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Microbial Load And Public Health Risks of Contaminated Keypads of Selected Automated Teller Machines of Some Banks in Abraka-Nigeria.

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Abstract
In a fast-paced world like ours, the use of Automated teller machines has become necessary to carry out financial transactions daily. The contamination of such machines raises serious public health concerns for users, as microorganisms thrive everywhere. This study is aimed at microbiologically evaluating the keypads of automated teller machines of some banks in Abraka-Nigeria. A total of 32 sterile swab sticks moistened with normal saline were used to swab the keypads of each ATM at different time intervals (morning and evening), after which the swab sticks were transferred immediately to the laboratory and analysed using standard microbiological methods. The bacterial counts ranged from 2.5×10^6 to 9.4×10^6 cfu/ml, while the fungal counts ranged from 1.4×10^6 to 6.9×10^6 cfu/ml. The bacterial contaminants were *Escherichia coli, Staphylococcus aureus, Bacillus cereus, Citrobacter* sp., *Enterobacter* sp., *and Klebsiella* sp., while the fungal isolates were *Candida* sp., *Penicillin notatum*, *Aspergillus fumigatus*, *Aspergillus niger,* and *Mucor* sp. *Bacillus cereus* had the highest frequency of occurrence, which accounted for 80.00% while *Enterobacter* sp. occurred the least and accounted for 30.00% among the bacterial isolates. Although *Candida* sp. had the highest occurrence rate of 80.00%, *Penicillin notatum* had the lowest frequency of occurrence among the fungi. Most of the microorganisms isolated can give rise to disease conditions, especially the enteric bacteria, which are easily picked up by the fingers. It is therefore necessary that hands are washed after coming in contact with ATM keypads and proper hygiene habits are practised in order to forestall cross contamination of pathogenic microbes.

Keywords: Contaminants, Automated Teller Machines, Microbes, Health, Risks

Introduction

In today's world, automated teller machines (ATMs) have become an integral part of modern-day business transactions. They provide a secure, convenient, and fast way for not only individuals but also businesses to access their funds and conduct financial transactions, without having to visit a physical bank.

Humans can carry out various transactions at different times; however, only one person can engage the machine at a time (Osatohanmwen and Omoike, 2020). As a result of the advantages associated with automated teller machines, they are operated by numerous persons, thereby increasing the likelihood of contamination of the surface area of the machines with different kinds of microorganisms. Given the ubiquity of microorganisms, their existence on the buttons of ATMs cannot be ruled out. A previous study has shown that the keypads of ATMs can harbour a variety of microorganisms, including bacteria and viruses, that can cause illnesses (Mabel *et al.,* 2014). The transmission of these microorganisms can occur through direct contact with contaminated surfaces, contaminated fingers, or through the air via droplets from individuals by way of laughing, sneezing, or coughing (Onuoha and Fatokun, 2014; Aquino *et al.,* 2019). Animate or inanimate objects are known to serve as reservoirs of microorganisms (Nworie *et al.*, 2012), which is important in the epidemiology of any infection as microorganisms live and multiply in the reservoir on which their survival depends.

Many epidemiological studies have shown that contaminated surfaces play a major role in the spread of infectious diseases (Anastasiades *et al*., 2009; Ashgar and El-Said, 2012; Jerkovic-Mujkic *et al*., 2013). The ATM keypad has been proven to harbour bacteria that can cause serious gastroenteritis, and it is also known that environmental surfaces can transmit microbes to hosts (Oluduro *et al*., 2011; Ashgar and El-Said, 2012). An infection chain begins when the infective agent enters a suitable entry portal to infect a susceptible host after exiting its reservoir or host through a portal of exit and being transmitted by some methods. Numerous elements, such as the characteristics of the source and destination surfaces, the types of bacteria involved, moisture level, inoculum size, pressure, and friction between the contact surfaces, have been proven to affect the transmission of germs between surfaces. (Taylor *et al*., 2013). Once an ATM is contaminated, it becomes a vehicle for transmission of infection, such that its users may actually end up picking up these pathogens after making use of the machines, since there are no restrictions as to who has access to the facility and no guidelines to ensure hygienic usage (Onuoha and Fatokun, 2014).

Most people do not realise that microbes are found on many common outdoor objects, in their offices, and even in their homes. Items such as the ATM keypads can have public health implications for users; hence, it is crucial to microbiologically evaluate the keypads of the Automated Teller Machine (ATM) from time to time.

Materials and Methods

Study Area

Abraka is a semiurban centre. It is located in Ethiope East local government area of Delta State. Being a university town, it is largely populated with students enrolled in various programmes from different parts of Nigeria.

Approval of the study

Permission was sought from the management of all the banks where the automated teller machines were located. The ATMs in these banks were coded as A, B, C, D, E, F, G, and H.

Collection of Samples

A total of thirty-two (32) swab sticks were used to swab the keypads of the ATMs at the bank premises. Sterile swab sticks moistened with normal saline were used to swab the keypads, after which the swab sticks were transferred immediately to the laboratory for microbiological analysis. Samples were collected twice a day (morning and afternoon).

Treatment of samples and Enumeration of microorganisms

The method described by Agu (Agu *et al.,* 2012) was used. The swab stick bearing the sample was dipped in a test tube containing nutrient broth and agitated for 5 minutes; thereafter, total viable bacterial and fungal counts were determined using serial dilution and spread plate methods (Agu *et al.,* 2012). In the process, 1 ml of the nutrient broth containing the swap sample was serially diluted to achieve a 1:10000, and then 0.1 ml of each aliquot was spread on sterilised petri dishes of Nutrient agar (for the determination of the total aerobic microbial count), Sabouraud Dextrose Agar, (for the total fungal count), Mannitol Salt Agar, MacConkey, and Centrimide Agar (for the determination of specific microorganisms). This was carried out in duplicate. The plates were incubated at 37 ºC for 24 hours, while fungi culture plates were incubated at room temperature for 2 to 5 days. Emerging colonies on both nutrient agar and Sabouraud dextrose agar plates were enumerated and recorded. The plates were examined daily for growth, and bacterial and fungal counts were taken. The resulting pure cultures were used for characterization and subsequent identification.

Characterization and Identification

Characterization and identification were done based on the cultural appearance of the organism, colonial morphology, use of differential and selective media, and also by biochemical tests, mostly for bacterial isolates. Fungal isolates were identified by cultural and morphological characteristics, the lactophenol cotton blue technique, and a biochemical test (germ tube test). These characteristics were compared to those stated in the microbiology laboratory photographic atlas. (Leboffe and Pierce, 2011).

Results

The bacterial and fungal counts of samples obtained from keypads of some automated teller machines in different banks at Abraka for the period of analysis are presented in Table 1. The results revealed that both pathogenic and non-pathogenic microbes colonised the keypads of the Automated teller machines. The bacterial counts ranged from 2.5 x 10^6 to 9.4 x 10^6 cfu/ml, while the fungal counts ranged from 1.4 x 10^6 to 6.9 x 10^6 cfu/ml. The bacteria isolated from the keypads of the automated teller machines are given in Table 2. *Bacillus cereus* had the highest frequency of occurrence, accounting for 80.00%, while *Enterobacter* sp. occurred the least and accounted for 30.00%. Table 3 shows the fungal isolates from the keypads of the automated teller machine. *Candida* sp. had the highest frequency of occurrence (80.00%), while *Penicillin notatum* was the least common among others, accounting for 50.00%.

Table 1: Total Microbial Counts from Keypads of Automated Teller Machine (ATM) of Different Banks

Banks	Bacterial count (cfu/ml)		Fungal count (cfu/ml)	
	Morning	Afternoon	Morning	Afternoon
A	9.0x10^6	8.1 x10^6	4.0x10^6	1.6 x10^6
B	5.5 x10^6	2.5 x10^6	1.4 x10^6	2.4 x10^6
C	5.0 x10^6	8.6 x10^6	4.9 x10^6	6.9 x10^6
D	9.2 x10^6	9.4 x10^6	1.9 x10^6	2.0 x10^6
E	8.4 x10^6	9.3 x10^6	3.0 x10^6	2.8 x10^6
F	6.9 x10^6	8.0 x10^6	2.0 x10^6	2.2 x10^6
G	6.9 x10^6	6.3 x10^6	2.3 x10^6	2.3 x10^6
H	3.6 x10^6	3.7 x10^6	1.6 x10^6	2.3 x10^6

Table 2: Bacterial isolates from the keypads of Automated Teller Machines of Different Banks

Organisms	A	B	C	D	E	F	G	H	Frequency of occurrence (%)
Escherichia coli	+	+	+	+	-	-	+	-	50
Staphylococcus aureus	-	+	+	+	-	+	-	-	40
Bacillus cereus	+	+	+	+	+	+	+	+	80
Citrobacter sp.	-	+	+	+	-	-	-	+	40
Enterobacter sp.	-	-	+	+	-	+	-	-	30
Klebsiellla sp.	+	+	+	+	+	-	+	-	60

Table 3: Fungal isolates from the keypads of Automated Teller Machines of Different Banks

Organisms	A	B	C	D	E	F	G	H	Frequency of occurrence (%)
Aspergillus niger	+	+	+	-	-	+	+	+	60
Aspergillus fumigantus	+	+	+	+	+	-	+	-	60
Mucor sp.	+	+	+	+	+	-	+	+	70
Candida sp.	+	+	+	+	+	+	-	-	80
Penicillium notatum	-	+	+	+	+	-	+	-	50

Discussion

Bank Automated Teller Machines have become an essential requirement of our social lives. These ATMs are frequently located in city centres, commercial areas, and around healthcare facilities. Hundreds of individuals from various walks of life use the ATM daily (Tekerekoglu *et al*., 2012). Most people do not realise that microbes are found on many common objects outdoors, in their offices, and even in their homes. Such objects include playground equipment, kitchen sinks, office desks, computer keyboards, escalator handrails, elevator buttons, and, with the proliferation of supermarkets and hypermarkets, shopping cart handles are among the items. All of the later items are places where people's bare hands are used the most. Some people have a false sense of security in other areas because they think that germs are exclusively present in research labs, hospitals, and clinics (Malik and Naeem, 2014).

The total bacterial and fungal counts of the keypads of automatic teller machines in different banks showed that there were variations at different sampling sites (Table 1). The ATM of Bank D, along Ekrejeta Road had the highest bacterial counts for both morning and afternoon, respectively. The high bacterial count recorded may be due to the large number of individuals that use the ATM, as the bank is situated in a central area that is densely populated with a busy road network linking other areas of the town. It could also be credited to cross-contamination from various human activities such as touching the ATM keypads, coughing, sneezing, and talking during the process of using the ATM; other factors include environmental contamination. High levels of contamination of ATM keypads with microorganisms have also been previously reported (Mbajiuka, 2015).

However, Bank B's automated teller machine had the fewest bacterial counts. The low bacterial count may be due to low human traffic to the ATM because it is seldom used. This finding corroborates a previous study (Agu *et al.,* 2018), which reported that exposure to many users, environmental components like rain, and climatic elements such as wind may be responsible for the high microbial load on the keypad of ATMs. One major factor to consider in disease transmission is that disease-causing microorganisms are transmitted by hand contact (Adedeji, 2019).

Very high fungal counts were recorded from the ATM of Bank C along Police Station Road both in the morning and afternoon. In contrast, the Bank B ATM had the least fungal load, possibly because the ATM is only used by a few individuals. In epidemiological studies, the number and type of microorganisms present on a surface are among the microbe-associated factors that determine if an infection will occur or not (Fraser and Girling, 2007).

The bacteria isolated from the keypads of the automated teller machine include *Escherichia coli, Staphylococcus aureus, Bacillus cereus, Citrobacter* sp., Enterobacter sp., *and Klebsiella* sp. (Table 2). This finding is consistent with previous reports (Awua *et al*., 2022; Ya'aba *et al.,* 2020).

Bacillus cereus had the highest incidence frequency. The high occurrence frequency may be linked to its spore forming nature, with regards to the possible consequence of the spores settling on inanimate objects or surfaces (Sosan and Kinal, 2011). *Bacillus sp.* is well documented for its high pathogenicity, causing even death in some major outbreaks and infections (Mbajiuka, 2015). *Escherichia coli followed closely, with a 50% frequency of occurrence*. This result is in agreement with a previous study (Awua *et al.,* 2022), which reported a 43% and 47% prevalence of *E.coli* respectively. This clearly suggests that the ATMs may be frequently contaminated with faeces. Poor hygiene habits in humans such as not washing their hands after defecation, may account for such an outcome (Nworie *et al.,* 2012). Unwashed hands when used to consume food after using the ATM can give rise to health hazards such as gastrointestinal infections (Oluduro *et al*., 2011).

Klebsiella sp. accounted for 60% of the prevalence, although Ya'aba reported a lower prevalence of *Klebsiella pneumoniae* in his study. Isolating *Klebsiella* from the keypad of ATMs may present a public health risk to users who do not wash their hands after using these machines (Okoro *et al.,* 2018). Findings from this study also revealed that *Stalphylococcus aureus,* a normal flora of the human body, accounted for 40% of its occurrence. Although it is a normal flora of the skin, its presence should not be taken for granted. Abscesses, boils, and wound infections are some health hazards that can erupt because of *Stalphylococcus aureus*. Furthermore, the incidence of Methicillin Resistant Staphylococcus aureus (MRSA) seems to be on the rise, especially in patients with lowered immunity (Anastasiades *et al.,* 2009).

Enterobacter sp. was the least prevalent bacterial contaminant isolated; this agrees with a previous study (Yaaba *et al*., 2020). Contamination of ATM keypads with Enterobacter sp raises some concern as it has been proven to have the potential to cause nosocomial infections (Ducel *et al.,* 2002). Though Citrobacter sp. is frequently connected with neonatal sepsis and meningitis, species members are rare causes of sporadic pneumonia, septicemia, wound infection, and burn infection.

The isolation of fungi from the ATM's keypad is not surprising. Fungal isolates obtained include *Candida* sp., *Penicillin notatum* , *Aspergillus fumigatus* , *Aspergillus niger* , and *Mucor* sp. While *Candida* sp. occurred the most, *Penicillium notatum* was the least common of all. One main reason for *Candida* sp. to be prevalent is due to the fact that *Candida sp.* can be associated with human skin and other surfaces. *Aspergillus* sp. is well known for its ability to give rise to pulmonary pneumonia, especially in immunocompromised patients.

The findings of this research indicated that ATM keypads can be considered as reservoirs of bacteria as well as fungi. ATM keypads are similar to other contaminated surfaces in public places, such as telephones and door handles. A Previous report revealed the existence of viable pathogenic bacteria on inanimate objects (Sosan *and Kinal,* 2011). People with different levels of hygiene and health standards use these machines; their hands can pick up, harbour, and transfer infectious microorganisms. Nworie reports that touching the ATM keypads with unclean hands can spread germs to the keypads and currency notes (Nworie *et al*., 2012). Eventually, this will aid in the spread of infectious diseases. All these raise public health concerns.

Conclusion

Generally, ATMs are located throughout town, and there is a high probability of the transmission of pathogenic organisms, especially when they are close to hospitals, since they are capable of adsorbing and transmitting pathogens. The present study revealed that ATM keypads in banks are homes for pathogenic organisms. It is imperative that these devices be considered as potential vehicles for the transmission of infections.

Recommendation

With the unrestricted use of ATMs, it is advised that guidelines be put in place to control the spread of infections through these devices. Also, members of the public should take measures to prevent the spread of infectious organisms when using these machines. The practise of good personal hygiene and regular disinfection of the keypad surface will drastically reduce the microbial burden on the keypads of ATMs.

Conflict of interest

None declared.

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