

Original research Articles

Bacterial Contamination of User Interface of Automated Teller Machines (ATM) Of Various Banks in Umuahia Metropolis, Abia state. Nigeria.

Nwankwo E.O^{1*}, Offiah J.C¹

¹Department of Microbiology, College Of Natural Science, Michael Okpara University Of Agriculture, Umudike

ABSTRACT

Aims: To evaluate the bacterial diversity and degree of contamination obtainable on the ATM buttons as money is being collected and antibiotic susceptibility pattern of the isolates.

Study design: Cross-sectional study including all ATM user interface in the banks within Umuahia metropolis.

Place and Duration of Study: Department of Microbiology, Michael Okpara University of Agriculture, Umudike, Abia state, between August 2015 and September 2015.

Methodology: A total number of sixty-eight (68) samples were collected from 14 different commercial banks in Umuahia metropolis. Isolation and identification of bacteria were done by standard microbiological techniques. Antibiotic susceptibility testing was carried out by disc diffusion technique.

Results: Nine (9) different organisms were isolated which include- *E.coli* (26.5%), *S. aureus* (17.6%), *Bacillus* spp (4.9%), *Klebsiella* spp (6.9%), *Proteus* spp (8.8%), *Pseudomonas aeruginosa* (9.8%), *Streptococcus* spp (13.7%), *Salmonella* spp (4.9%) and Coagulase Negative *Staphylococcus* (6.9%). Most of the isolates were sensitive to Ceftriaxone, Ciprofloxacin, Amoxicillin/Clavulanate and Gentamicin and resistant to Cotrimoxazole, Ampicillin and Cephalixin.

Conclusion: The result of the study reveals that high levels of bacterial contamination were detected on ATM hardware user interface. This is of public health importance.

Keywords: Bacterial pathogens, ATM, Antibiotic sensitivity pattern, South-eastern Nigeria.

1. INTRODUCTION

Several studies of the human environment have demonstrated colonization and contamination of objects such as door handles, faucets, phones, money, fabrics and plastics [1]. People come into daily contact with all sorts of fomites, with an increasing rate of bacterial infection [2]. The spread of infectious disease through hand contact has been an area of major concern. According to a study conducted by [3], Gram positive *staphylococcus aureus*, and Gram negative enteric bacteria such as *Escherichia Coli*, *klebsiella* species, *citrobacter* species was found to contaminate various contact surfaces including tables, chairs, windows, door handles and many other common household fixture [3]. Some epidemiological studies have suggested that contaminated surfaces may play a role in the spread of respiratory viruses and several laboratory studies have corroborated this hypothesis [4, 5, 6].

Bacteria that can cause severe gastroenteritis have been found on ATM machine keypads/buttons. Fomites such as ATM machines carry germs and when one touches it and then touches the mouth, nose, eye etc., there may be transfer of germs in the body. The presence of pathogenic bacteria on the user interface of ATM machines possesses a potential risk to vulnerable, immune compromised individuals. It has been shown that hard, non-porous surfaces such as ATM machines have the highest bacteria transfer rates to hands [7].

ATM machines once contaminated becomes vehicles for transmission of infection, such that the user may succeed in picking these pathogens after making use of an ATM machine, the organisms thus

picked can introduce infections into such individual orally or topically or can be transferred to another person. However, personal hygiene and good hand washing technique have been found to be an effective method of preventing the transmission of pathogens through fomites such as the user interface of ATM machines.

2. MATERIAL AND METHODS

2.1 STUDY AREA

This study was carried out in Umuahia, Abia State, Southeastern Nigeria. It covered various commercial banks located within the Umuahia metropolis.

2.2 COLLECTION OF SAMPLES

A total number of sixty-eight (68) swab samples were collected from the user interface of 14 different commercial banks situated at various parts of Umuahia metropolis with the aid of sterile cotton swab sticks moistened with sterile physiological saline before swabbing the buttons of the ATM machines. The cotton swab sticks were transferred immediately to the laboratory within one hour of collection for bacteriological analysis.

2.2 BACTERIAL INOCULATION

The first phase of bacterial inoculation involved a direct streaking of the swab sticks on MacConkey agar, Mannitol salt agar and Blood agar respectively and incubated for 24 hours at 37°C after which colonies were counted.

In the second phase, individual buttons on the user interface were swabbed and soaked in 3ml of normal saline for 1hr. Serial dilution was later carried out and 0.1ml of the 10⁻³ dilution cultured by streak plate on MacConkey agar, Mannitol salt agar and Blood agar respectively and incubated for 24 hours at 37°C. Colony forming units was calculated in CFU/cm².

2.3 COLONY COUNTING

After 24 hours of incubation and the colonies were counted and assigned values (+, ++, +++) to determine the nature and severity of growth. Where;

+ = Scanty growth (1-30 colonies)

++ = Moderate growth (31-70 colonies)

+++ = Profuse growth (71 and above)

2.4 ISOLATION AND IDENTIFICATION OF BACTERIA ISOLATES

The isolation and identification of bacteria from the internal surface of handbags were done by standard methods. The isolate were identified by the modification of the methods described by [8] based on their; morphological appearance, Gram reaction and Biochemical characteristics.

2.5 ANTIBIOTICS SUSCEPTIBILITY TESTING

The antibiotics sensitivity of the isolates was tested against the following antibiotics streptomycin (30mcg), tarivid (10mcg), peflaxine (10mcg), ciproflox (10mcg), Augmentin (30mcg), Gentamicin (10mcg), septrin (30mcg), ceporex (10mcg) and Ampicillin (30mcg) using Kirby Bauer antibiotics disc method[9]. A colony of the test organisms was picked with sterile wire hoop and immersed in peptone water. The turbidity of the suspension was compared against a reference 0.5 Mcfarland tube. The suspension of the organism was streaked on the entire of nutrient agar and the antibiotic disc was placed on the centre of the plate using forcep. The plates were incubated at 37°C for 24 hours. The diameter of the zone of inhibition was measures using CLSI standard guidelines [10].

3. RESULTS

TABLE 1A: BACTERIAL DIVERSITY AND DEGREE OF CONTAMINATION OF USER HARDWARE INTERFACE IN VARIOUS BANKS

ISOLATES	B1		B2		B3		B4		B5		B6		B7	
	M	D	M	D	M	D	M	D	M	D	M	D	M	D
<i>E. Coli</i>	18.3±55.9	+++	19.4±50.1	+++	-	-	31.6±53.6	+++	11.6±55.9	+++	-	-	10.5±53.7	+++
<i>S. aureus</i>	20.5±57.6	+++	13.8±59.4	+++	17.2±51	+++	11.5±58	+++	9.1±20	++	-	-	-	-
<i>Klesiella</i> spp	6.5±12.6	+	-	-	-	-	7.5±38.7	++	-	-	-	-	-	-
<i>P. aeruginosa</i>	0.7±2.5	+	7.9±25	++	5±10	+	-	-	-	-	8.6±37.8	++	9.2±20	++
<i>Streptococcus</i>	9.6±26.8	++	13.2±22.5	++	14.4±38.6	++	-	-	-	-	-	-	1.5±3.3	+
<i>Bacillus</i> spp	13.1±25.6	++	-	-	-	-	-	-	-	-	13.8±59.4	+++	-	-
<i>Proteus</i> spp	9.4±26.4	++	13.4±51	+++	-	-	-	-	-	-	-	-	-	-
CoANS	7.5±6.3	+	7.6±26.7	++	2.1±4.3	+	-	-	8.2±27.5	++	-	-	-	-
<i>Salmonella</i> spp	6.3±11.5	+	-	-	-	-	-	-	-	-	9.4±18.2	+	-	-

KEY: M = Mean number of colonies per swab + = Scanty growth (From 1-20 colonies) ++ = Moderate growth (From 21-50 colonies)
D = Degree of bacterial contamination where; +++ = Profuse growth (51 colonies and above)

Table 1B: BACTERIAL DIVERSITY AND DEGREE OF CONTAMINATION OF USER HARDWARE INTERFACE IN VARIOUS BANKS

ISOLATES	B8		B9		B10		B11		B12		B13		B14	
	M	D	M	D	M	D	M	D	M	D	M	D	M	D
<i>E. coli</i>	13.1±23	++	27.2±50.1	+++	10±55	+++	13.4±51	+++	8.5±26.6	++	17.2±61	+++	14.2±30.1	+++
<i>S. aureus</i>	11.4±20.7	++	18.7±51.6	+++	23.6±50	+++	20.5±57.6	+++	13.7±56.8	+++	13.8±79.4	+++	-	-
<i>Klesiella</i> spp	-	-	-	-	-	-	1.7±2.8	+	-	-	-	-	2.3±5.2	+
<i>P. aeruginosa</i>	-	-	10.4±23	++	6.5±27.5	++	-	-	-	-	-	-	-	-
<i>Streptococcus</i>	1.7±2.7	+	2.2±5.7	+	-	-	-	-	-	-	10.2±30.6	++	8.4±28.2	++
<i>Bacillus</i> spp	-	-	-	-	1±3	+	7.5±6.3	+	-	-	-	-	-	-
<i>Proteus</i> spp	8.5±23.7	++	-	-	-	-	-	-	5.6±36.4	++	7.9±25	++	12.2±21.5	++
CoANS	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Salmonella</i> spp	-	-	-	-	-	-	-	-	-	-	-	-	-	-

KEYS:

M = Mean number of colonies per swab + = Scanty growth (From 1-20 colonies) ++ = Moderate growth (From 21-50 colonies)
D = Degree of bacterial contamination where; +++ = Profuse growth (51 colonies and above)

109 Table 2: The diversity of bacteria obtained from the different ATM user interface which were screened in various banks. Banks with more customers than the
110 others showed a wider spectrum of bacteria types.

111

112 **TABLE 2: TYPES OF BACTERIA ISOLATES OBSERVED FROM DIFFERENT BANKS**

S/N	BANKS	BACTERIAL ISOLATED
1	B1	<i>Pseudomonas aeruginosa</i> , <i>E. coli</i> , <i>proteus</i> spp, <i>S. aureus</i> , <i>Klebsiella</i> spp, <i>Streptococcus</i> spp, <i>Bacillus</i> spp, Coagulase Negative <i>Staphylococcus</i> , <i>Salmonella</i> spp
2	B2	<i>Streptococcus</i> spp, <i>proteus</i> spp, <i>E. coli</i> , <i>S. aureus</i> , <i>Pseudomonas aeruginosa</i> , Coagulase Negative <i>Staphylococcus</i>
3	B3	<i>S. aureus</i> , <i>Streptococcus</i> spp, <i>Pseudomonas aeruginosa</i>
4	B4	<i>E. coli</i> , <i>Klebsiella</i> spp, <i>S. aureus</i>
5	B5	<i>E. coli</i> , <i>S. aureus</i> , Coagulase Negative <i>Staphylococcus</i>
6	B6	<i>Bacillus</i> spp, <i>Pseudomonas aeruginosa</i>
7	B7	<i>Pseudomonas aeruginosa</i> , <i>Streptococcus</i> spp, <i>E. coli</i> , Coagulase Negative <i>Staphylococcus</i>
8	B8	<i>Streptococcus</i> spp, <i>E. coli</i> , <i>S. aureus</i> , <i>Proteus</i> spp.
9	B9	<i>Pseudomonas aeruginosa</i> , <i>E. coli</i> , <i>Streptococcus</i> spp, <i>S. aureus</i>
10	B10	<i>S. aureus</i> , <i>E. coli</i> , <i>Pseudomonas aeruginosa</i> , <i>Bacillus</i> spp.
11	B11	<i>E. coli</i> , <i>S. aureus</i> , <i>Klebsiella</i> spp, <i>Bacillus</i> spp
12	B12	<i>Proteus</i> spp, <i>S. aureus</i> , <i>E. coli</i> ,
13	B13	<i>E. coli</i> , <i>S. aureus</i> , <i>Streptococcus</i> spp, <i>Proteus</i> spp.
14	B14	<i>Klebsiella</i> spp, <i>Proteus</i> spp, <i>E. coli</i> , <i>Streptococcus</i> spp.

113

114 Table 2 shows the diversity of bacteria and degree of contamination of user hardware interface in various banks. Banks with ore customers than the others
115 showed both a wider spectrum of bacteria types and higher degree of contamination.

116

117

118

119

120

121

122

123

124

125

126

127 Table 3: The differentiation of isolates according to Gram stain reaction. Two (2) gram positive bacteria, *S. aureus* and *Streptococcus* spp showed 17.6% and
128 13.7% respectively while two (2) Gram negative bacteria, *E. coli* and *Pseudomonas* spp showed 26.5% and 9.8% respectively.
129
130

131 **TABLE 3: DIFFERENTIATION OF ISOLATES FROM STUDY BY GRAM STAINING**
132

GRAM STAIN REACTION	BACTERIA ISOLATES	NO. OF BACTERIA	PERCENTAGE (%)
Gram positive	<i>S. aureus</i>	18	17.6
	<i>Streptococcus</i> spp	14	13.7
	<i>Bacillus</i> spp	5	4.9
	<i>Coagulase Negative Staphylococcus</i>	7	6.9
Gram negative	<i>Klebsiella</i> spp	7	6.9
	<i>E. coli</i>	27	26.5
	<i>Proteus</i> spp	9	8.8
	<i>Pesudomonas aeruginosa</i>	10	9.8
	<i>Salmonella</i> spp	5	4.9
Total		102	100

133
134
135
136
137
138
139
140
141
142
143

Table 4: The percentage of occurrence of each organism in the various banks screened. *E. coli* (26.5%) and *S. aureus* (17.6%) were the most frequently isolated organisms in the study.

TABLE 4: PERCENTAGE OF OCCURENCE OF ISOLATES IN VARIOUS BANKS

[illegible]

158 Table 5: The antibiotics susceptibility of the bacterial isolates from various ATM machines in Umuahia metropolis. Most isolates were sensitive to Ofloxacin,
159 Peflacin, Ceftriaxone but resistant to Ampicillin, Cephalixin and Septrin.
160

161 **TABLE 5: ANTIBIOTICS SUSCEPTIBILITY OF THE BACTERIAL ISOLATES FROM VARIOUS ATM MACHINES IN**
162 **UMUAHIA METROPOLIS**

ISOLATTES	NO TESTED	NUMBER OF ORGANISMS (%) SENSITIVE TO								
		S	OFX	PEF	AU	CRO	CEP	SXT	PN	CN
<i>E. coli</i>	27	5(18.5)	25(92.6)	20(74.0)	15(55.5)	20(74.0)	8(29.7)	0(0)	4(14.8)	20(74.0)
<i>S. aureus</i>	18	10(55.5)	15(83.3)	12(66.7)	9(50.0)	10(55.5)	7(38.9)	8(44.4)	5(27.8)	12(66.7)
<i>Proteus</i> spp	9	3(33.3)	5(55.5)	4(44.4)	9(99.9)	9(99.9)	2(22.2)	1(11.1)	0(0)	5(55.5)
<i>Klebsiella</i>	7	2(28.6)	4(57.1)	3(42.8)	5(71.4)	2(28.6)	1(14.3)	7(100.0)	1(14.3)	6(85.7)
<i>P. aeruginosa</i>	10	1(10.0)	3(30.0)	9(90.0)	5(50.0)	4(40.0)	2(20.0)	0(0)	0(0)	7(70.0)
<i>Streptococcus</i> spp	14	6(42.9)	6(42.8)	2(14.3)	5(35.7)	7(50.0)	12(85.7)	0(0)	0(0)	4(28.6)
<i>Bacillus</i> spp	5	0(0)	1(20.0)	3(60.0)	2(40.0)	3(60.0)	1(20.0)	4(80.0)	4(80.0)	2(40.0)
COANS	7	3(42.9)	5(71.4)	4(57.1)	7(100)	6(85.7)	5(71.4)	1(14.2)	2(28.6)	5(71.4)

163
164 **KEYS:**
165
166 S = Streptomycin CEP = Cephalixin CRO = Ceftriaxone
167 OFX = Ofloxacin SXT = Septrin
168 PEF = Peflacin PN = Ampicillin
169 AU = Amoxycillin/Clavulanate CN = Gentamicin
170
171
172
173
174
175
176
177
178

179 Table 6: Viable bacteria count per button from the different ATM screened in different banks. *E. coli* was found in all the buttons enumerated.

180 **TABLE 6: ASSESSMENT OF BACTERIAL COUNT FROM VARIOUS BANK OF EACH ATM BUTTONS**

BANK	AREA OF BUTTON(cm ²)	BACTERIA ISOLATES					
		<i>E. coli</i>	<i>Strept.</i> spp	<i>S. aureus</i>	<i>Kleb. spp</i>	<i>Proteus spp</i>	<i>Sal. spp</i>
B1	7.3	2.5x10 ⁵	-	1.5 x 10 ⁴	-	1.0 x 10 ⁵	1.0 x 10 ⁵
B2	6.2	3.0x10 ⁵	5.0 x 10 ⁴	1.0 x 10 ⁵	1.0 x 10 ⁴	-	-
B3	7	3.5x10 ⁵	-	5.0 x 10 ³	-	5.0 x 10 ⁴	-
B4	1.7	5.0 x 10 ⁴	5.0 x 10 ⁴	-	-	5.0 x 10 ⁴	-
B5	1.2	3.5 x 10 ⁵	-	5.0 x 10 ⁴	-	-	1.0 x 10 ⁵
B6	3.3	1.0 x 10 ⁵	3.5 x 10 ⁵	-	-	-	-
B7	6.7	3.0 x 10 ⁵	-	5.0 x 10 ⁴	-	-	1.5 x 10 ⁵
B8	2.4	2.0 x 10 ³	-	5.0 x 10 ³	3.5 x 10 ⁴	-	-
B9	6.2	2.0 x 10 ⁵	-	1.0 x 10 ⁵	1.0 x 10 ⁴	-	-
B10	1.2	3.0 x 10 ⁵	5.0 x 10 ⁴	5.0 x 10 ⁴	-	-	-

181
182 **KEY:** SAL. = Salmonella species

183
184

4. DISCUSSION

ATM machines are one of the most commonly touched surfaces today. The study evaluated the bacteria contamination of shared surfaces on user hardware interface of 14 commercial banks randomly scattered within the Umuahia Metropolis in Southeastern Nigeria. A total of 102 bacterial organisms comprising nine (9) different species, were isolated. The isolation of both Gram negative and Gram positive organisms disagrees with the findings of [11] who isolated only Gram positive bacteria: *Staphylococcus*, *Enterococcus*, *Micrococcus* and *Streptococcus* from mobile phones. In comparison with the other studies [12] and [13] obtained Gram positive and Gram negative bacteria in their work from currency note and computer keyboards, curtains, cellphones, white coats and ties respectively.

Findings from this study revealed *E. coli* to be the most frequently occurring isolate with a percentage occurrence of 26.47%. This was found to be at variance to the findings of [14] who reported *S. aureus* (35.8%) as the frequent bacteria contaminant of electronic hardware interfaces in Ile-ife. *E.coli* is a normal flora of the gastrointestinal tract which can easily be picked up from toilet door handles. In a society of low hygiene, this probably explains its preponderance as a bacterial contaminant of shared user hardware interfaces. It has also been associated with numerous infectious disease conditions and nosocomial infections. It follows that since users constantly touch interfaces there is every chance of introducing *E.coli* onto the interface in use. Also, airborne organisms can be transported from users or passer-by.

Bacillus spp was isolated from the findings in this research, and its high presence could be explained by the fact that *bacillus* spp are ubiquitous in nature with their spores able to resist environmental changes, withstand dry heat and certain chemical disinfectants for moderate periods. This finding is in agreement with the research carried out by [15] who reported that *Bacillus* spp was found to be among the predominant organisms from user hardware interface.

The isolation of *S. aureus* agrees with the findings of [16]. *Staphylococcus aureus* is a major component of the normal flora of the skin and nostrils, which probably explains its high prevalence as a contaminant, as it can be easily discharged by several human activities including sneezing, talking, and contact with moist skin [3]. It has also been associated with numerous infectious disease conditions and nosocomial infections. It follows that since users constantly touch interface and often sneeze, there is every chance of introducing *S. aureus* on to the interface in use. Also, airborne organisms can be transported from users to passerby.

In the present study, a sustained pattern of similarity in the bacterial diversity obtained from the user interfaces of ATM machines of different banks was observed. This could be attributed to frequent dermal contact and sharing by numerous users with different hygiene practices and health conditions. High microbial loads were observed as in the reports of [14]. A higher number of different types of bacteria isolates and contamination were found to be more in B1 because of the high number of customers which is in agreement with the research of [17] who revealed that high proportion of organisms were found in surfaces associated with crowded public utilities and the least count in non-crowded public utilities.

Antibiotics susceptibility studies of the isolates showed a pattern of resistance to commonly used antibiotics. This agrees with the reports of [16], who worked on door handles in a tertiary institution.

5. CONCLUSION

In conclusion, interfaces such as ATM machine were found to be contaminated with potentially pathogenic bacteria, highly resistant to some commonly used antibiotics. ATMs harbor more bacterial contaminants than other electronic hardware; this can be attributed to their structural design and large surface area, coupled with the fact that ATMs are usually located in open places exposed to wind and rain.

These interfaces are therefore potential vehicles for the transmission of clinically important pathogens through human own hands.

6. RECOMMENDATION

The spread of infection can be interrupted by good hygienic practices which include adherence to hand hygiene recommendation, cleaning and disinfecting contaminated environmental surfaces. It is extremely difficult to completely eliminate all bacteria from surfaces. However, strict adherence to basic rules of hand washing and disinfection of ATM user interface will reduce possible spread of infectious agents.

REFERENCES

1. Bures S, Fishbain JT, Uyehara CF, Parker JM, Berg BW. Computer keyboards and Faucet handles as reservoirs of noscomial pathogens in the intensive care unit. *American Journal of Infection Control*. 2001;29(2):131-132.
2. Eguia JM, Chambers HF. Community acquired methicillin resistant staphylococcus aureus: Epidemiology and potential virulence factors. *Current Infectious Disease Report*. 2003;5:459-466
3. Itah AT and Ben AE. Incidence of enteric bacteria and *Staphylococcus aureus* in day care centers in Akwa-Ibom state, Nigeria. *Southeast Asian Journal of Tropical Medicine and Public health*. 2004;35(1):202-209
4. Neely AN and Maley MP. Survival of Enterococci and Staphylococci on Hospital fabrics and plastics. *Journal of clinical microbiology*. 2000;38(2):724-726
5. Fraser MA and Girling SJ. Bacterial carriage of computer keyboards In Verterinary practices in Scotland. *Veterinary records*. 2009;165:26-27
6. Gholamreza S, Nooshin T, Ali M, Touraj-Reza M, Ehsan S. Bacterial contamination and resistance of health care workers' Mobile Phones In Teaching Hospitals, Kerman, Iran. *American Journal of Applied Science*. 2009;6(5): 806-810
7. Rusin P, Maxwell S, Gerba C. Comparative Surface-to-hand and Fingertip-to-mouth transfer efficiency of gram positive bacteria, gram negative bacteria and phage. *Journal of Applied Microbiology*. 2002;93:585-592
8. Cheesbrough M. *Medical laboratory manual for tropical countries*. 2006;200-234.
9. Bauer AW, Kirby WM, Sherris JK, Turck M. Antibiotic susceptibility testing by a standardized single disk method. *American Journal of Clinical Pathology*. 1966;45:493-496.
10. Clinical and laboratory standard institute. Performance standards for antimicrobial susceptibility testing. Fifteen informational supplement, 2005;M100-S15
11. Datta P, Rani H, Chander J and Gupta V. Bacterial contamination of mobile phones of health workers. *Indian Journal of Medical Microbiology*. 2009;27(3)279-281
12. Yazah A, Yusuf J and Agbo A. Bacterial contaminants of Nigerian currency notes and associates risks factors. *Research Journal of medical sciences*. 2012;6:1-6
13. Catano L, Echeverri and Szela C. Bacterial contamination of cloths and environmental items in a third level Hospital in Colombia. *Interdisciplinary perspectives on Infectious disease*. 2012;5:40-45
14. Oluduro AO, Ubani EK, Ofoezie IE. Bacterial assessment of electronic hardware user interfaces in Ile-ife, Nigeria. *Journal of Basic and Applied Sciences*. 2011;93:585-592.
15. Brooks GF, Carrol KC, Butel JS, Morse SA, Jawetz, Melnick, Adelberg's *Medical Microbiology*. New York, McGraw Hill. 2007;26e.
16. Nwankwo EO and Afuruobi HC. Bacterial contamination of door handles. *Nigeria Journal of Microbiology*. 2015;29:3139-3147.
17. Baker, J., and Bloomfield, S.F. (2000). Survival of salmonella in bathroom and toilet in homes. *Journal of Applied Microbiology*. 89:137-144