest occurrence in the morning and afternoon (Figure 3).

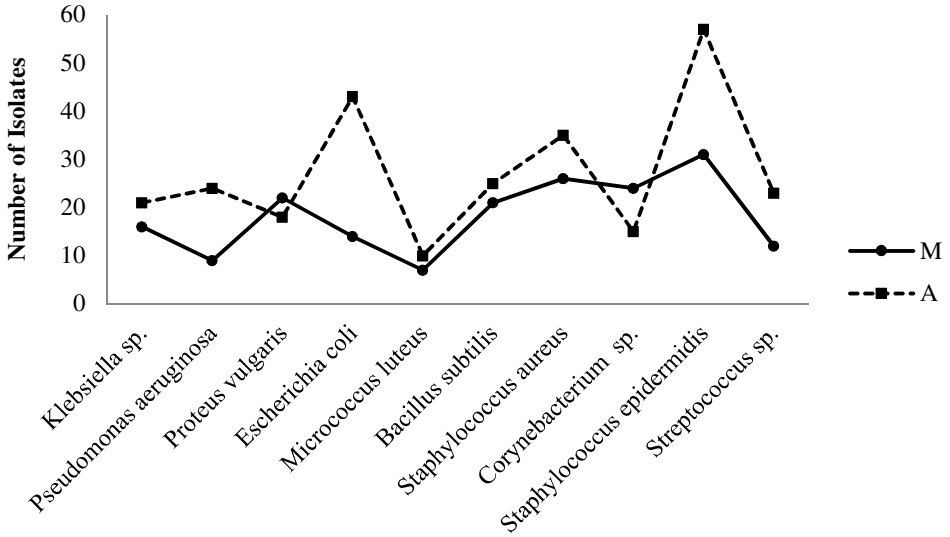

Figure 3: Bacterial distribution by time

Time had a significant effect ($p < 0.05$) on bacterial contamination in the locations sampled ($F = 6.711$; df = 1; p-value = 0.011). This can be attributed to the frequency of use of these devices which appears to be more crowded in the latter part of the day and also the socio-economic behaviour of the users.

3.5. Cash Withdrawal Simulation

A total of 27 bacteria were isolated from five different ATM keypads used in cash withdrawal simulation set-up. Table 6 shows that the highest number of isolates observed is the bacteria *Staphylococcus epidermidis* (18.52%) while the lowest was *Proteus vulgaris* (3.70%) and *Corynebacteria* sp. (3.70%). The bacteria isolated from the finger swab culture after disinfection with Dettol antiseptic were: *Pseudomonas aeruginosa, Staphylococcus aureus* and *Staphylococcus epidermidis.* Swab culture of disinfected fingers used in cash withdrawal simulation experiment showed that there was no transfer of *Proteus vulgaris* and *Corynebacteria* to the fingers after cash withdrawal. *Escherichia coli* had the highest occurrence of 5 (21.74%).

Table 6: Isolated microorganisms in cash withdrawal simulation

Isolates	Swabs of ATM command key surfaces	Swabs of disinfected fingers	Swabs of disinfected fingers used in cash withdrawal simulation
Klebsiella sp.	4 (12.81%)	-	2 (8.69%)
Pseudomonas aeruginosa	2 (7.40%)	1 (25%)	3 (13.04%)
Proteus vulgaris	1 (3.70%)	-	-
Escherichia coli	3 (11.11%)	-	5 (21.74%)
Micrococcus luteus	2 (7.40%)	-	1 (2.34%)
Bacillus subtilis	3 (11.11%)	-	2 (8.69%)
Staphylococcus aureus	4 (12.81%)	1 (25%)	3 (13.04%)
Corynebacterium sp.	1 (3.70%)	-	-
Staphylococcus epidermidis	5 (18.52%)	2 (50%)	3 (13.04%)
Streptococcus pyogenes	2 (7.40%)	-	4 (17.39%)
Total	27 (100%)	4 (100%)	23 (100%)

3.6. Public Health Implication

The increasing incidence of epidemic outbreaks of certain diseases and its rate of spread from one community to the other has become a major public health concern (Oranusi *et al*., 2013).Possible diseases that can be caused by the isolated bacteria include foodborne diseases (*Staphylococcus aureus* and *Escherichia coli*), urinary tract infections (UTI) (*Escherichia coli* and *Pseudomonas aeruginosa*), pneumonia (*Klebsiella* sp.), sore throat (*Streptococcus pyogenes*) and diarrhoea (*Escherichia coli*) (Agbagwa and Nwechem, 2010). *Escherichia coli* have been reported to be the most common cause of UTIs with some clones that may be associated with gastrointestinal infections. *Escherichiacoli* serovars, especially the enteropathogenic *Escherichia coli* O157: H7 has been implicated in major food borne disease outbreaks and infections mainly from eating contaminated meat (EFSA, 2010). *Bacillus* sp. *Staphylococcus aureus*, *Klebsiella* sp. and *Pseudomonas aeruginosa* are well documented for their high pathogenicity, causing even death in some major outbreaks and infections (EFSA, 2010).

Dirty surfaces would harbour more bacteria than clean ones. This makes the process of dusting and removal of soil and dirt by simple cleaning procedures of paramount influence on the reduction of surface contamination. Although drying plays an important part in maintenance of hygiene on surfaces and other environments, drying per se cannot be relied upon to prevent transfer of infection from laminate surfaces due to the resistance of some microbes to that measure (Scott and Bloomfield, 2008). Result of this current study (Table 6) suggests that an observable number of microbes is transferred from fomites (ATM keypads)

to the fingers of innocent users during the use of the machines for transactions. Clinical investigations indicate that infection risks depend on numbers of organisms transferred and the immune status of the person (Scott and Bloomfield, 2008).

The use of dettol wipes as hand disinfectant was found to be highly effective at removing or emasculating pathogens like *Escherichia coli*, *Bacillus subtilis, Klebsiella* sp. and *Corynebacterium* sp. however not limited to the aforementioned after 5-second application with a sterile wipe (Table 6). This is in consonance with Reynolds *et al*. (2015) who showed a hygiene program, including an alcohol-based hand sanitizer and disinfecting surface wipes, reduced transmission of a surrogate organism introduced on employee hands and workplace surfaces (doorknobs, telephones, computer mice) after the intervention. Also, cleaning all other user accessible surfaces of the machine and use of hand sanitizers will reduce the bacterial burden tremendously (Boyce, 2007; Tuladhar *et al*., 2012). This shows that risk of transmission from contaminated user interfaces (ATM keypads) could be eliminated if users carried out hand hygiene after contact with such inanimate objects. Inanimate objects have been known to play a role in the transmission of human pathogens either directly by surface to mouth contact or indirectly by contamination of fingers and subsequent hand to mouth contact (Rusin *et al*., 2002). Even when contaminated surfaces containing relatively low numbers of organisms come into contact with the fingers and other surfaces, organisms may be transferred in sufficient numbers to represent a potential infection hazard (Scott and Bloomfield, 2008).

4. CONCLUSION

The ATM found in the banks having high bacterial load may be adduced to large population of people using the ATM machine, and the environment where the ATM is situated. The traders in the market take hygiene with levity, and people touch different dirty things with their bare hands, including money. Others pick their nose, use the toilet, put their hands in their dirty body carrying lots of bacteria and then inoculating it on the ATM keypads while pressing it. The findings of the study confirm the presence of potentially pathogenic bacteria on the keypads of the ATM. This interface is therefore a potential vehicle for the transmission of clinically important pathogens. Hand-washing and the use of hand sanitizers which are portable and easy to use are recommended, for reducing, if not eliminating these organisms to avoid cross contamination as it removes soil and transient microorganisms from the hands and markedly reduces population of microbes.

5. ACKNOWLEDGMENT

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6. CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

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