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BACTERIOLOGICAL ASSESSMENT OF SOME AUTOMATED TELLER MACHINE (ATM) KEYPADS IN ILORIN METROPOLIS

Odebisi-Omokanye, M. B.*[1], Anibijuwon, I. I.[1], Oke, M. A.[1,2], Ahmed El-Imam, A. M.[1] and Makinde, T. O.[1]

[1]Department of Microbiology, Faculty of Life Sciences, University of Ilorin, P.M.B. 1515, Ilorin, Nigeria.

[2]Microbiology Division, Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603, Kuala Lumpur, Malaysia.

Abstract

An investigation was conducted on the level of bacterial contaminants on the metallic keypads of automated teller machines (ATMs) in Ilorin metropolis. Total of 32 samples were collected in eight banks and sampling was done at two times of the day using standard microbiological methods. Results showed that total aerobic bacterial count on the ATM keypads ranged from 2.6 x10^1 cfu/m^2 to 2.13 x 10^2 cfu/m^2 in the morning, while it ranged from 2.9 x 10^1 cfu/m^2 to 8.3 x 10^1 cfu/m^2 in the afternoon. The results indicated the possibility of cross-contamination during usage of the machines with pathogens such as: *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Enterococcus aerogenes*, *Escherichia coli*, *Lactobacillus fermentii*, *Lactobacillis casei* and *Klebsiella pneumoniae*. Proper cleaning regimen to sanitize these facilities regularly and public education on their hygienic usage are therefore recommended to reduce the associated risks.

Keywords: Bacteria, Automated Teller Machine (ATM), Cross-contamination, Public Health.

1. Introduction

Contamination of environmental objects and surfaces by microorganisms is a common phenomenon. The presence of viable pathogenic bacteria on inanimate objects has been reported by earlier researchers (Stephen and Kwaku, 2011). Several studies of the human environment have demonstrated contamination and colonization of inanimate objects such as door handles, plastics, faucets, phones, money, fabrics, plastics and other fomites by bacteria (Bures *et al*., 2001; Michael *et al*., 2001; Despina *et al*., 2008; Famurewa and David, 2009; Stuart *et al*., 2006)) which is also responsible for the spread of various bacterial infections (Eguia and Chambers, 2003).

*Corresponding Author: Odebisi-Omokanye, M. B.
Email: odebisimutiat@yahoo.com, odebisi.mb@unilorin.edu.ng

Human hands have been shown to play a significant role in the transmission and cross-contamination of microorganisms between environmental surfaces. (Hardy *et al*., 2006). Furthermore, microorganisms found to contaminate fomites have been shown to persist on the surfaces for periods ranging from a few hours to several months, and have been detected and recovered from surfaces after routine conventional cleaning (French *et al*., 2004). The ability of inanimate objects to support viable microorganisms for a prolonged period of time is well documented (Stuart *et al*., 2006) and such environmental surfaces and objects, especially those in close proximity with persons and frequently touched, poses a lot of threat to human health and is a cause for public concern. Examples of such inanimate objects in the environment that are currently in frequent contact with the hands are the keypads of an automated teller machine (ATM).

Automatic teller machines (ATMs), also known as cash machines in the United States are the longest standing and most widely used form of computer driven public technology (Hone *et al*., 1998), with an estimated over 2.4 million units in use (Anonymous, 2011) since their invention and use in the late 1960's. This wide usage has consequently led to regular and unrestricted sharing of interfaces among users. With the harboring of microorganisms acquired from the human microflora or as transient organisms from the environment, and previous accounts of cross contamination of microorganisms (Hardy *et al.*, 2006), it is readily conceivable that pathogens could be transferred among users who share interfaces.

Also, there is no restriction as to who has access to the facility, and no guidelines to ensure hygienic usage. But like all surfaces, when there is no proper cleaning regimen in place for most of these ATM facilities microbial colonization of these metallic keypads is eminent (Stephen and Kwaku, 2011). Most people do not realize that microbes are found on many common objects outdoors, in their offices, and even in their homes. Such objects include; playground equipments, ATM keyboards, kitchen sinks, office desks, computer keyboards, escalator handrails, elevator buttons and the shopping carts handles in supermarkets. The dearth of information in the public space about the potential public health impact of ATM-spread infections and diseases may be responsible for the poor hygiene which sees users not bothering to ensure that their hands are properly sanitised after use.

Considering the fact that 80% of infections are spread through hand contact with contaminated hands or fomites (Reynolds *et al.*, 2005), and the increasing incidence of antimicrobial resistance by many pathogenic microorganisms, the focus of public health management is now on disease prevention as opposed to treatment.

There is no scientific report to the best of our knowledge on the isolation and identification of bacteria from ATMs in Ilorin, Nigeria. To this end, it is imperative that the level of danger posed by the use of ATMs to our health by bacteria is evaluated. Ilorin is a large city in North-Central Nigeria which is very diverse in culture, demographic pattern and trade, and possesses a moderate climate. Thus the results obtained from Ilorin can be extrapolated to many other similar locations. This research investigates the presence of bacteria, particularly those of pathogenic significance, on the keypads of ATMs of commercial banks in Ilorin.

2. Materials and Methods

Materials and Surfaces

One ATM each from eight (8) different banks comprising U bank – OjaOba; FBank - Baboko; U bank – Challenge; SBank – Challenge; ABank – Tanke; Gbank – Tanke; Gbank - Unilorin Permanent Site; U bank - Unilorin Permanent Site all situated in Ilorin metropolis were used for the study.

Sample collection

Double strength nutrient broth (9ml) in screw cap test tubes and nutrient agar (NA; Merck, Darmstadt, Germany) plates were also prepared according to manufacturers' specifications.

The ATMs were sampled on two occasions daily. The keys were double swabbed with sterile cotton swab on each visit; between the hours of 08:00 to 09:00 and 14:00 to 15:00 local time. The swabs were immediately dipped into labelled tubes containing nutrient broth and transported to the laboratory in ice chest.

Isolation and Identification of Bacterial Isolates

One millilitre aliquots of each nutrient broth culture from swabs were plated in NA for total aerobic bacteria counts and also on Eosine Methylene Blue (EMB) agar and MacConkey agar (Merck, Darmstadt, Germany) to test for the presence of coliforms. All plates were incubated at 37^{o}C for 18 - 24hrs. Colonies from the NA plates were also tested for faecal coliforms in MacConkey broth (Oxoid,) with Durham tubes and on EMB agar. The pure cultures of isolates were then characterized and presumptive identification carried out based on descriptions in the Buchnan and Gibson (1981).

3. Results and Discussion

Table 1: Total heterotrophic Bacteria Count (THC) from metallic Keypads of Automated Teller Machines (ATM) of Different banks in the morning and afternoon.

Sampling points	**THC (cfu/m^2)**	
	Morning	**Afternoon**
A	2.1×10^2	8.3×10^1
B	1.3×10^2	6.3×10^1
C	5.2×10^1	4.3×10^1
D	3.5×10^1	7.7×10^1
E	3.2×10^1	4.0×10^1
F	2.6×10^1	2.9×10^1
G	3.7×10^1	4.9×10^1
H	4.4×10^1	3.6×10^1

KEY

A = Ubank – OjaOba; **B** = Fbank - Baboko; **C** = Ubank – Challenge; **D** = Sbank – Challenge; **E** = Abank – Tanke; **F** = Gbank – Tanke; **G** = Gbank - Unilorin Permanent Site; **H** = Ubank - Unilorin Permanent Site

Table 2: Incidence of bacteria isolated from ATM keypads in Ilorin Metropolis.

ISOLATES	**FREQUENCY (%) Morning**	**FREQUENCY (%) Afternoon**	**TOTAL FREQUENCY (%)**
Escherichia coli	23.08	11.11	33.19
Enterobacter aerogenes	11.54	27.78	39.32
Staphylococcus aureus	11.54	22.22	33.76
Lactobacillus fermentii	3.85	16.67	20.52
Klebsiella pneumonia	19.23	11.11	30.34
Staphylococcus epidermidis	15.38	5.56	20.94
Lactobacillus casei	15.38	5.56	20.94
TOTAL	**100**	**100**	

Table 3: Antibiotic Susceptibility Patterns of Bacterial Isolates from ATM keypad	Diameter of Zones of Inhibition (mm): Standards				ISOLATES						
ANTIBIOTICS	**Potency (µg)**	**R**	**I**	**S**	***E. coli***	***E. aerogenes***	***S. aureus***	***L. fermentii***	***K. pnuemoniae***	***S. epidermidis***	***L. casei***
Pefloxacin	10	≤ 12	13-14	≥ 15	28(S)	24(S)	36(S)	30(S)	30(S)	30(S)	24(S)
Gentamycin	10	≤ 12	13-14	≥ 15	20(S)	28(S)	28(S)	28(S)	30(S)	28(S)	24(S)
Ampiclox	30	≤ 13	14-16	≥ 17	ND	ND	12(R)	0(R)	20(S)	ND	14(I)
Zinnacef	20	≤ 14	15-17	≥ 18	ND	ND	24(S)	28(S)	16(I)	ND	24(S)
Amoxicillin	30	≤ 28	-	≥ 29	6 (R)	8(R)	0(R)	0(R)	0(R)	16(R)	0(R)
Rocephin	25	≤ 10	11-12	≥ 13	ND	ND	24(S)	28(S)	28(S)	ND	12(I)
Ciprofloxacin	10	≤ 10	11-12	≥ 13	26(S)	28(S)	30(S)	30(S)	30(S)	28(S)	24(S)
Streptomycin	30	≤ 14	15-16	≥ 17	0 (R)	0(R)	28(S)	0(R)	0(R)	16(I)	20(S)
Septrin	30	≤ 10	11-15	≥ 16	6 (R)	4(R)	12(I)	12(I)	24(S)	20(S)	12(I)
Erythromycin	10	≤ 13	14-22	≥ 23	ND	ND	20(I)	14(I)	20(I)	ND	30(S)
Tarivid	10	≤ 14	15-18	≥ 19	20(S)	20(S)	ND	ND	ND	34(S)	ND
Chloramphenicol	30	≤ 14	15-20	≥ 21	4 (R)	8(R)	ND	ND	ND	10(R)	ND
Sparfloxacin	10	≤ 13	14-22	≥ 23	24(S)	8(R)	ND	ND	ND	30(S)	ND
Augmentin	30	≤ 28	-	≥ 29	8 (R)	10(R)	ND	ND	ND	8(R)	ND

KEY: S = Susceptibility, I = Intermediate, R = Resistant, ND = Not Determined

Discussion

The bacterial loads on the ATMs sampled in the mornings ranged from 2.6 x10^1 – 2.1 x 10^2 cfu/m^2, while that from the afternoon ranged from 2.9 x 10^1 – 8.3 x 10^2 cfu/ml (Table 1). Bacterial load was higher in samples from the ATMs of Oja-Oba and Baboko markets having bacterial count of 2.1 × 10^2 and 1.3 × 10^2 cfu/m^2 respectively in the morning and also having the highest and third highest counts in the afternoon of 8.3 × 10^1 and 7.7 × 10^1 cfu/m^2 (Table 1) respectively. This can be ascribed to the location of the machines in the markets where there are many people trading foods, feeds, animal products such as meat and fish etc.

Microorganisms from these materials may be transferred from the large number of shoppers/traders who patronize the ATMs to withdraw money for morning transactions, thus increasing the number of microbes on the keypads. The proximity of these ATMs to the roads may also be a contributing factor. Passing vehicles contribute to the contamination of these ATMs by raising dust, particularly in the numerous potholes on the streets which settle on the ATM keypads.

The machines had more bacteria in the mornings, probably because they had been left overnight and a lot of dust had accumulated on them. The bacteria adhere to the tiny dust particle suspended in the air and then settle on the ATM keypads

The frequency of occurrence of bacterial species varied from morning to afternoon. More bacterial species were found on the ATM in the morning than in the afternoon because of milder temperature and higher relative humidity in the morning which favoured bacterial growth. The bacteria isolated were *Escherichia coli, Enterobacter aerogenes, Staphylococcus aureus*, *Lactobacillus fermentii*, *Klebsiella pnuemoniae*, *Staphylococcus epidermis* and *L. casei.* This is similar to the findings of Stephen and Kwaku (2011), who also isolated these organisms on ATM machine which they sampled (Table 3).

Enteric bacteria like *Escherichia coli, Enterobacter aerogenes,* and *Klebsiella pnuemoniae* were found on the ATM keypads, these bacteria reside normally in the intestinal tracts of animals including humans and some are pathogenic, causing disease and food poisoning in

humans, improper hand washing could be adduced to why enteric organism were isolated from the sample ATM machines.
Numerous studies have indicated that Automated Teller Machine (ATM) can become contaminated with pathogenic bacteria. In health care settings, it is perhaps not unexpected that such microorganisms would contaminate these common public devices. A particularly interesting finding was that multiple-user ATM machine had significantly more numbers of microorganisms, as well as greater numbers of potentially pathogenic species, compared with ATM machine used by predominantly few persons.

A similar study was carried out in England comparing the bacteria isolated from ATM keypads with those isolated from toilets seats and found that the ATM machines had similar levels of bacteria described as heavily contaminated and both contained Pseudomonads and *Bacillus* species (Allwell, 2011).

Species of *Staphylococcus* e.g. *S. aureus* and *S. epidermis* were isolated from all ATM keypads and this is not too surprising as they are known resident microflora of the skin (Hardy*et al*., 2006) and *S. aureus* is carried by 20-40% of healthy individuals at any given time. However, because *S. aureus* is the most important human staphylococcus pathogen and causes boils, abscesses, wound infections, pneumonia, in addition to the rise in Methicillin-Resistant *Staphylococcus aureus* (MRSA) incidence, the presence of this organism in all the machines should not necessarily be taken with levity. *S. epidermis* is a common skin resident that is sometimes responsible for endocarditis and infections of patients with lowered resistance (Willey *et al.,* 2008).

It is thus recommended that the same infection prevention measures employed during direct contact with patients (i.e. hand washing and use of gloves), should be enforced when handling computer hardware (Anderson and Palombo, 2009). Species of Lactobacilli namely *L. fermentii* and *L. casei* were also isolated from some ATM keypads. These bacteria are part of the normal flora of the mouth, intestinal tract and vagina of humans where they are usually not pathogenic (Willey *et al*., 2008). Again the presence of these organisms on ATM keypads may indicate contact of patrons' hands with the said human organs just prior to using the machines.

Occasional presence of *Lactobacillus* spp. may represent improper disinfection of the fingers selected. It is important to note however that, disinfection of the fingers was effective most of the time, thus hand washing is an important tool for control of cross contamination from fingers (Bloomfield *et al*., 2007). *L. casei* is closely related to *L. acidophilus* which secretes peptidoglycan which supports the natural defenses of the body and stimulates immune responses in the intestinal tracts.

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, people touch different dirty things with their bare hands, including money, 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 ATM situated near a busy road e. g. the banks in Challenge also have some percentage of bacteria load, because of movement of vehicles causing disturbance of dust particle, smoke, infectious dust, droplet that increase the rate of microorganism in the air.

The findings of the study confirm the presence of potentially pathogenic bacteria on the metallic keypads of the ATM. This interface is therefore a potential vehicle for the transmission of clinically important pathogens. This situation is likely to be true for other surfaces like public telephones and doors handles in public facilities. User awareness is of paramount importance especially in the handling of foods after making use of these public utilities, especially ready-to-eat foods, as some studies have shown the inadequacies in the general public's knowledge with regards to food handling principles (De Jong *et al*., 2008; Van Asselt *et al*., 2009).

Hand washing and the use of hand sanitizers which are portable and easy to use is well documented as a means of reducing, if not eliminating these organisms (Oke *et al*., 2013) to avoid cross contamination. It removes soil and transient microorganisms from the hands and markedly reduces population of microbes (Bloomfield *et al*., 2007).

4. Conclusion

The findings of this study identify the ability of pathogenic organisms to cause cross contamination on the metallic keypads of the ATM. Cleaning regimen aimed at reducing the population and presence of these pathogenic organisms on such surfaces should be developed using appropriate sanitizers and strictly adhered to by custodians of such facilities.

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