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RESEARCH ARTICLE

Microbial Carriage of Shuttle Door Handles and Campus Bank's Automated Teller Machines

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Abstract

Microorganisms are ubiquitous organisms that can cause microbial contamination in both indoor and outdoor settings, with frequently touched surfaces acting as fomites that increase the ability of pathogens to be transferred from host to host. This study was aimed at isolating, identifying, and characterizing bacteria and fungi present on frequently used Automated Teller Machines (ATMs) and campus shuttle bus handles at Adekunle Ajasin University, Akungba-Akoko, Ondo State. Swab samples were obtained from the keypads of ATMs and door handles of campus shuttle buses. Enumeration of total microbial counts was carried out using the pour plating technique. The bacterial isolates were identified using Bergey's Manual of Determinative Bacteriology based on the results obtained from microscopic examination, cultural and morphological examination and biochemical tests. Fungal isolates were identified using the Atlas and Compendium of Soil Fungi, based on the results obtained from cultural and morphological examination, as well as microscopic examination. The antibiotic and antifungal susceptibility pattern of the isolated microorganisms was also determined. Results showed that the ATM keypads and shuttle door handles contained *Staphylococcus aureus* (8.82%), *Bacillus* spp. (32.35%), *Proteus mirabilis* (8.82%), *Escherichia coli* (5.88%), *Salmonella* spp. (5.88%), *Enterobacter cloacae* (5.88%), *Klebsiella pneumoniae* (2.94%), *Citrobacter freundii* (2.94%), *Vibrio cholerae* (2.94%), *Serratia marcescens* (2.94%), *Aspergillus* spp. (5.88%), *Cladosporium* sp. (2.94%), *Geomyces* sp. (2.94%), *Oidiodendron griseum robak* (2.94%), *Penicillium paneum* (2.94%) and *Fusarium culmorum* (2.94%). This study shows that campus shuttles and ATMs, aside from their primary functions, could also serve as a means of transmitting both pathogenic and non-pathogenic microorganisms, which pose public health risks. Personal hygiene and sanitation, such as hand washing and the use of hand sanitizer to clean hands, could serve as a means of reducing the incidence of microbial transmission.

Key Words: *Microbial carriage; Automated Teller Machines (ATM); Bacteriology; Public health; Microbial transmission*

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Introduction

Microorganisms, which consist of bacteria, fungi, protists and viruses, are extremely tiny organisms which can only be seen with the aid of microscope they, however, have both positive and negative roles in various environments [1,2]. There are approximately 159,000 known species of microorganisms, which are believed to represent less than 5% of the total microbes in existence [2]. Microorganisms have an exceptional ability to adapt to new environments and multiply quickly, which is why they can be found on soil surfaces, acidic hot springs, radioactive wastewater, deep in the earth's crust, as well as organic matter and living organisms such as flora and fauna [2]. It is important to note that water, food, and fomites can act as environmental reservoirs to increase the ability of pathogens to spread from host to host [3]. Additionally, an inanimate object that can transmit an infectious agent is known as a fomite [4].

Fomites are inanimate porous and non-porous surfaces that can become contaminated with pathogenic microorganisms and serve as reservoirs of microbial pathogens and vectors for cross-transmission in the domestic environment and in community settings [4,5]. Potential pathogens from sources such as raw foods, infected persons and animals can be transferred between inanimate and animate surfaces through either direct or indirect contact. Environmental surfaces become contaminated with viruses, bacteria or parasites shed by infected or colonized individuals by direct contact with body secretions such as blood, feces, urine, saliva, and nasal fluid, contact with soiled hands, contact with aerosolized virus or bacteria generated by talking, sneezing, coughing, or vomiting [3]. Recent epidemiological studies have revealed that fomites are a major source of bacterial, viral, and fungal transmission in hospitals, children's health centers, long-term care centers, educational institutions, and sports facilities [3,6]. Contact surfaces in institutions of higher learning, being one of the heavily trafficked areas, have often been overlooked as vulnerable sources of infection transmission [7]. Whereas, in heavily visited places such as schools, hospitals, marketplaces and malls and any other place where human traffic is heavy, the rate of contamination of inanimate objects is usually very high [8]. Pathogens present in bodily fluids such as saliva, mucus, nasal secretions, blood, urine, and feces can be discharged onto these surfaces in public places. These surfaces can then become contaminated and serve as a mode of transmission for infections, as other individuals who come into contact with these surfaces may pick up the pathogens either orally or topically and become infected or transfer the pathogens to other people through contaminated hands [9,10]. In 2005 the United States Centers for Disease Control and Prevention (CDC) found that microbes could be exchanged between contaminated hands and digital devices such as Automated teller machines (ATMs) due to the large number of people who frequently come into contact with these devices [11].

The outbreak of population (community) acquired infections have been proven to be emanating from surface bio-contamination of fomites while in constant contact with human or natural environments of pathogenic organisms according to studies [3]. Hidden microorganisms in indoor and outdoor sites are unavoidable and they pose harmful health hazards in our different human activities. In recent years, apprehension of microbial contamination has increased with the implementation of new technology in households, hospitals, industries and schools, banks and other settings [3,12]. To manage this,

there has also been increased interest in assessing the risk of microbial types and pollution and is considered an important step towards infection prevention [3,12]. The spread of infectious disease through hand contact has been an area of major public health concern because of the frequent contact of the hand with fomites which are potential carriers of pathogenic organisms may lead to an alarming rate of outbreaks of infections transmitted by the fomites. Globally, there are 1.7 million deaths from diarrhoeal diseases and 1.5 million deaths from respiratory infectionsannually. Recently, mortality from diarrhoea has declined over the past two decades from an estimated 5 million deaths among children fewer than five to 1.5 million deaths in 2004. Despite these declines, diarrhoea remains the second most common cause of global death cases among children under five [13,14]. This infection is one among several others which could be contracted by humans via fomites. According to [15], Gram positive *Staphylococcus aureus*, and Gram-negative bacteria such as *Escherichia coli, Klebsiella* species, *Pseudomonas* species, were found to contaminate various contact surfaces including chairs, tables, windows, door handles and many other common household fixtures. The presence of these pathogenic bacteria on environmental surfaces poses a potential risk to vulnerable and immune-compromised individuals [16].

Materials and Methods

Collection Of Samples

A total of 28 swab-samples were collected from the handles of campus shuttle buses and ATM keypads located at four commercial banks; United Bank of Africa, Access Bank, Zenith Bank, and Polaris Bank, within Adekunle Ajasin University, Akungba-Akoko. Ondo state is located on the latitude 5°45' and 7°52' and longitude 4°20' and 6°05' E.

Samples were collected by swabbing the buttons of the ATMs and handles of the shuttle buses with sterile cotton swab sticks moistened with sterile physiological saline water. The cotton swab-sticks were then immediately transferred to the laboratory within 15 minutes of collection for microbial analysis.

Preparation of the samples

Nine milliliters (9ml) of distilled water were dispensed into 5 test tubes, corked with cotton wool and then sterilized at 121^0C for 15 minutes using an autoclave. After sterilization, the cooled test tubes containing the sterile distilled water were labeled as 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4} and 10^{-5} respectively. The swabbed samples were then introduced aseptically into each labelled test tube. 1 ml of the stock dilution (10^{-0}) was then serially diluted in aliquots up to the rest 9ml sterile distilled water in test tubes (10^{-1}- 10^{-4}) to the fourth diluent [17].

Bacteriological analysis of samples

Using the pour plate method of inoculation, 0.5ml of the five-fold dilution of $10^{-2}$and 10^{-4} samples (inoculum) was aliquoted into sterile Petri dishes containing sterile prepared media. Cultural and microscopic examinations were done to identify the pure isolate. The preliminary identification of the isolate was based on characteristics of its cellular morphology such as shape, elevation, appearance, and creamy pigmentation. Additionally, various biochemical tests were conducted, including tests for catalase, indole, coagulase, citrate, starch hydrolysis, motility, gram staining, fermentation of sugars (sucrose, lactose, dextrose, glucose, fructose, and maltose), urease, hydrogen sulfide, gas production, and oxidase, in order to identify the isolate conventionally. The bacteria were further identified using Bergey's Manual of Systematic Bacteriology (Nineth Edition) (Williams and Wilkins Co., Baltimore, 1993) [18].

Isolation and identification of fungi

Pour Plate method was used for inoculation, 0.5ml of dilution (10^{-2} and 10^{-4}) each dilution was carefully inoculated into the centre of three different sterile Petri dishes, after which the sterilized prepared PDA media (Potato Dextrose agar) was poured aseptically into each Petri dish and mixed together with the inoculums by combination of to and fro and circular. Antibiotic (Chloramphenicol) was added to inhibit the growth of bacteria. The plates were then allowed to gel and then placed in a sterile incubator in inverted form. After 72 hours, growth (colonies) became visible and due to morphological appearance, each colony was sub-cultured using PDA and antibiotics were also added to further inhibit the growth of bacteria [18].

The pure isolates were subjected to microscopic examination. Clean greased free slide was used for the identification. A drop of water was mounted in the center of the slide, and then a small portion of the fungal mycelium was cut out with a sterile inoculating needle. The cut piece was put directly in the water droplet and tease out. A drop of Lactophenol blue cotton stain was put directly in the teased-out mycelium. A cover slide was then placed over the teased portion and mounted on the microscope stage. The viewing was first done with the lower magnification (10×), then the higher magnification objective lens (40×). The nature of the mycelium, the types of fruiting body and the spore structure served as the criteria for the identification of the isolates. The isolates were identified and confirmed with the mycological Atlas and compendium of soil fungi [19].

Results

In this study, 28 Swab samples of ATM keypad and the campus shuttle buses were collected at Adekunle Ajasin University, Akungba-Akoko, Ondo state. Total of plates were recovered. The organisms were isolated using macroscopic examination as well as microscopic examinations. Preliminary biochemical tests and sugar fermentation were also done to further identify the bacterial organisms. The antibiotics resistant pattern of the isolated bacteria and fungi isolated were determined using Kirby-Bauer method and Agar-well diffusion method and with the aid of ultraviolet spectrophotometer the growth dynamic and death rate of the isolates were determined.

A total of 34 organisms were isolated using plate count agar, MacConkey agar, nutrient agar and potato-dextrose agar. Bergey's manual of determinative bacteriology and mycological Atlas and compendium of soil fungi was used in identifying the organisms and were identify as *Staphylococcus aureus* (8.82%), *Bacillus* spp. (32. 35%), *Proteus mirabilis* (8.82%), *Escherichia coli* (5.88), *Salmonella* spp. (5.88%), *Enterobacter cloacae* (5.88%), *Klebsiella noculums* (2.94%), *Citrobacter freundii* (2.94%), *Vibrio cholerae* (2.94*%), Serratiama rcescens* (2.94%), *Aspergillus* spp. (5.88%), *Cladosporium* sp. (2.94%). *Geomyces* sp. (2.94%), *Oidiodendron griseumrobak* (2.94%), *Penicillium paneum* (2.94%) and *Fusarium culmorum* (2.94%).

Table 1 Shows the type of sample collected, the number of samples collected, and place of collection and time of collection. In this table, 25 swab-samples were collected from ATMs and campus shuttle door handles in Adekunle Ajasin University, Akungba Akoko, Ondo state.

Table 2 shows the dilution factors of the cultured samples collected from ATM keypads, as well as the corresponding colony counts on plate count agar, blood agar, and MacConkey agar. In total, 12 plates were recovered, and each plate contains inoculum in serial dilutions, with the highest dilution factor being 10^{-2} and the lowest

dilution factor being 10^{-4}. ATMs 1, 3, 4, 5, 6, 8, and 11 had a dilution factor of 10^{-2}, while ATMs 2, 7, 9, 10, and 12 had a dilution factor of 10^{-4}. The table also shows the number of colonies found on each plate. ATM 5 and ATM 3 had the highest colony counts, with 26 and 20 colonies, respectively, while ATM 8, ATM 1, ATM 7, and ATM 9 had the lowest colony counts, with 6, 6, 9, and 9 colonies, respectively.

Table 3 shows the dilution factors of the shuttle samples cultured, as well as the corresponding colony counts of isolates cultured on MacConkey agar, blood agar, and plate count agar. In total, 15 plates were recovered, and each plate contained inoculums in serial dilutions, with the highest dilution factors being 10^{-2} and the lowest dilution factor being 10^{-4}. SH 11, SH 12, and SH 15 had a dilution factor of 10^{-2}, while SH 1, SH 2, SH 3, SH 4, SH 5, SH 6, SH 7, SH 8, SH 9, SH 10, SH 12, and SH 14 had a dilution factor of 10^{-4}. The table also explains the number of colonies found on each plate. SH 10 and SH 15 had the highest colony counts, with 40 and 32 colonies, respectively, while SH 11 and SH 12 had the lowest colony counts, with 4 and 3 colonies, respectively.

Table 4 shows preliminary biochemical tests were performed on the recovered isolates from shuttle door handles. The tests included oxidase, catalase, citrate, motility, urease, indole, sugar fermentation, gas production, and hydrogen sulfide tests. It was observed that ATM 4 was positive for the oxidase test, while the rest of the isolates were negative. All isolates were positive for the catalase test. Additionally, ATM 1, ATM 3, ATM 5 and ATM 8 were positive for the coagulase test, while the remaining isolates were negative. ATM 9, ATM 10 and ATM 12 were negative for the citrate test, while the rest of the isolates were positive. Similarly, ATM 6, ATM 7, ATM 10, ATM 11 and ATM 12 were negative for the starch hydrolysis test, while the remaining isolates were positive. ATM 1 and ATM 11 were negative for the motility test, while the other isolates were positive. Furthermore, ATM 10 and ATM 12 were positive for the indole test, while the rest of the isolates were negative. Regarding the urease test, ATM 3, ATM 4, ATM 9 and ATM 10 were negative, while the remaining isolates were positive. ATM 1, ATM 5, ATM 8, ATM 10, ATM 11 and ATM 12 were positive for lactose fermentation, while the rest of the isolates were negative. All isolates were positive for glucose/dextrose fermentation. ATM 6, ATM 7, ATM 9 and ATM 10 were positive for the hydrogen sulfide test, while the rest of the isolates were negative. ATM 10 and ATM 12 were negative for the fructose fermentation test, while the remaining isolates were positive. Finally, ATM 6, ATM 7, ATM 10 and ATM 12 were negative for the maltose fermentation test, while the rest of the isolates were positive.

Table 5 shows preliminary biochemical tests were performed on the recovered isolates from shuttle door handles. The tests included oxidase, catalase, citrate, motility, urease, indole, sugar fermentation, gas production, and hydrogen sulfide tests. It was observed that SH 6, SH 7, SH 9, and SH 10 were positive for the oxidase test, while the rest of the isolates were negative. All isolates were positive for the catalase test. Additionally, SH 2, SH 7, SH 9, SH 10, SH 11, SH 13, and SH 14 were positive for the coagulase test. SH 4 was negative for the citrate test; the rest of the isolates were positive. Similarly, SH 3, SH 5, SH 11, and SH 12 were negative for the starch hydrolysis test, while the remaining isolates were positive. All the isolates were positive for motility test. Furthermore, and SH 6 was positive for the indole test, while the

rest of the isolates were negative. Regarding the urease test, SH 5, SH 6, SH 7, SH 10, and SH 12 were negative, while the remaining isolates were positive. SH 3 was positive for lactose fermentation, while the rest of the isolates were negative. All isolates were positive for glucose/ dextrose fermentation. SH 1, SH 2, SH 3, and SH 11 were positive for the hydrogen sulfide test, while the rest of the isolates were negative. All isolates were positive to fructose fermentation test. Finally, SH 10 was negative for the maltose fermentation test, while the rest of the isolates were positive.

Table 6 shows the list of bacterial isolates identified using Bergey's manual of determinative bacteriology. In this table, a total of 27 organisms were identified and were identify as *Staphylococcus aureus* (8.82%), *Bacillus* spp. (32. 35%), *Proteus mirabilis* (8.82%), *Escherichia coli* (5.88), *Salmonella* spp. (5.88%), *Enterobacter cloacae* (5.88%), *Klebsiella inoculums* (2.94%), *Citrobacter freundii* (2.94%), *Vibrio cholerae* (2.94%), *Serratia marcescens* (2.94%).

Table 7 shows the list of fungal isolates identified using mycological Atlas and compendium of soil fungi. A total of 7 organisms were identified as *Aspergillus* spp. (5.88%), *Cladosporium* sp. (2.94%). *Geomyces* sp. (2.94%), *Oidiodendron griseum robak* (2.94%), *Penicillium paneum* (2.94%) and *Fusarium culmorum* (2.94%).

TABLE 1

Sample collected, number of sample collected, place and time of collection

Sample collected	Place of collection	Number of swabs collected	Collection time
ATM swab	Access bank	4	9.05am
ATM swab	UBA	3	9.30 am
ATM swab	Polaris Bank	2	9.00 am
ATM swab	Zenith Bank	4	9.30 am
Shuttle handle swab	Opposite Obasanjo Hall	3	10.25 am
Shuttle handle swab	Opposite Obasanjo Hall	3	10.00 am
Shuttle handle swab	Opposite Big gate	3	10.00 am
Shuttle handle swab	Opposite Obasanjo Hall	3	10. 05 am
Shuttle handle swab	Opposite Obasanjo Hall	3	9. 00 am

TABLE 2

Dilution factors, location and colony count of campus bank's automated teller machines (atm) swab sample isolates cultured on MacConkey agar, blood agar and plate count agar

Sample code	Agar used	Location	Dilution factor	Number of colony	Cfu/ml
ATM 1	Blood agar	Polaris bank	10-Feb	6	1.2×10^{-1}
ATM 2	Plate count agar	UBA	10-Apr	18	3.6×10^{-3}
ATM 3	Plate count agar	Polaris bank	10-Feb	20	4.0×10^{-1}
ATM 4	Blood agar	UBA	10-Feb	7	1.4×10^{-1}
ATM 5	Plate count agar	Access bank	10-Feb	26	5.2×10^{-1}
ATM 6	MacConkey agar	Polaris bank	10-Feb	12	2.4×10^{-1}
ATM 7	MacConkey agar	UBA	10-Apr	9	1.8×10^{-1}
ATM 8	Blood agar	Polaris bank	10-Feb	6	1.2×10^{-1}
ATM 9	MacConkey agar	Access bank	10-Apr	9	1.8×10^{-3}
ATM 10	Plate count agar	Zennith bank	10-Apr	14	6.0×10^{-3}
ATM 11	Blood agar	Zennith bank	10-Feb	19	5.0×10^{-1}
ATM 12	MacConkey agar	Zennith bank	10-Apr	10	2.0×10^{-3}

TABLE 3

Dilution factors and colony count of shuttle doors sample cultured on MacConkey agar, blood agar and plate count agar

Sample code	Agar used	Dilution factor	Number of colony	Cfu/ml
SH 1	Plate count agar	10-Apr	21	4.2×10^{-3}
SH 2	Plate count agar	10-Apr	5	1.0×10^{-3}
SH 3	Plate count agar	10-Apr	8	1.6×10^{-3}
SH 4	MacConkey agar	10-Apr	10	2.0×10^{-3}
SH 5	MacConkey agar	10-Apr	4	8.0×10^{-3}
SH 6	MacConkey agar	10-Apr	5	1.0×10^{-3}
SH 7	Blood agar	10-Apr	18	3.6×10^{-3}
SH 8	Blood agar	10-Apr	10	2.0×10^{-2}
SH 9	Blood agar	10-Apr	15	3.0×10^{-3}
SH 10	Plate count agar	10-Apr	40	8.0×10^{-3}
SH 11	MacConkey agar	10-Feb	4	8.0×10^{-3}
SH 12	MacConkey agar	10-Apr	3	6.0×10^{-3}
SH 13	Blood agar	10-Feb	5	1.0×10^{-1}
SH 14	Blood agar	10-Apr	26	5.2×10^{-3}
SH 15	Plate count agar	10-Feb	32	6.4×10^{-1}

TABLE 4

Preliminary biochemical characteristic of campus bank's Automated Teller Machines (ATM) isolates

Sample1 Isolates	Oxidase test	Catalase test	Coagulase test	Citrate test	Motility	Indole	Urease	lactose	Dextrose	Sucrose	H_2S production	Glucose	fructose	Maltose	Starch hydrolysis
ATM 1	-	+	+	+	-	-	+	+	+	+	-	+	+	+	+
ATM 2	-	+	-	+	+	-	+	-	+	+	-	+g	+	+	+
ATM 3	-	+	+	+	+	-	-	-	+	+	-	+	+	++	+
ATM 4	+	+	-	+	+	-	-	-	+	+	-	+	+	+	+
ATM 5	-	+	+	+	+	-	+	+	+	+	-	+	+	+	+
ATM 6	-	+	-	+	+	-	+	-	+	-	+	+g	+	-	-
ATM 7	-	+	-	+	+	-	+	-	+	-	+	+g	+	-	-
ATM 8	-	+	+	+	+	-	+	+	+	+	-	+	+	+	+
ATM 9	-	+	-	-	+	-	-	-	+	+	+	+	+	+	+
ATM 10	-	+	-	-	+	+	-	+	+	+	-	+	-	-	-
ATM 11	-	+	-	+	-	-	+	+	+	+	-	+	+	+	-
ATM12	-	+	-	-	+	+	-	+	+	+	-	+	-	-	-

Key: +=positive; - =negative; g=gas production through bubbles

TABLE 5

Preliminary biochemical characteristic of campus shuttle doors isolates

Sample 2	Oxidase test	Catalase test	Coagulase test	Citrate test	Motility test	Indole	Urease	Lactose	Dextrose	sucrose	H_2S production	Glucose	Fructose	Maltose	Starch hydrolysis
SH 1	-	+	-	+	+	-	+	-	+	+	+	+	+	+	+
SH 2	-	+	+	+	+	-	+	-	+	+	-	+	+	+	+
SH 3	-	+	-	+	+	-	+	+	+	+	+	+g	+	+	-
SH 4	-	+	-	-	+	-	-	-	+	-	+	+g	+	+	+
SH 5	-	+	-	+	+	-	-	-	+	+	-	+g	+	+	-
SH 6	+	+	-	+	+	+	-	-	+	+	-	+	+	+	+
SH 7	+	+	+	+	+	-	-	-	+	+	-	+	+	+	+
SH 8	-	+	-	+	+	-	+	-	+	+	-	+	+	+	+
SH 9	+	+	+	+	+	-	+	-	+	+	-	+	+	+	+
SH 10	+	+	+	+	+	-	-	-	+	+	-	+	+	+	+
SH 11	-	+	+	+	+	-	+	-	+	-	++	+g	+	-	-
SH 12	-	+	-	+	+	-	-	-	+	+	-	+g	+	+	-
SH 13	-	+	+	+	+	-	+	-	+	+	-	+	+	+	+
SH 14	-	+	+	+	+	-	+	-	+	+	-	+	+	+g	+
SH 15	-	+	-	+	+	-	+	-	+	+	-	+g	+	+	+

Key: +=positive; - =negative; g=gas production through bubbles

TABLE 6

Morphological characteristics of isolated fungi from campus bank's Automated Teller Machines (ATM) and shuttle door handles

Isolate code	Appearance of colony on Pda	Growth rate	Nature of hyphae	Sporangiophore/ Conidiophore
ATM UBA	The colour of the colony was greenish-\yellow, while reverse side of the colony was pale-yellow in colour.	Fast-growing	The hyphae of *Aspergillus flavus* were septate and hyaline, which branch profusely and extend radially from the center of the colony.	Conidiophores
ATM POL	The Colour of the colony was typically olive-green to later turn brown with a velvety surface, while the reverse side of the colony was a dark green to black colour.	Fast-growing	The hyphae of *Cladosporum herbarum* were septate and hyaline, which branch profusely and extend radially from the center of the colony.	
ATM ACC	The colony colour was pale gray with a velvety texture, while reverse side of the colony was typically pale yellowish-brown.	Slow-growing	The hyphae of *Geomyces pannorum* were septate and hyaline, and they branch profusely in all directions.	Conidiophores
ATM ACC 2	The colony colour was typically gray-green with a woolly texture, while the reverse side of the colony is typically white to pale yellow.	Fast-growing	The hyphae of *Aspergillus fumigatus* were septate and hyaline, and they branch profusely in all directions.	Conidiophores
SH 1	The colony colour was cream with a cottony texture, while the reverse side of the colony was pale yellow.	Slow-growing	The hyphae of *Oidiodendron roback* were septate and hyaline, and they branch profusely in all directions	Conidiophores
SH 2	The colony colour was typically blue-green to gray-green with a velvety or texture, while the reverse side of the colony is typically yellow or orange.	Fast-growing	The hyphae of *Penicillium paneum* were septate and hyaline, and they branch profusely in all directions.	Conidiophores
	The colony colour is white to light brown with a cottony texture, while the reverse side of the colony appears in light brown.	Fast-growing	The hyphae of *Fusarium culmorum* were septate and hyaline, and they branch profusely in all directions.	Conidiophores

TABLE 7

List of campus bank's Automated Teller Machines (ATM) and shuttle door handles isolates characterize using Bergey's manual of determinative bacteriology

Isolates	Probable organisms
ATM 1	*Staphylococcus aureus*
ATM 2	*Bacillus cereus*
ATM 3	*Bacillus subtilis*
ATM 4	*Bacillus subtilis*
ATM 5	*Staphylococcus aureus*
ATM 6	*Proteus mirabilis*
ATM 7	*Proteus mirabilis*
ATM 8	*Staphylococcus aureus*
ATM 9	*Salmonella typhi*
ATM 10	*Escherichia coli*
ATM 11	*Klebsiella pneumonia*
ATM12	*Escherichia coli*
SH 1	*Bacillus cereus*
SH 2	*Bacillus subtilis*
SH 3	*Citrobacter frendii*
SH 4	*Salmonella typhi*
SH 5	*Enterobacter cloacae*
SH 6	*Vibrio cholera*
SH 7	*Bacillus subtilis*
SH 8	*Bacillus cereus*
SH 9	*Bacillus subtilis*
SH 10	*Bacillus subtilis*
SH 11	*Proteus mirabilis*
SH 12	*Enterobacter cloacae*
SH 13	*Bacillus subtilis*
SH 14	*Bacillus subtilis*
SH 15	*Serratia marcescens*

Discussion

The purpose of this study is to determine the microbial carriage of shuttle door handles and campus bank's automated teller machines in Adekunle Ajasin University, Akungba-Akoko, Ondo State.In this study, 28 swab samples from campus bank's automated teller machines (ATM) and campus shuttle door handles in Adekunle Ajasin University, Akungba-Akoko were analyzed. Result obtained validates the presence of microorganisms on contact surfaces of ATM and shuttle door handles in Adekunle Ajasin University, Akungba-Akoko. The presence of microbial contaminants on ATMs can be attributed to the fact that they are located outdoors, which makes them easily accessible to users, and exposes the ATM machines to the elements such as wind and rain. The constant usage by different elements exposes the machine to different human microflora both from humans, rodants and reptiles such as lizard, wall gecko, and insect such as cockroach.

The constant exposure of ATMs to the environment and users with varying levels of hygiene can also makes the machines more susceptible to accumulating dirt, debris, and microbial colony, which pose a dangerous health risk to other users who come into contact with the same machine surface. The health hazard risk is particularly high in high-traffic areas where the machines are frequently used, likewise the ability of shuttle door handles to harbour microorganisms can be attributed to the high amount of traffic and frequent use by human.

Many people touch shuttle door handles with bare hands, are known to be a major source of bacterial contamination in both the shuttle door and ATM machines. Bacteria can survive on surfaces for extended periods of time, and this increases the likelihood of bacterial transmission from person to person, person to door, door to person and person to ATM etc. [20,21].

The occurrence and survival of these microorganisms on a surface is one of the factors that determine the likelihood of an infection occurring. The bacterial load on a surface also affects the survival of bacteria; higher concentrations of microorganisms increase their survival time and the chances of picking up the microbe from the environment [2] is another factor to consider. In addition, [22] reported that microorganisms have a longer survival time on plastics, iron and inanimate objects, which are commonly used as materials for user interfaces, compared to other surfaces such as fabrics or steel. Shuttle door handles too are often made of plastic, which could suggest that they serve as potential reservoirs and vehicles for transferring microorganisms.

In this study, both pathogenic and non-pathogenic microorganisms were isolated. These included *Staphylococcus aureus* (8.82%), *Bacillus* spp. (32.35%), *Proteusmirabilis* (8.82%), *Escherichiacoli* (5.88%), *Salmonella* spp. (5.88%), *Enterobacter cloacae* (5.88%), *Klebsiella pneumoniae* (2.94%), *Citrobacter freundii* (2.94%), *Vibrio cholerae* (2.94%), *Serratia marcescens* (2.94%), *Aspergillus* spp. (5.88%), *Cladosporium* sp. (2.94%), *Geomyces* sp. (2.94%), *Oidiodendron griseum robak* (2.94%), *Penicillium paneum* (2.94%), and *Fusarium culmorum* (2.94%). Of these, 52.4% were Gram-positive bacteria and 47.6% were Gram-negative bacteria. This finding is related to the work of [2] on Isolation and identification of microorganisms associated with Automated Teller Machines in Federal Polytechnic Ede campus, where isolated Gram-positive bacteria were found to occur more than Gram-negative bacteria.

Furthermore, *Bacillus* spp. (32.35%) was found to be the most common isolate in this study, which is similar to the findings [23], who also found *Bacillus* spp. to be the most common bacteria isolated from contact surfaces at bus terminals in Uyo Metropolis. The predominance

of *Bacillus* on the surfaces could be attributed to its spore-forming ability, which may cause it to be dispersed into the air and settle on fomites [23]. Likewise, *Aspergillus* spp. were the most common fungi in this study, their predominance is likely due to their ability to thrive in damp or wet environments and grow on surfaces that are not regularly cleaned. The presence of *Aspergillus* on these surfaces poses a potential health risk to human health as these organisms are capable of producing mycotoxins that are harmful to human health if inhaled or ingested [23].

Moreover, the isolation of *Staphylococcus aureus* could be attributed to its ubiquitous nature as part of the normal flora of human skin and hands, which often come into contact with objects in the environment [24,25]. This finding can also be likened to the study carried out by [23] that revealed that the users' hands had higher levels of contamination with presence of body flora such *Staphylococcus aureus*. The presence of *Staphylococcus aureus* validates the fact that human skin serves as medium for the transmission of this organism and subsequent infection in individuals with low immunity. Staphylococcus is responsible for several infections one of which includes abscesses (boils) which is highly contagious. Other infections caused by this bacterium are furuncles and cellulitis. Thus, *S. aureus* is a medically important microorganism.

In addition to the bacteria found on the ATM and shuttle door handles, enteric organisms including *Salmonella typhi, Escherichia coli, Citrobacter freundii, Enterobacter cloacae* and *Vibrio cholera* were also isolated from the same surfaces during this study. Thus, individuals living in this environment could be exposed to infections by the ESKAPE pathogens. In extreme cases, there could be a disease outbreak in form of an epidemic in such places. Hence, there is need for adequate health measure to be put in place such as handwashing hygiene. Food handlers in particular should ensure proper cooking of food and good personal hygiene and sanitary practices. Typhoid which is caused by *Salmonella typhi* is a notorious issue in Akungba-Akoko. The presence of these pathogenic enteric organisms on the contact surfaces of ATM and shuttle door handles is indicative of fecal contamination, likely from the hands of people who do not practice proper hand washing after using the toilet [26].

Conclusion

This study underscores the importance of maintaining good hygiene practices, to reduce the risk and scourge of microbial infections transmission in public spaces, particularly in university settings through campus shuttle doors and banks ATM machine. The findings in this study suggest that commonly touched surfaces, such as shuttle door handles and ATM surfaces are potential reservoirs of various microorganisms, including pathogenic ones. The presence of these microorganisms on frequently touched surfaces raises concerns about the possible spread of infectious diseases. Therefore, the study highlights the need for regular cleaning and disinfection of high-touch surfaces to mitigate the risk of infection transmission.

Recommendation

Based on the results obtained from this study, it is recommended that ATM keypads and shuttle door handles be regularly cleaned and disinfected to minimize the risk of infection transmission, especially in public places where many people with varying levels of hygiene come into contact with these surfaces daily.

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