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MICROBIOLOGICAL SURVEY OF AUTOMATED TELLER MACHINES (ATM) IN CALABAR METROPOLIS

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ABSTRACT

The Key pads of seventy four (74) Automated Teller machines (ATMS) were examined in Calabar Metropolis to determine the public health implications of microorganisms isolated from the machines and their potentials as reservoirs of microbes. Swab sticks dipped in sterile peptone water and swabbed on the ATM keypads were cultured, physiological and biochemical analysis carriedout to identify the organisms. The results showed that the ATM keypads harbored microbes. Fifty two (70.3%) of the ATM sampled were contaminated with various microbial pathogens including: *Coagulase negative staphylococci* 22 (38.5%), *Staphylococci aureus* 12(21.1%), *Enterococci* 4 (4.7%), *Escherichia coli* 4(4.7%), *Klebsiellaspp* 2(3.8%). Others were *Aspergillusspp* 3(5.8%), *Rhizopus* 3 (5.8%) and *penicilliumSpp* 2(3.8%). Parasites were not detected. Greater hygiene measures especially regular hand-washing before and after ATM use is advocated.

INTRODUCTION

Microorganisms are very small organisms, which can only by seen with the aid of a microscope (Christner *et al*., 2008) however they are capable of being put to great good and can equally cause great harm. Micro organisms will include bacteria, fungi and protoctists (Science daily, 2012). There are about one hundred and fifty nine thousand (159,000) known species, of micro organisms in existence although this is thought to be less than five percent (5%) of the total microbes in existence (Bernd and Bill, 2011).Micro organisms are ubiquitous and have an amazing ability to adapt to new environments and further multiply in large numbers within a very short time (Ogilrie and Hirsch, 2012). Their ability to adapt and multiply on various surfaces and in different environments is key to their being found on soil surfaces, acidic hot springs, radioactive waste water, deep in the earth's crust, as well as organic matter and life bodies of plants and animals (Balkwill *et al*, 1997). This realization has given rise to a new but interesting aspect of study which focuses on the interaction between microbes with cyber appliances and their implication for the end user of such cyber systems – man.

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In the past, common assumption was that science and if ill but today, we understand that science and technology holds property harnessed great capacity for mass destruction and harm as it does have potential for mass good (http://www.sciencedaily.com, 2013).Studies by the United Statescentre for disease control (2005), has revealed that microorganisms could be passed from contaminated hands to cyber appliances such as the surface of the keyboard of automated teller machines and subsequently passed on to other unsuspecting users of the appliance. The automated Teller Machine (ATM), which may be called a cash point machine, cash machine or a hole in a wall is a computer supported telecommunication device that enables the client of a financial institution carry out banking transactions from almost anywhere in the world were an ATM is available (http://www.About.com, 2011). Considering that most users of the ATM are largely ignorant of the potential hazards they face each time they use an ATM, this work investigates the microorganisms that could be isolated from ATM keyboards and the public health implication of such.

MATERIALS AND METHODS

This study was carried out in Calabar metropolis, comprising two local government areas – Calabar South and

CalabarMunicipality respectively. Seventy four Automated Teller Machines being the total identified useable machines in the town were sampled by swabbing with peptone water immersed swab sticks. Standard bacteriological, mycological and parasitological methods were employed in the analysis of the sample. Presumptive identification of bacterial isolates was by cellular morphology, Gram staining reaction, motility, catalase, indole production test, urease test, oxidase strip test and kleigler Iron Agartest. Fungal identification was by cultural and morphological characteristics as reported by Samson *et al*, (1984). Samples were analyzed for parasites by rinsing the swab in 10ml sterile normal saline which was spun at 1800rpm for 5 minutes to concentrate the parasites. The supernatant was discarded. The sediment was placed on a grease free glass slide covered with a clean cover slip and viewed under the microscope using the appropriate magnifying objectives (Cheesbrough, 2000).

RESULTS

The data obtained from this work were analyzed using Analysis of variance and simple percentage, while bar charts were employed in data representation. The results are shown in Tables 1-4.

DISCUSSION

This study has demonstrated the microbial contamination of ATM keypads in CalabarMetropolos, corroborating the work of Stephen Abban (2011). Of the seventy four ATM keypads sampled, 52 (70.3%), were shown to be contaminated with various micro organism 45 (60.%) of which were bacterial and 7 (15.6%) fungal. This is a relatively high percentage of contamination and is consistent with the work of Eltablawy and Elhifnawi, 2009 which showed 99-100% contamination rates for keypads sampled. These levels of contamination could be detrimental to the health of ATM users. The high level of contamination is possibly as a result of frequency of usage, poor hygiene status of users and environmental condition around the ATMs. Table 1 shows the microbial contamination of ATMs based on their locations in Calabar. The ATM's located in Hospitals were most contaminated (100%) while those in fast food centers were least contaminated (50%). The levels of contamination could be linked to several factors ranging from frequency of machine use, hygiene status of users and the surrounding environment. The levels of contamination on ATM keypads located at hospitals is not strange as several research works have shown

Table 1. Microbial contamination of atm's based on their locations in calabar

Location	No of ATMs Examined	No of Positive for Microbes			Total No of Organisms isolated
		Bacteria	Fungi	parasites	
Banks	56	34 (60.7)	5(8.9)	0 (0.00)	39 (69.6)
Shopping malls	7	4 (57.1)	0 (0.00)	0 (0.00)	4(57.1)
Fast food centers	2	1(50.0)	0 (0.00)	0 (0.00)	1(50.0)
Hospitals	3	2(66.6)	1(3.3)	0 (0.00)	3)100.0)
Campuses	6	4(66.6)	1(16.7)	0 (0.00)	5(83.3)
Total	74	45(60.8)	7(15-6)	0 (0.00)	52(70.3)

Table 2. Frequencies of Organisms Isolated

Organisms isolated	Frequency	Percentage (%)
BACTERIA		
Escherichioa coli	4	7.7
Staphylococcus aureus	12	23.1
Coagulase negative staphylococci	20	38.5
Enterococci SPP	4	7.7
Aeromonasspp	2	3.8
KlebsiedlaSpp	2	3.8
FUNGI		
Aspergillusspp	3	5.8
Penicilliumspp	2	3.8
Rhizopusspp	3	5.8
Total	52	100%

Table 3. Bacterial contaminants and their identifcation characteristics

										K KIA				Organisms Isolated
SHAPE	GRAM	MEILITY	CATALASE	COALULASE	INDOLE	STRING	UREA	LACTOSE	OXIDASE	GAS	H_2S	BUTT	SLOOP	
Rod	-	+			+					+		Y	Y	*Esherichia Coli*
Cocci	+		+	+				+				Y	Y	*Staphylococcusaureus*
Cocci	+		+	-								V	V	*Coagulase Negative Staphylococcus*
Rod	-	+							+					*Aeromonasspp*
Rod	_						+	+				Y	Y	*Klesiella Pneumonia*
Cocci	+	V						+						*Enterococcus spp*

KEY:

\+ = Positive
\- = Negative
Y = yellow
V` = variable

Table 4. Fungal contaminants and their identification characteristics

Fungal species	Morthology	
	Microscopic	Colornial
AspergillusFumin gatus	Conidiophore = short, small and greenish, though may appear colourlessatimes Phialides = uniseriate and viside have around columnar head	Appears blue green to gray on the surface and white to tan on the revers
TPenicilliumMar neffei	Conidiophore = has both simple and branched conidighors with metube. Phialides = have brush – like clusters referred to as "Penicill". Conidia = Appear as round, unicellular and unbranching chains	The colories are cottony in texture. There are initially whitish bhish-gray green at centre and white at the periphery. The red, rapidly cliffusing, soluble pigment observed from the reverse is very typical. At 37^0c, penicillurmarneffeicolories are cream to slightly pink in color and glabrous to convoluted in texture
Rhizopusazygosp orus	They have sparely septakephyphae, sporangiophorethizoids. Sporangiophores are brown in colorand usually branched can grow solitary.	Has a cotton candy like texture. Appears white initially and turns grey to yellowish on the surface, with time. The reverse appears white too.

Table 5. Statistical Analysis of data using analysis of varance (anova)

Location of ATM	No of Organisms isolated(n)	Mean (X)	Standard deviation (SD)
Banks	39	10.5	2.6
Shopping malls	4	5.2	2.0
Fast food centres	1	3.5	1.0
Hospitals	3	4.6	2.5
Campuses	2	6.3	1.8
Total	52	30.1	9.9

Table 6. Summary of data for the one-way analysis of variance (anova)

Source of variation	SS	Df	Mean square (ms)	F Cal.value No line	Signficance of F
Between group	180.317	5.0	36.06	4.11	3.51
Within group	42.083	480	8.76	No line	No line
Total	222.400	53.0	44.82		

Signficant at 0.001 = df = 5 and 48, critical value = 3.51

that microbes find a ready and welcomed place in hospital settings, because most persons don't keep simple hygiene protocol (Gaynes *et al*., 2007, Burke, 2003) Chairman *et al*, 2011). It is equally common knowledge, especially among health experts that microbes are ubiquitous in the hospital environment and could perch on any material or equipment around (Chairman *et al*, 2011). Keypads of ATMs located within and around campuses ranked next to those I hospitals, in levels of contamination, revealing that users of the ATM on campuses are not acquainted with simple hygiene tips. Keypads of ATMs located in banks and fast food centers were least contaminated. This differs with the work by Oluduro *et al*. (2011) which had more contamination in Keypads located in banks than those located elsewhere. The frequent and heavy usage was giving as a possible reason for those levels of contamination on the ATM keypads in banks.

The *Coagulasenegativestaphlylococcu*s was the most frequently isolated bacterial organism (38.5%); possibly due to the fact that they reside on the skin and mucus membranes of humans and other organisms and equally from a small component of the soil microbial flora (Madigam and Martinko, 2005). *Coagulase negative Staphylococcus* is known to be responsible for several infections such as bacteriamia, endocarditis, vrinary tract in fections and endophtalmit is (Heubner and Goldmann, 1999). This study also establishes the presence of *Staphycococcusaureus* (23.1%) onthe ATM keypads. A work on Automated teller machines in Ebonyi State, Nigeria carried out by Akoro *et al*. 2013 showed that *Staphylococcus aureus* are ubiquitous and can be found on several exposed surfaces.

They cause illnesses ranging from pimples, boils, pneumoria and meningitis (Books *et al*, 2013). *Esherichia Coli* and *Enterococci Spp*. were the third most isolated organisms (4.7%) respectively. Both organisms have something in common – there are enteric pathogens. In other words they are linked with gastro enteritis (Beriot and Denis, 2000). This may suggest some form of fecal contamination of the keypads, most likely from contaminated and unwashed hands. The isolation of *E. coli* and *Enterococci* species differs with the works carried out by Collier, 1998; WHO, 2004 and Abban *et al*, 2011 where Aeromonas and Klebbsiella species were the least isolated bacterial organisms (3.8%). The reason may be attributed to the microbial pattern among users of the ATMs and environmental conditions as supported by Lenox *et al*, 2011.

Fungal organisms such as *Aspergillus fumigates*, *Rhizopusazygosporus* and *Penicilliummarneffei*, were isolated with the frequency 5.8% and 3.8% respectively. These fungal isolates have their health implications like their bacterial counterparts (Adamu *et al*., 2012) and inhabit the soil and air (Joanne *et al*., 2008), hence can be found on several surfaces. Parasites could not be detected on any of the ATM keypads sampled, may be due to the period of sample collection, prevailing environmental conditions, the highly mobile nature of some parasites and hygiene status of the ATM user. Lawrence *et al* in 2013 observed that detecting parasites could be very difficult, chiefly because they hide and secondly because most available methods are not sensitive enough to pick up the parasites. Other research works show that parasites can be detected on paper money (Uneke *et al*, 2007)

Parasites and bacterial transmission by paper currency are common in Nigeria especially among food related workers (Hassan *et al* 2011). It has been reported that parasites such as mites have the ability of crawling long distances and if an infected person happens to scratch an infected area of the body, the parasites get into the fingernails and where the individual gets to touch objects like Atms or naira notes, the mites can drop there and infect other people (Joy, 2013). In Table 3 the identification characteristics of each of the isolated bacterial organism is shown. This follows standard procedure for bacterial identification and isolation. The identification characteristics of fungal contaminants are shown in Table 4. This is based on their microscopic and colonial characteristics. Table 5 and 6 are a summary of the statistical representation of the data obtained in the study. This work has established that ATM keypads can harbor potentially hazardous organisms, hence the need for adequate public health awareness.

Conclusion

The research has confirmed the presence of pathogenic bacterial and fungal species on ATM keypads, with possible health implications. The microbes isolated are *coagulase negative staphycococcus, staphycoccusaruesus, Escherichia coli, Enterrococaspp, Aeromonasspp, Klebsiellaspp, Aspergillusfunningatus, Rhizopusazygosporus and Penicilliummarneffei*. If pathogens can be found on ATM keypads, it is simple to understand why there are concerns about public health safety. The need to marry technological innovation with safe and healthy use is therefore strongly advocated in the light of current findings. This therefore presents a collective public responsibility to see that measures are in place to ensure that transfer of infections via ATMs is reduced to the barest minimum and if possible completely eradicated.

Recommendations

- That public health care be prioritized and emphasized while machinery is put in place by government and non-governmental organization on simple hygiene tips
- Banks and owners of ATMs place notices close to the machines directing users on the best hygiene practices when using the ATMs
- Simple hand washing exercise be encouraged before and after use of ATMs
- As a policy, hand washing posts must be set up very close to every ATM point.
- The use of copper and copper-alloy materials as ATM keypads is strongly advocated, as their antimicrobial properties have been well researched
- Environment around the ATMs must be kept clean to avoid the transfer by environmental factors of pathogenic microbes to the ATM keypads.

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