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# ANTIBACTERIAL SUSCEPTIBILITY OF PATHOGENIC BACTERIAL ISOLATED FROM SELECTED AUTOMATED TELLER MACHINES WITHIN KADUNA METROPOLIS

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**ABSTRACT:** Pathogenic bacteria such as *E. coli*; *S. dysenteriae*; *S. typhimurium*; *P. aeruginosa*; *K. pneumonia*e and *S. aureus* isolated from the Automated Teller Machines (ATMs) located in NNPC/KRPC (Nigerian National Petroleum Corporation/Kaduna Refinery and Petrochemicals Company); ABW (Ahmadu Bello Way); AAW (Ali Akilu Way); SCS (Shopping Complex around Station); KR/ST (Kachia Road/Sabon Tasha); KR (Kano Road Axis) and NAW (Nnamdi Azikiwe Way) within Kaduna Metropolis were subjected to antibacterial susceptibility test using known antibiotics. The result obtained showed that 30 (100%) of the isolated pathogenic bacteria were sensitive to Ciprofloxacin.

**KEYWORDS:** Antibacterial Susceptibility, Automated Teller Machines, Antibiotics

## INTRODUCTION

Information and Communication Technology (ICT) is a major driver of improved quality of life, economic growth and development in the countries of the world. It is indisputable that ICT has the potential to continue driving growth for the foreseeable future. Anwana (2010) is of the view that electronic banking is an offshoot of ICT and it provides the classic and current means of banking. Electronic banking (e-banking) has brought colossal transformation into the banking industry and is still having major effects on banking relationships; e-banking is gradually becoming 'an essential to have' than 'a pleasure to have' service. E-banking systems evolved technologies such as Automated Teller Machines (ATMs), Point of Sales Terminals (POS), Electronic Funds Transfer and Telebanking. Out of all these technologies, the Automated Teller Machines or Automatic Teller Machines (ATMs) has the most significant impact on the common man (Folorunsho *et al*., 2010).

An Automatic Teller Machine (ATM) according to Sharma and Rathore (2012) is an electronic unattended banking outlet, which allows customers to complete basic banking transactions without a direct branch interaction or a branch representative or teller. It is connected to a data system and related equipment and activated by a bank customer to obtain cash withdrawals amongst other services such as cell-phone recharge and inter- account transfer. The ATM comprises a computer with a keypad and screen to perform tasks to access bank accounts through telephone networking, a host processor, and a bank computer to authenticate data. This means that a customer must be in physical interaction with the machine to carry out transactions.



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Automated Teller Machines (ATMs) services are considered as one of the most essential services offered by the banking industry globally. These services are provided within certain locations, either within the area of the bank branches or outside the area of the bank branches (Okafor and Ezeani, 2012; Mehdi *et al* 2013). Transition from the traditional monetary instruments of paper and metal based currency to "plastic money" in the form of credit cards and debit cards accelerated the global use of ATM as one of the fastest means of cash dispensing in use (Ndife *et al*, 2013). Mehdi *et al* (2013) believes that development of the ATMs services not only has affected economic status of countries, it has had several deep social and cultural effects on quality of lives of individuals.

The wide acceptance of e-banking technology has created new environmental challenges on publicly used electronics and technological devices; it provides an avenue for high human dermal contact which could be a source of contamination, infection and health hazard to man. The ATM has been perceived as low performing when it is without cash to 'give out' and therefore much resources has been expended to maintain and ensure that it possesses and dispenses cash as quickly as possible; the hygienic, aesthetic and environmental safety conditions have been at the mercies of employed general cleaners.

Most of these cleaners may not have proper training to differentiate between generalised and specialized cleaning; they may use rags for cleaning toilets, tables and chairs to clean ATMs. These types of cleaning regimes overtime could discolour the machine, dispose and disseminate germs which could be transferred between and within the banking premises via ATMs. These machines are sometimes left at the mercies of impulses of different weather and climatic conditions as most of the ATMs are filthy, covered with dust and grime especially after a heavy rain that one may have to cover ones nose to make use of the machines in cities like Lagos, Port Harcourt, Kano, and Abuja (Faroyji, 2013).

There is no restriction as to who has access to the facility, and no guidelines to ensure hygienic usage. But like all surfaces, microbial colonization of these metallic keypads are eminent, particularly so when there are no proper cleaning regimen in place for most of these facilities. Such colonisations and their subsequent biofilm formation have been the theme of research by several investigators (Hood and Zottola, 1997; Sharma and Anand, 2002). Many factors have been shown to influence the bacteria transfers between surfaces, including the source and destination surface features, bacterial species involved, moisture levels, pressure and friction between the contact surfaces and inoculum size on surfaces (Chen *et al*., 2001; Rusin *et al*., 2002; Montville and Schaffner, 2003; Whitehead and Verran 2006).

## LITERATURE REVIEW

### History of ATM and Its Introduction to Banking Operation

Milligan (2007) and Miller (2011 maintained that an ATM service was used first in 1967 and became fully integrated in mainstream banking in the 1980s. ATM services have since its development, improved day after day to meet customers' demands. Jegede (2014) noted that the first ATM in Nigeria was installed by National Cash Registers (NCR) for the defunct Societe Generale Bank Nigeria (SGBN) in 1989. Since then, the number of these machines installed across the country has increased as it became more popular after the post-consolidation era of 2005 (Ojo, 2010).



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## The Spread of ATMs in Nigeria

A recent report by Udenze (2013) confirms that as at the end of October 2013, there were about 12,100 active ATMs performing transactions across the country at bank branches, hotels and airports while the nation's banks have so far invested a whopping N390 billion in the acquisition of Automated Teller Machines (ATMs) deployed across the country in a bid to ease payment system. This amount excludes the quarterly technical support from these ATMs suppliers; more billions are spent on this. ATMs have transformed the face of electronic payment in Nigeria.

## ATMs in Public Places

ATMs can be regarded as public places considering the number of persons that use them daily especially in metropolitan, cosmopolitan and other urban/peri-urban areas. Public places are spatial locations where large numbers of people meet. They could refer to street, alley, park, public building, any place of business or assembly open to or utilised by the public and any other place which is open to the public view or to which the public has access. These places vary in the number of persons that use them, the amount of time spent there and the type of activities that occur in the area (WHO, 2014). Thus, studies like Folorunsho *et al*. (2010), Abban and Thano Debbra (2011), Sharma and Rathore (2012), Okafor and Ezeani (2012), Al-abedallat (2012) and Saroja *et al*. (2013) reveal that increasing number of persons prefer to use the ATMs than to queue at banking halls for financial transactions especially as most economies of the world are gravitating towards cashless economies.

The days of carrying huge cash around with its attendant risk may have gone as the ICT age has made money virtually plastic. ATMs offer convenience to customers, provide 'round the clock' (twenty four hours by Seven days) banking services, and ensures withdrawals for immediate needs rather than the bulk withdrawals that characterised the past. These conveniences make the ATMs more popular as the number of users increase daily justifying the huge investment by banks. While enormous investment has been made in its acquisition, installation, maintenance and even its security, little has been done in ensuring its sound environmental quality. The ATM is increasingly seen as an open place for financial transactions and may be one of the busiest public places in the world today considering long queues noticed around it in many Nigerian cities.

## ATMs as Dispensers of Diseases

The ATMs may not only be cash providers but dispensers of diseases considering the population of pathogenic micro-organisms that may be present as large number of persons assess them on a daily basis without adequate regard for sound environmental quality. Users usually stop over ATMs without the knowledge that the keypad they touch contains a blend of pathogenic bacteria, germs and even viruses which can eventually be transferred between individuals. The poor environmental conditions may even have impact on the quality of service and the level of functionality of the machine apart from the health challenge that it is likely to pose (Faroyji, 2013).

The Central Bank of Nigeria appears to focus more on 'important' areas of compliance for instance; the Cashless Policy has been imperceptibly seen as more important than the customer's health. Commercial and Microfinance banks have taken high security measures to prevent theft of cash at the ATMs, however they have failed to take preventive, corrective and security initiatives on maintaining safe and clean ATM machines. The technical engineers



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contracted by these banks also, tend to focus more on the inner parts of the ATMs; as long as the software is up to date and any electro-mechanical part is tested and effectively operational, their business is completed.

Organisations like the National Agency for Food and Drugs Administration and Control (NAFDAC), Standards Organisation of Nigeria (SON), and other Consumer Protection Agencies have not initiated studies nor have they carried out any proactive measure on these machines which could be disease dispensers. The foremost environmental regulations agency, the National Environmental Standards and Regulation Enforcement Agency (NESREA), a parastatal under the Ministry of environment has not captured the use of ATMs in its twenty four (24) regulations. Very few works have reported on bacterial contamination of ATMs in the banks.

Some scholars have tried to probe the quality and environmental challenges associated with the computers in hospitals and other public places from the standpoint of environmental hygiene in qualitative and quantitative terms. Nothing has been done about the study of ATMs in Kaduna Metropolis especially relating to environmental quality assessment of pathogenic microbial contamination. However, this study aims at assessing the Antibacterial Susceptibility of Pathogenic Bacterial Isolated from Selected Automated Teller Machines within Kaduna Metropolis.

## MATERIALS AND METHODS

### Study Area

The study area covered the ATMs located within Kaduna Metropolis. A total of two hundred (200) swabbed samples were obtained from seven (7) different locations within Kaduna metropolis. These locations were: Nigerian National Petroleum Corporation (NNPC); Ahmadu Bello Way (ABW); Ali Akilu Way (AAW); Shopping Complex around Station (SCS); Kachia Road/Sabon Tasha (KR/ST); Kano Road (KR) and Nnamdi Azikiwe Way (NAW). The pathogenic bacteria isolated from the ATMs were subjected to antibacterial susceptibility test.

### Antibacterial Susceptibility of isolated Pathogenic Bacteria to known Antibiotics

Antibacterial susceptibility of isolated pathogenic bacteria to known antibiotics was carried according to KIRBY-BAUER method (Willey *et al*., 2011). The isolated pathogenic bacteria were subjected to ten diffusion discs with antibacterial drugs which comprised of Augmentin (30µg), Amoxacillin (25µg), Erythromycin (5µg), Tetracycline (10µg), Cloxacillin (5µg), Gentamycin (10µg), Cotrimoxazole (25µg), Chloramphenicol (30µg), Cefepime (30µg) Ciprofloxacin (10µg) and Streptomycin (30µg). The isolated pathogenic bacteria were inoculated in Nutrient Broth (NB) and after twenty-four (24) hours of incubation at 37$^{o}$C, they were streaked using sterile swabs on Mueller-Hilton agar plates. Plates were kept at environmental temperature for a period of five (5) minutes and then diffusion discs with antibacterial drugs were distributed on the plates and incubated for twenty (24) hours at 37$^{o}$C. Results were interpreted by measuring zones of inhibition with the use of a millimetre scale rule. The results were presented as resistant or sensitive according to National Committee for Clinical Laboratory Standards (NCCLS, 2002).



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## RESULT

### Antibacterial Susceptibility Test carried out on the Isolated Pathogenic Bacteria

The result of the antibacterial susceptibility test carried out on the isolated pathogenic bacteria is presented in Table 1. Out of the five (5) *E. coli* isolates that were subjected to antibacterial susceptibility test, 5 (100%), 3 (60.00%), 2 (40.00%) and 2 (40.00%) were sensitive to Ciprofloxacin, Gentamycin, Streptomycin and Cefepime respectively while it was resistant to Augmentin, Amoxacillin, Erythromycin, Tetracycline, Cloxacillin and Cotrimoxazole (Table 1). On the other hand, *P.aeruginosa* was sensitive to Ciprofloxacin with 5 (100%), Gentamycin with 1 (20.00%) and Streptomycin with 1 (20.00%) and resistant to Cefepime, Augmentin, Amoxacillin, Erythromycin, Tetracycline, Cloxacillin and Cotrimoxazole (Table 1). The five (5) isolates of *S.dysenteriae* had 5 (100%) sensitive to Ciprofloxacin, 1 (20.00%) sensitive to Gentamycin and 1 (20.00%) sensitive to Streptomycin and resistant to Cefepime, Augmentin, Amoxacillin, Erythromycin, Tetracycline, Cloxacillin and Cotrimoxazole (Table 1).

Table 1 also revealed that, *S.aureus* was sensitive to Ciprofloxacin, Gentamycin, Streptomycin and Cefepime in this order: 5 (100%), 2 (40.00%), 2 (40.00%) and 2 (40.00%). *S.aureus* was resistant to Augmentin, Amoxacillin, Erythromycin, Tetracycline, Cloxacillin and Cotrimoxazole. *K.pneumoniae* was sensitive to Ciprofloxacin (5(100%)), Gentamycin (4(80.00%)), Streptomycin (3(60.00%)), and Cefepime (4(80.00%)) and resistant to Augmentin, Amoxacillin, Erythromycin, Tetracycline, Cloxacillin and Cotrimoxazole (Table 1).

In addition, out of the five (5) *S.typhimurium* isolates that were subjected to antibacterial susceptibility test, 5 (100%) were sensitive to Ciprofloxacin, 3 (60.00%) sensitive to Gentamycin, 2 (40.00%) sensitive to Streptomycin and 4 (80.00%) were sensitive to Cefepime but resistant to Augmentin, Amoxacillin, Erythromycin, Tetracycline, Cloxacillin and Cotrimoxazole (Table 1).



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**Table 1: Antibacterial Susceptibility Test on Pathogenic Bacteria isolated from the ATMs (in number/percentage)**

| | | ANTIBIOTICS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ISOLATES** | **NO OF ISOLATES** | **CIP** | **GEN** | **STR** | **CEF** | **AUG** | **AMO** | **ERY** | **TET** | **CLO** | **COT** |
| *E. coli* | 5 | 5(100) | 3(60.00) | 2(40.00) | 2(40.00) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| *P. aureginosa* | 5 | 5(100) | 1(20.00) | 1(20.00) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| *S. dysenteriae* | 5 | 5(100) | 1(20.00) | 1(20.00) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| *S. aureus* | 5 | 5(100) | 2(40.00) | 2(40.00) | 2(40.00) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| *K. pneumonia* | 5 | 5(100) | 4(80.00) | 3(60.00) | 4(80.00) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| *S. typhimurium* | 5 | 5(100) | 3(60.00) | 2(40.00) | 4(80.00) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) | 0(0) |
| **TOTAL (%)** | **30** | **30(100)** | **14(46.67)** | **11(36.67)** | **12(40.00)** | **0(0)** | **0(0)** | **0(0)** | **0(0)** | **0(0)** | **0(0)** |

**KEY:**

CIP-Ciprofloxacin; GEN-Gentamycin; STR-Streptomycin; CEF-Cefepime; AUG Augmentin; AMO-Amoxacillin; ERY-Erythromycin;TET-Tetracycline; CLO-Cloxacillin; COT-Cotrimoxazole



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## DISCUSSION

### Antibacterial Susceptibility Test on the Pathogenic Bacteria isolated from the Selected ATMs

The result shown in Table 1 revealed that the isolates were sensitive to Ciprofloxacin; Gentamycin; Streptomycin and Cefepime and resistant to Augmentin; Amoxacillin; Erythromycin; Tetracycline; Cloxacillin and Cotrimoxazole. The result indicates that the highest sensitivity value of 30 (100%) was recorded when Ciprofloxacin was used and this suggests that Ciprofloxacin will have a better killing effects on the isolated pathogenic bacteria in case any of the ATMs users is infected with any of the pathogenic bacteria. This result is in line with that of Oloninefa *et al*. (2015).

### Implication to Research and Practice

The result obtained from this research work implies that some of the isolated pathogenic bacteria were sensitive while others were resistant to known antibiotics (Ciprofloxacin, Gentamycin, Streptomycin, Cefepime, Augmentin, Amoxacillin, Erythromycin and Tetracycline) that they were subjected to. Hence, not all known antibiotics can get rid of the isolated pathogenic bacteria.

## CONCLUSION

Pathogenic bacteria such as *E. coli*; *S. dysenteriae*; *S. typhimurium*; *P. aeruginosa*; *K. pneumonia*e and *S. aureus* were isolated from the Automated Teller Machines (ATMs) located in NNPC/KRPC (Nigerian National Petroleum Corporation/Kaduna Refinery and Petrochemicals Company); ABW (Ahmadu Bello Way); AAW (Ali Akilu Way); SCS (Shopping Complex around Station); KR/ST (Kachia Road/Sabon Tasha); KR (Kano Road Axis) and NAW (Nnamdi Azikiwe Way) within Kaduna Metropolis. They were subjected to antibacterial susceptibility test. The result obtained showed that all the isolated pathogenic bacteria were sensitive to Ciprofloxacin.

## FUTURE RESEARCH

The future research that will be carried out will be the killing kinetics of the isolated pathogenic bacteria isolated from selected ATMs.

## REFERENCES

Abban, S. and Tano-Debrah, K. (2011). Automatic Teller Machines (ATMs) as Potential Sources of Food-Borne Pathogens – a Case from Ghana. *Nature and Science*, 9(9), 63-67. *http://www.sciencepub.net.*

Al-abedallat, A. Z. (2012). Expansion of the Customers in the using of ATMs: Case Study on the Jordanian Commercial Banks. *International Journal of Economics and Research*, 3(5), 129-141.



ISSN 2054-6351 (print), ISSN 2054-636X (online)

Anwana, E. O. (2010). Geographic Factors Inhibiting E-Banking in Nigeria: A Case Study Of Akwa Ibom And Cross River States, *International Journal of Economic Development Research and Investment* 1(1): 68-81

Chen, Y., Jackson, K. M., Chea, F.P. and Schaffner, D. W. (2002). Quantification and variability analysis of bacterial cross contamination rates of common food service tasks. *Journal of Food Protection*, x; 64: 72-80.

Faroyji, S. (2014). Nigerian ATMs are Disease Dispensers. *The Punch Newspapers (*Lagos), 2 March, retrieved from *http://thenationonlineng.net/new/nigeria-atms-are-disease-dispensers*/, accessed on 5 March 2014.

Folorunsho, O. Ateji, A. O. and Awe, .O. (2010). An Exploratory Study of the Critical Factors affecting the Acceptability of Automatic Teller Machine (ATM) in Nigeria. *Anale Seria Informatica.* 8(1): 151-162.

Hood, S. K. and Zottala, E. A. (1997). Adherence of stainless steel by food borne microorganisms during growth in model food systems. *International Journal of Food Microbiology*, 37:145-153.

Jegede, C.A. (2014). Effects of Automated Teller Machine on the Performance of Nigerian Banks." *American Journal of Applied Mathematics and Statistics* 2(1): 40-46.

Mehdi, M. T, Bushehrian, O. and Moghadam, R. (2013). Locating ATM in Urban Areas, *International Journal on Computer Science and Engineering (IJCSE.),* 5(08): 753-759.

Miller, A. (2011). Who Invented the ATM Part 1, *ATMInventor.com* 2011 Retrieved from *http://www. atminventor.com/,* accessed on March 25, 2014.

Milligan, B. (2007). The Man who invented the Cash Machine, *BBC News*. Monday, 25 June, 2007, retrieved from *http://news.bbc.co.uk/2/hi/6230194.stm*, accessed on 2 April 2014.

Montville, R. and Schaffner, D. W. (2003). Inoculum size influences on bacterial cross contamination between surfaces. *Environmental Microbiology*, 69(12): 7188-7193.

National Committee for Clinical Laboratory Standards (2002). MIC testing supplemental tables M100-S10 ($M_7$).

Ndife, A.N.; Ifesinachi, E.O.; Okolibe, A.U., and Nnanna, .D.K. (2013). An Enhanced Technique in ATM Risk Reduction using Automated Biometrics Fingerprint in Nigeria, *International Journal of Scientific Engineering and Technology*, 2(11)1132-1138.

Noble, J. (2001). *Text book of primary care medicine*. 3rd Edition. St Louis, Mo: Mosby. pp8.

Nworie, O., Mercy M., Chukwudi A., Oko I., Chukwudum O., Agah V. M. and Ekuma U. O. (2012). Antibiogram of Bacteria isolated from Automated Teller Machines within Abakaliki Metropolis. *American Journal of Infectious Diseases*, Published Online 8 (4) 2012 (http://www.thescipub.com/ajid.toc), 8(4), 168-174.

Ojo, J. (2010). Automatic Teller Machines: A Revolution and its Pains. Extracted from: http://jideojong.blogspot.com/2010/03/automatic-teller-machines-revolution.html, accessed on 2 April, 2014.

Okafor, E. E. and Ezeani, F. N. (2012). Empirical Study of the Use of Automated Teller Machine (ATM) Among Bank Customers in Ibadan Metropolis, South Western Nigeria, *European Journal of Business and Management*, 4(7): 19-34.

Oloninefa, S.D., Daniyan, S.Y. and Abalaka, M.E. (2015). Antibiotics Susceptibility profile and rate of killing of Cronobacter sakazakii. *Journal of Medicine & Applied Biosciences*, 2(2), 71-78.

Rusin, P., Maxwell, S. and Gerba, C. (2002). Comparative surface-to-hand and fingertip-to-mouth transfer efficiency of gram positive bacteria, gram negative bacteria and phage. *Journal of Applied Microbiology*, 3: 585- 592.

Ryan, K.J. and Ray, C.G. (2004). Sherris Medical Microbiology (4th ed.). McGraw Hill.



ISSN 2054-6351 (print), ISSN 2054-636X (online)

Saroja, V., Kamatchiammal, S., Brinda, K. and Anbazhagi, S. (2013). Enumeration and Characterisation of Coliforms from Automated Teller Machine (ATM) Centers in Urban Areas. *Journal of Modern Biotechnology*, 2(1)14–22.

Sharma, M. and Anand, S. K. (2002). Biofilms evaluation as an essential component of HACCP for food/dairy processing industry – a case. *Food Control*, 13: 469–477.

Sharma, N. and Rathore, V. S. (2012). Analysis of Different Vulnerabilities in Auto Teller Machine Transactions, *Journal of Global Research in Computer Science* 3(3): 38-40.

Udenze, B. (2013). Banks Expend N390bn on ATM Acquisition. *The Sun Newspapers (*Lagos), 12 November, retrieved from www.sunnewsonline.com accessed on 23 March 2014.

Whitehead, K. A. and Verran, J. (2006). The effect of surface topography on the retention of microorganisms. *Food and Bioproducts Processing*, 84(C4): 253–259.

Willey, M. J., Sherwood, M. L., and Woolverton, C. J. (2011). Antimicrobial Sensitivity, In: *Prescott's Microbiology*. 8th Ed, New York: McGraw-Hill, Companies, Inc: 806-819

Winfield, M. and Eduardo G. (2003). "Role of Nonhost Environments in the Lifestyles of Salmonella and Escerichia coli". Applied and Environmental Microbiology 69 (7): 3687–3694.

World Health Organisation (2014). Fact sheets on Environmental Sanitation. Extracted from: www.who.int/water_sanitation_health/hygiene/emergencies/envsanfactsheets, accessed on 20 March 2013.

Yabuuchi E. (2002). Bacillus dysentericus (sic) 1897 was the first rather than Bacillus dysenteriae 1898. *Int. J. Syst. Evol. Microbiol*., 52, 1041-1041.



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