JOURNAL OF COMPLEMENTARY MEDICINE RESEARCH

Journal of Complementary Medicine Research, ISSN: 2146-8397 Vol. 13, No. 5, 2022 (pp. 16-20)

RESEARCH ARTICLE WWW.JOCMR.COM

Surveillance Study on Bacterial Contamination Associated With Automated Teller Machines of Different Banks in Jazan Region

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ABSTRACT

The environmental surfaces play an important role in the spread of pathogens and infectious diseases. Human are particularly susceptible to pick up microbes from environmental objects, especially from publicly and regularly used objects. The Automated teller machines (ATMs) are very likely to be the reservoir of different kinds of microorganisms, both pathogenic and non-pathogenic.

In our study, we investigated the microbial contamination of multiple ATM machines in Jazan region. This is a descriptive cross-sectional study which was conducted between September to November, 2021. A sum of 42 sample were collected which yielded a total of 15 isolated bacterial species that was identified as follows: Bacillus spp. (73%), CoNS. (15%), Staphylococcus aureus (14%), Pseudomonas luteola (12.5%), Pantoea agglomerans (10%), Acinetobacter baumannii (7.5%), Escherichia coli (5%), Enterobacter cloacae (5%), and other 5 Gram negative species (total of 12.5%). Antibiotic susceptibility pattern of the isolates to commonly prescribed antibiotics showed that the highest resistant species are *S. aureus* (44%), CNS (48%) and E. coli (40%), while all the other bacteria showed varied degrees of resistance to the antibiotics tested.

These results suggest that ATMs machines may play a role in transmission of drug resistant bacteria in Jazan, therefore, creating a public health risk. Intriguingly, our study comes after a large-scale and intense hygienic COVID-19 awareness programs. Hence, there is an urgent need to implement and improve hygienic practices and regulation when using such public machines.

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How to cite this article: Abdel-Razik NE, Alfifi RA, Ageel H, Gobri R, Alfaifi M, Nassib Z, Almalki W, Awaji O, Bantun F (2022) Surveillance Study on Bacterial Contamination Associated With Automated Teller Machines of Different Banks in Jazan Region. Journal of Complementary Medicine Research, Vol. 13, No. 5, 2022 (pp. 16-20).

INTRODUCTION

Microorganisms are ubiquitous in the environment which can grow and even form persistent biofilm on any surface. Although most of them are harmless, some are pathogenic and can be fatal, especially for people with a weakened immune system. Controlling microorganisms on different surfaces in the community is one of the most critical steps towards preventing the spread of infectious diseases.[1] Contamination of environmental objects and surfaces is a common phenomenon where viable pathogenic bacteria on inanimate objects have been reported by earlier investigators.[2,3] Many factors have been identified that influence the bacteria transfers between surfaces, including source and destination surface features, bacterial species involved, moisture levels, pressure and friction between contact surfaces and inoculums size on surfaces.[4] One of the main and most common means for the microbial transfer from inanimate objects to humans is direct contact by hand, particularly, in individuals with poor hygienic practice.[5]

The ATMs are very likely to be the reservoir of different kinds of microorganisms, both pathogenic and non-pathogenic, due to the continuous usage by many people on a daily basis, especially in an overcrowded environment.[6] Indeed, this may serve to spread infectious agents among the community, such as the recent pandemic COVID-19.[7] Multiple studies have reported the presence of a variety of bacterial and fungal contamination on ATMs as well as other electronic devices[7-9]. In numerous studies, members of *Enterobacteriaceae* bacteria have been reported, such as *Escherichia coli*, *Salmonella* spp. and *Enterobacter* Spp., indicating poor hygienic practice among the society. Surly, the most

KEYWORDS:
MRSA,
ATMs,
S. aureus,
Antibiotics

ARTICLE HISTORY:
Received : June 05, 2022
Accepted : Oct 04, 2022
Published: Dec 03, 2022

DOI:
10.5455/jcmr.2022.13.05.03

common reported species among the *Enterobacteriaceae* was *E. Coli* indicating faecal contamination.[7,8] Several other bacterial species were also found including *Staphylococcus* Spp., *Bacillus* Spp., CoNS, *Streptococcus* Spp., *Pseudomonas* Spp., where *Staphylococcus* Spp. was the most common species among them.[7,8] Indeed, most of the abovementioned species were reported as persistent with a high survival rate on hard surfaces[5]. Shockingly, antibiogram analysis revealed the existence of many antibiotic resistance bacteria colonizing ATMs in the community, including methicillin-resistant *Staphylococcus aureus* (MRSA) and *Pseudomonas aeruginosa*.[9,10] Such bacteria are well documented for their problematic infections which may, eventually, lead to death[11]. This is quite concerning as ATMs can serve as a point of infection spread and transmission through the community. Reported microbial contamination of ATMs was not exclusive to the keypad. In fact, Ozkan and colleagues conducted a study in Turkey that reported contamination of ATM bank cards which could be transferred to the ATM then transferred to another card.[12] Although the microbial contamination on the cards was not as heavy as on the keypad or touch screen, they cannot be completely excluded as a potential source for microbial transmission. In light of such data, the present study was undertaken to investigate probable bacterial contamination of ATMs in Jazan region and perform antibiogram analysis for all isolates. This evaluation will provide further insight into the public health hazards in the society of the Jazan region.

MATERIALS AND METHODS

Study Design

This was a descriptive cross-sectional study in which a total of 42 samples were collected from ATMs of six different banks in Jazan region. The study was conducted from September to November, 2021. Ethical clearance was not required for such study as no human or animal experimentation was involved.

Sample criteria and processing:

A total of 42 samples were collected using sterile swabs from the keypad of 42 ATMs located in Jazan region in Saudi Arabia. The machines belonged to six different banks. Prior to collecting the sample, the cotton swabs were slightly moistened with sterile saline to enhance proper sample collection. The swab was incubated in nutrient broth media and transported immediately to the laboratory for processing. Samples were inoculated onto Blood agar (Oxoid), MacConkey agar (HiMedia) and mannitol salt agar (HiMedia) plates and incubated at 37^{0}C for 24 hours. The various media were prepared according to the manufacturer's instructions. Upon the establishment of growth, each culture plate was examined for distinct colonies from which sub-cultures were made on fresh solid agar media and incubated as described earlier. When new growth appeared, they were examined for uniformity as a mark of purity. The resulting pure cultures were used for characterization as well as subsequent identification[13].

Identification of Isolates and Antibiotic susceptibility:

The isolates were identified both macroscopically and microscopically using colony morphology, gram reaction and conventional biochemical identification procedures.[9] Furthermore, bacterial species were confirmed using the Microscan Walkaway 96 Plus System (Beckman Coulter) along with their antibiotic susceptibility profile.[14]

Determination of bacterial occurrence

Each isolated bacterial isolate was given a percentage ratio that is relevant to the total number of samples tested, calculated as indicated.[8] In brief, the number of positive tests was divided by the total number of samples then multiplied by 100. Similar approach was used to calculate the bacterial percentage in each bank.[8]

RESULTS

A total of 42 swab samples were obtained from six different banks' ATM keypads. To sustain hostility a letter was allocated to each bank. Overall, the findings indicated a significant amount of bacterial contamination. Bank D had the most germs (40%) isolated from their ATMs. **Figure-1** shows all the additional percentages for the other banks.

A total of 15 bacterial species were isolated and identified from the 42 ATMs by standard identification procedures and the Microscan Walkaway 96 Plus System. Both gram-positive and gram-negative bacteria were detected. Isolated bacteria were mostly non-pathogenic *Bacillus Spp.* (73%). Other isolated species are illustrated in **Figure-2**, which are as follows: CoNS. (15%), *Staphylococcus aureus* (14%), *Pseudomonas luteola* (12.5%), *Pantoea agglomerans* (10%), *Acinetobacter baumannii* (7.5%), *Escherichia coli* (5%), *Enterobacter cloacae* (5%), and other 5 gram-negative species (total of 12.5%). CoNS species were *Staphylococcus haemolyticus* (10%), *Staphylococcus xylosus* (2.5%) and *Staphylococcus simulans* (2.5%). All 15 isolated species were tested against 25 different commonly used antibiotics using the Microscan Walkaway 96 Plus System (Beckman Coulter). However, only those that showed multiple resistances to different antibiotics are reported here. Interestingly, MRSA was identified in 5% of the isolates. The antibiotic susceptibility test pointed out S. *aureus*, CoNS and E. coli as the highest resistance, 44%, 48% and 40% respectively, to the applied antibiotics. On the other hand, the other isolated bacteria showed variable degrees of resistance to the tested antibiotics **Table-1** and **2**.

CoNS species (15%) were identified as *Staphylococcus haemolyticus* (10%), *Staphylococcus xylosus* (2.5%) and *Staphylococcus simulans* (2.5%). Antibiotic susceptibility testing for S. *aureus* species(14%) revealed MRSA (5%), while the rest was susceptible (9%).

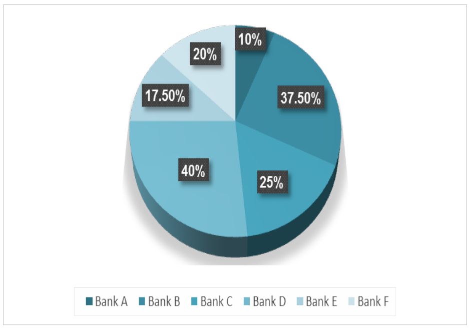

Fig. 1: The percentage of bacterial isolates of different banks from ATMs keypad.

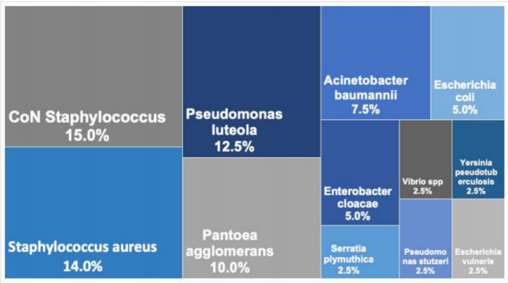

Fig. 2: Percentages of identified bacterial Isolates from ATM keypads

Table : Antibiotics susceptibility of gram positive bacterial isolates from ATMs

	Staphylococcus aureus	*Staphylococcus haemolyticus*	*Staphylococcus simulans*
Amox/K Clav	R	R	R
Ampicillin	R	R	R
Cephalothin	R	R	R
Ciprofloxacin	S	R	R
Clarithromycin	R	R	R
Clindamycin	R	S	R
Erythromycin	R	R	R
Fosfomycin	R	S	S
Fusidic Acid	R	I	R
Levofloxacin	S	R	R
Moxifloxacin	S	I	I
Oxacillin	R	R	R
Penicillin	R	R	R
Tetracycline	R	S	S
Vancomycine	S	S	S

*R = Resistant, S= Susceptible, I= Intermediate.

Table 2: Antibiotics susceptibility of gram negative bacterial isolates from ATMs

	E. coli	*Vibrio spp*	*Yersinia pseudotuberculosis*	*Enterobacter cloacae*	*Pseudomonas luteola*	*Pantoea agglomerans*
Amox/K Clav	S	S	S	R	S	S
Ampicillin	R	R	S	S	S	R
Aztreonam	ESBL	S	R	S	R	S
Cefazolin	R	S	S	R	S	S
Cefepime	R	R	R	S	S	S
Cefotaxime	ESBL	R	R	S	S	S
Cefoxitin	S	R	S	R	S	R
Ceftazidime	ESBL	R	R	S	S	S
Cefuroxime	R	R	R	R	S	S
Fosfomycin	S	S	S	S	S	R
Piperacillin	R	S	S	S	S	S
Tetracycline	R	S	S	S	S	S
Trimeth / Sulfa	R	S	S	S	S	S

*R = Resistant, S= Susceptible, ESBL= Extended Spectrum Beta-Lactamase.

DISCUSSION

The study was conducted to evaluate the current practice of the public regarding using ATM machines and the possibility of disease transmission via such machines. Based on our results, there is a high level of bacterial contamination on ATM machines in Jazan. These results were consistent with previous reports in other areas with a slight variation in the percentage of predominant organisms. In our study, Bacillus spp. was the most prevalent species out of 15 isolated species (73%), none of which were identified as pathogenic. Skin flora was also found on the ATM keypad, including *S. aureus* and some members of CoNS. This could be attributed to the frequent direct contact of the skin surface with the keypad. Interestingly, MRSA comprised nearly 5% of our samples. The existence of such an organism in the community poses a real health risk to the general population.[15,16] Although *S. aureus*, *S. epidermidis* and *S. haemolyticus* are part of the skin flora, they are considered the most frequent etiological agents of staphylococcal infections in immunocompromised patients.[17,18] However, their virulence factors differ depending on the species. This kind of diversity within strains seems to be essential for their colonization. Indeed, *S. aureus* is very well known as the cause of a broad spectrum of infections, ranging from minor skin diseases to systemic infections and sometimes septic shock, especially if it was the MRSA strain.[19,20] CoNS have long been regarded as non-pathogenic but their importance as pathogens and their increasing incidence have been recognised and studied in recent years[17]. For instance, *S. haemolyticus* is known to be an opportunistic pathogen and one of the most commonly isolated CoNS from bloodstream infections that are related to invasive devices.[21] The pathogen has been found to be associated with immunocompromised patient.s[22]. In addition, *S. haemolyticus* has been isolated previously from domestic animals, suggesting that domestic animals can act as reservoirs for this organism[23]. Our isolates of *S. haemolyticus* have shown a distinctive methicillin-resistance phenotype (Table-1) which could be problematic as it is known as an opportunistic pathogen that can be difficult to treat[24] Such an organism may also contribute to the emergence of particularly virulent staphylococci, such as *S. aureus*, through dissemination or exchange of resistance genes.[25]

S. simulans was also one of our CoNS isolates from the swabbed ATMs which showed methicillin-resistance characteristics. Despite its classification as an animal pathogen, reports indicate that it may also be transmitted to humans[26,27]. Notably, the facts that it was isolated from multiple ATM keypads in our study indicate the chances of indirect spread through the community. In regards to the other less abundant isolates, most of them can be found in soil and would not be considered of huge risk to the community unless it is under certain host conditions (28). However, in consistent with previous reports from different areas around the world[7,8,29], members of *Enterobacteriaceae* were isolated from the tested ATMs such as *E. coli* and *E. cloacae*. This might indicate a possible fecal contamination and poor hygienic habits. Upon testing antibiotic susceptibility, our *E. coli* was found to be multidrug-resistant (MDR) (Table-2). This MDR strain might cause serious infections, posing a real threat to the public health in Jazan region[30].

Overall, we have demonstrated that contaminated ATM machines may pose a potential threat to society's wellness. In addition, the antibiotic resistance of the isolated microorganisms implies that ATM users might be at risk of being exposed to bacterial infections that would be difficult to treat. The indirect transmission of microbial agents among ATM users will not only affect them, but also their families and their surrounding communities. Although the majority of the organisms detected were low-virulent strains, they may still be pathogens in some susceptible hosts or under certain conditions. Our results call for particular attention to ATMs as sources of many microbial infections, although our focus was on bacterial contamination. Interestingly, our study was conducted after public health measures were implemented regarding hand hygiene habits due to the COVID-19 pandemic. There is still serious microbial contamination present. Hence, there is a need for the relevant authorities and the general public to ensure that these surfaces are disinfected on a regular basis. This will increase public awareness about proper hygiene practices. It is also crucial to track down the origin of such MDR organisms. This is because the tested ATM machines are located in general areas that are not close to any healthcare centers. Furthermore, a nationwide awareness campaign needs to be launched to educate people on the importance of disinfecting contact surfaces and to improve their attitudes toward disinfecting contact surfaces in order to reduce the spread of multidrug resistance. This will help in monitoring MDR infections and may stop their spread.

Acknowledgments: none.

Fund: Self

Conflict of interests

The authors of this paper declare no competing or conflict of interest and deny the presence of any financial or external affiliations regarding this paper.

Ethical approval

There is no need for ethical approval for this study.

Authorship contributions

The authors have the same contributions

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