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ORIGINAL RESEARCH

Bacterial colonization on Automated Teller Machines from selected Local Government Areas in Ibadan, Oyo State

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Abstract

Background: Automated Teller Machines (ATM) are interactive physical platforms that respond to touch command of the user when an account holder inserts a coded bank card. They are operated with finger impressions of bank customers after insertion of the coded card.

Objective: To determine the prevalence of isolates, quantify and determine the susceptibility of the isolates to conventional antibiotics and to test the efficacy of disinfectants on the bacterial isolates from these selected ATMs.

Methods: Ten(10) ATMs were selected per Local Government Areas (LGA) in five LGA. Sterile swab impregnated with physiological saline was aseptically impressed and rolled over the keypad and screens of the ATMs. The swabs were inoculated in peptone broth and incubated for 24 to 48hours. The inoculums from the broth were streaked on five (5) different selective agar media and standard biochemical tests were used to confirm the bacterial isolates.

Results: The prevalence rates of the bacterial agents found on the ATMs were as follows: *Staphylococcus aureus* (30; 60%), Coagulase-Negative *Staphylococcus spp* (10; 20%), *Pseudomonas spp* (16; 32%), and *Streptococcus spp* (20; 40%) respectively. Antibiogram was carried on biochemically identified isolates, and most of the isolates showed varied susceptibility to the antibiotics and the disinfectants tested.

Conclusion: Multiple bacterial isolates found in this study have the potential to attain pathogenic status in compromised hosts and the possibility of transmission of these isolates from one user to another is a challenge of epidemiological magnitude.

Keywords: Automated Teller Machine, Bacterial contamination, Disinfectants, Ibadan.

Introduction

The Nigerian banking sector over the years has been experiencing significant changes and development in its information and communication technology. Among the development is the introduction of Automated Teller Machine (ATM). Automated Teller Machine is a self-service machine that dispenses cash and performs a programmed function like bill payment, auto-retraction of deposit money and response to balance inquiries. This brainchild of Scottish inventor

Shepherd-Barron was put to test on the 27thof June 1967 at a branch of Barclays bank in Enfield, North London. ATM was first introduced into the Nigerian financial service sectorinlate 1980 by Societe Generale Bank. Thereafter, First Bank and Equity Bank followed to test run it but it was short-lived because of many unforeseen factors. [1]

Different people from different socio-economic levels and hygienic status use the ATMs daily and increase the chances of hand-borne transmission of microorganisms to the machine's surfaces. One of the most important routes for the spread of many infectious agents in the community is the hand-borne transmission. Hand-borne transmission of organisms is a critical factor in the spread of bacteria, fungi, and viruses causing diseases. [2]

Transient or resident microorganisms as skin flora under the superficial cell of the stratum corneum can move from hand to hand or from hand to surfaces, and once these microbes attach to hand surfaces they may survive for a while and be difficult to remove. Microbes are found on surfaces that require contact with human hands. Objects and social devices such as computer keyboards, mobile phones, door handles, and elevator could serve as a microbial reservoir. Many bacterial, fungal and viral pathogens could survive on inanimate objects for several hours or days and could cause epidemics. [3]

Some factors have been shown to influence the transfer of microbes between surfaces and these include pressure and friction between the contact surfaces, the inoculum density on surfaces, moisture levels, type of bacterial species, and the source and destination surface features. Many epidemiological studies have confirmed that contaminated surfaces played major roles in the spread of infectious diseases. Studies have shown that there is heavy contamination of the parts of ATMs that have contact with the hands of customers, such as the keypads and the screens. Therefore, ATMs have the potential for the transmission of infections in the community. [4]

Hand sanitizers are antimicrobial agents generally used to decrease the load of microbes on the hands. Alcohol-based disinfectants typically contain some combination of isopropyl alcohol, ethanol (ethyl alcohol), or *n*-propanol and it is preferable to hand washing with soap and water. They are available in liquid, foams, and gel. Formulations containing 60 to 95% alcohol are most effective. Alcohol-based hand sanitizer works against a variety of microorganisms but not against spores. The non-alcohol-based formulations may contain benzalkonium chloride or triclosan. [5] Some forms contain compounds such as glycerol to prevent drying of the skin. The dosing system designed to deliver a measured amount is very important.
The study was aimed at determining the prevalence of microbial contamination on ATMs, the susceptibility of the microbes to conventional antibiotics and common disinfectants.

Methods

Study Design
This was a cross-sectional study for which data collection was conducted between July and September 2019 in five selected Local Government Areas (LGA) in Ibadan, with an estimated population of 2.3 million people. Only ATMs installed outside selected banking halls but within the bank, premises were included in the study while those that were situated outside the banking premises were excluded.

Study sites
Five (5) LGAs comprising Akinyele, Oluyole, Ibadan South-west, Ibadan North-east and Ibadan North LGAs were selected.

Sample size

Fifty ATMs, based on an average of ten different ATMs from each of the five LGAs were studied.

Sampling technique

Purposive sampling was used to select the ten banks from each LGA.

Collection of samples

Samples were collected from the keypads and screens of the ATMs using sterile cotton swabs soaked in physiologic saline. The samples were plated on Cetrimide Nutrient agar, Mannitol Salt agar, MacConkey agar, Sheep Blood agar, and Eosin Methylene Blue agar media and were incubated for 24 hours at 37^0C.The isolates were Gram-stained and biochemically characterized to confirm their identities.

Antimicrobial Susceptibility Test

Antimicrobial susceptibility patterns of the isolates were determined using the agar–diffusion method of Kirby-Bauer. Three to five colonies of the overnight strains were inoculated into a tube containing peptone broth and were incubated overnight at 37^0C. Standardization of the inoculums was performed by diluting the broth cultures until turbidity matched the 0.5 McFarland standards. A sterile cotton swab was dipped into the standardized suspension, drained and used for inoculating 20 mL of Mueller Hinton agar (Oxoid, UK) on a 100-mm disposable plate. The inoculated plates were air-dried for 30 minutes and antibiotic discs were placed on the agar, using flamed forceps and were gently pressed down to ensure maximum contact. Discs containing the following antibiotics were used: Imipenem (IPM-10ug), Amoxicillin/Clavulanic (AMC-30ug), Chloramphenicol (Chl-15ug), Erythromycin (ERY-15ug), Nitrofurantoin (NIT-300ug), Sulphamethoxazole/Trimethoprim (SXT 25ug), Gentamicin (GN-30ug), Ofloxacin (OFX-5ug), Tetracycline (TE-30ug), Ceftazidime (CAZ-10ug), Cefotaxime (CTX-30ug) and Vancomycin (VA-30ug). The plates were incubated aerobically at 37^0C for 24 hours before measuring diameters of zones of inhibition. Sensitive and resistant strains were marked S and R respectively. [6]

Sensitivity testing of the bacteria to disinfectants

The agar cup diffusion method was used for this purpose. A 0.2ml of bacteria suspension was seeded into 20ml of molten and cooled agar. Thereafter, it was poured into a sterile Petri dish and was allowed to set. Four (4) holes were bored with the aid of 8mm cork borer. The four holes/wells were filled with disinfectants [Manufacturer in-use concentration of Dettol®, Salvon®, and Purit®]. Sterile distilled water and Gentamicin single discs [Oxoid, UK] were used as negative and positive controls, respectively. The Petri dishes were left for 45 minutes to diffuse and incubated at 37C for 24 hours. The zones of inhibition were measured and recorded. [7]

Statistical Analysis

Microsoft® Excel (Window 8) was used to collate the data while descriptive statistics were used to analyse the data.

Results

There are variations in the prevalence of bacterial isolates in this study. *Staphylococcus aureus* was most frequently isolated followed by *Escherichia coli* and *Streptococcus spp.* respectively. Coagulase-Negative *Staphylococcus* had the least prevalence as shown in Table I. The isolates of bacteria used in this study showed varied susceptibility and resistance to the twelve antibiotics appropriated. They are indicated by various zones of growth inhibition as showed in Table II.

Table I: Prevalence of bacterial isolates on ATMs

Isolate	*Prevalence*	*Percentage*
Staphylococcus aureus	30/50	60
Coagulase-Negative *Staphylococcus*	10/50	20
Pseudomonas spp.	16/50	32
Escherichia coli	25/50	50
Streptococcus spp.	20/50	40

The isolates showed varied susceptibility patterns to the three disinfectants tested for as shown in Table III. All the isolates tested were susceptible to the disinfectant with relatively varied zones of growth inhibition.

Discussion

Fifty ATMs were sampled, the common denominator was they were all contaminated with different microorganisms, with *Staphylococcus aureus* being the most prevalent followed by *Escherichia coli* and Streptococci respectively. Coagulase-Negative Staphylococci was the least prevalent in this study. Though microorganisms that could be pathogenic were found on some of the ATMs, some studies showed that they are unlikely to cause infections except in immune-compromised individuals. [8]

Twelve different antibiotics of varying concentrations were tested against the isolates and their resistance or sensitivity pattern was estimated according to the Clinical Laboratory Standard Institute breakpoint guide. [9] *Staphylococcus aureus* showed total resistance to ceftazidime and sulphamethoxazole except for isolate *Sa7* which was sensitive to sulphamethoxazole. The isolates were also resistant to tetracycline and ceftazidime except for some isolates which were sensitive to tetracycline and ceftazidime. The resistance of *Staphylococcus aureus* to these antibiotics could be due to strain selection or the genetic make-up of the tested isolates. [10]

Coagulase-Negative Staphylococci were highly resistant to vancomycin, erythromycin, ceftazidime, nitrofurantoin, tetracycline, amoxicillin, chloramphenicol, and others. The alarming resistance rate of Coagulase-Negative Staphylococci to most of the conventional antibiotics in this study is of epidemiological significance, though, Coagulase-Negative Staphylococci are commensals but could initiate infection in an immune-deficient individual. [11]

Pseudomonas aeruginosa, a nutritionally non-exacting organism was resistant to almost all the antibiotics tested in this study except for imipenem and gentamicin. *Escherichia coli* and Streptococcus species showed varying levels of resistance and sensitivity to the twelve antibiotics tested. The variations in the pattern of resistance and sensitivity observed in this study could be attributed to the composition and quality of each antibiotic, state of immunity of the individuals, over-exposure to those antibiotics, strain selection and genetic make-up of the isolates. A similar study on bacterial contamination of ATMs carried out by Tekerekoglu reported 42.5% prevalence for *Klebsiella*, 15% for *Pseudomonas aeruginosa* and 10% for *E. coli* from the 92 swabs studied. The different patterns of resistance recorded in this study are important and could be a source of public health concern.

The potency of three commercial disinfectants i.e Savlon®, Purit®, and Dettol® was tested against the isolates from the fifty ATMs. The zones of growth inhibition obtained were remarkable.

Table II: Susceptibility Tests of the bacterial isolates to selected antibiotics

	Diameter zones of growth inhibition (mm)											
	C	TET	SXT	CAZ	IMP	GEN	NIT	ERY	AMC	CTX	OFX	VAN
SA1	22	14	R	R	28	18	22	R	R	32	24	12
SA2	28	20	R	R	22	12	10	R	R	22	12	12
SA3	20	18	R	R	24	16	18	10	R	12	14	14
SA4	22	14	R	R	38	20	16	10	R	26	20	24
SA5	20	R	R	R	32	22	20	R	14	22	18	12
SA6	20	22	R	R	26	20	22	R	14	20	18	12
SA7	28	20	12	R	22	16	20	R	14	18	20	16
SA8	26	22	R	R	30	24	16	R	14	12	14	12
SA9	24	24	R	R	32	20	14	R	14	20	20	14
SA10	20	22	R	R	32	16	20	R	R	16	18	10
	C	TET	SXT	CAZ	IMP	GEN	NIT	ERY	AMC	CTX	OFX	VAN
Cn1	R	R	R	R	24	12	14	R	14	R	14	16
Cn2	R	12	R	R	16	12	R	R	R	R	20	R
Cn3	R	12	R	R	12	14	R	R	R	R	18	R
Cn4	R	R	R	R	12	24	R	R	R	-	14	R
Cn5	R	R	R	R	12	12	R	R	R	R	R	R
Cn6	R	R	R	R	30	12	R	R	R	R	22	R
Cn7	R	R	14	R	32	16	R	R	R	R	20	R
Cn8	R	R	R	R	14	12	R	R	R	R	22	R
Cn9	R	12	R	R	16	14	R	R	R	R	24	R
Cn10	R	12	R	R	24	10	R	R	R	R	22	R
	C	TET	SXT	CAZ	IMP	GEN	NIT	ERY	AMC	CTX	OFX	VAN
PA1	22	24	24	R	32	24	22	R	R	R	24	R
PA2	16	20	22	R	18	12	R	R	R	18	24	22
PA 1	R	16	20	R	24	14	18	R	R	22	12	R
PA2	20	14	24	R	26	24	10	R	R	28	16	18
PA 1	20	22	R	R	24	20	R	12	R	R	28	20
PA2	16	R	R	R	28	22	R	R	R	20	18	16
PA 1	R	R	R	R	30	28	R	R	R	24	20	14
PA2	R	R	R	R	20	20	22	R	R	14	14	R
PA 1	R	18	R	R	26	24	R	R	R	20	28	R
PA2	R	14	R	R	20	24	16	R	R	R	20	R
	C	TET	SXT	CAZ	IMP	GEN	NIT	ERY	AMC	CTX	OFX	VAN
Ec1	R	R	20	R	30	26	14	R	12	18	22	18
Ec2	R	R	R	10	24	22	26	R	R	20	28	R
Ec3	R	16	R	R	16	12	26	R	R	20	24	16
Ec4	R	14	20	R	28	16	16	R	R	22	18	16
Ec5	14	12	R	R	30	22	20	R	R	18	14	12
Ec6	R	14	12	R	14	22	18	R	R	R	16	20
Ec7	R	18	R	R	14	18	R	R	R	R	20	R
Ec8	R	10	R	14	R	R	R	R	R	R	16	R
Ec9	R	12	R	R	24	24	R	R	R	R	24	12
Ec10	R	12	14	R	12	R	R	R	R	R	R	12
	C	TET	SXT	CAZ	IMP	GEN	NIT	ERY	AMC	CTX	OFX	VAN
Stp 1	R	18	R	R	16	14	R	R	R	12	22	16
Stp2	20	28	12	R	18	24	24	14	10	28	26	18
Stp 3	R	20	12	R	20	26	22	R	R	32	26	20
Stp4	14	R	R	R	20	12	R	R	R	R	22	20
Stp 5	12	12	R	R	14	R	14	16	R	10	R	14
Stp6	R	18	22	R	22	14	R	R	R	20	20	22
Stp 7	R	20	R	R	20	R	12	R	R	R	24	20
Stp8	R	12	R	12	22	14	R	R	R	R	24	22
Stp9	R	12	R	12	22	14	R	R	R	R	24	22
Stp10	R	R	12	R	R	28	20	14	R	R	R	14

SA – *Staphylococcus aureus*; Cn – Coagulase-Negative *Staphylococcus*; PA – *Pseudomonas aeruginosa*; Ec – *Escherichia coli*; Stp – Streptococcus spp

C - Chloramphenicol (30µg), TET – Tetracycline (30 µg), SXT – Sulphamethazole/Trimethoprim (25 µg), CAZ – Ceftazidime (10 µg), IMP – Imipenem (10 µg;), GEN – Gentamicin (30 µg), NIT – Nitrofurantoin (30 µg) ERY - Erythromycin (15 µg), AMC – Amoxicillin/Clavulanic acid (30 µg), CTX – Cefotaxime (30 µg), OFX – Ofloxaxin (5 µg), VAN - Vancomycin (30 µg)

Table III: Susceptibility of the bacterial isolates to selected disinfectants

Diameter of Zone of growth Inhibition (mm)					
			Staphylococcus aureus		
ID	Savlon®	Purit®	Dettol®	Distilled water (Negative Control)	Gentamicin (Positive Control)
SA1	20	28	20	-	20
SA2	18	28	20	-	20
SA3	22	30	20	-	32
SA4	20	28	18	-	16
SA5	20	24	20	-	20
SA6	20	26	22	-	16
SA7	18	22	20	-	18
SA8	20	26	22	-	20
SA9	18	28	20	-	22
SA10	20	30	20	-	26
			Coagulase-Negative *Staphylococcus*		
ID	Savlon®	Purit®	Dettol®	Distilled water (Negative Control)	Gentamicin (Positive Control)
Cn1	18	28	20	-	20
Cn2	12	20	18	-	16
Cn3	22	26	22	R	24
Cn4	18	28	20	-	14
Cn5	20	26	20	-	16
Cn6	18	24	20	-	18
Cn7	20	28	18	-	14
Cn8	22	22	20	-	18
Cn9	18	20	18	-	18
Cn10	20	22	20	-	16
			Pseudomonas aeruginosa		
ID	Savlon®	Purit®	Dettol®	Distilled water (Negative Control)	Gentamicin (Positive Control)
PA1	20	22	18	R	20
PA2	28	36	12	R	26
PA 1	-	16	22	R	24
PA2	24	20	18	R	20
PA 1	20	22	20	R	14
PA2	24	24	18	R	16
PA 1	28	20	20	R	16
PA2	22	26	22	-	16
PA 1	20	30	18	-	14
PA2	18	28	20	-	18
			Escherichia coli		
ID	Savlon®	Purit®	Dettol®	Distilled water (Negative Control)	Gentamicin (Positive Control)
Ec1	22	22	14	-	22
Ec2	38	38	14	-	18
Ec3	28	28	26	-	20
Ec4	30	30	20	-	18
Ec5	32	32	18	-	14
Ec6	28	28	22	-	16
Ec7	26	26	20	-	14
Ec8	30	30	18	-	16
Ec9	28	28	18	-	14
Ec10	24	24	20	-	14
			***Streptococcus* Spp.**		
ID	Savlon®	Purit®	Dettol®	Distilled water (Negative Control)	Gentamicin (Positive Control)
Stp 1	22	30	20	-	20
Stp2	18	24	20	-	22
Stp 3	20	38	32	-	26
Stp4	18	-	-	-	-
Stp 5	14	30	20	-	18
Stp6	16	24	16	-	14
Stp 7	14	28	18	-	14
Stp8	16	24	20	-	18
Stp 9	14	28	22	-	16
Stp10	14	30	26	-	12

Interestingly, all the bacteria isolates were sensitive to the commercially available disinfectants, suggesting that the use of these disinfectants by contaminated individuals in

the form of hand cleaning may reduce the spread of the organisms. [12]

Conclusion

Automated Teller Machines (ATM) has a role in the transmission of microorganisms. In this study, *Staphylococcus aureus,* a normal commensal was prevalent on ATMs, followed by *Streptococcus spp* which has been implicated in many cases of upper respiratory tract infections, and *Escherichia coli,* which is a coliform. The latter may suggest poor toilet hygiene habits of some of the ATM users. Therefore, regular disinfection of the ATMs with commercially available disinfectants is recommended to reduce the spread of bacteria among the users of ATMs. The users of ATMs should be encouraged to disinfect their hands after using the interface to reduce microbial loads on their hands, which in turn reduces the risk of hand-to-hand, hand-to-object transmission of microbes. Banking service providers should be encouraged to clean the environment and disinfect their ATM outlets, at least twice daily, as it has been shown that pathogens can survive on fomites for months.

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