Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2582-2845.8573

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2021) *9*(1), 471-480

Indian Journal of Pure & Applied Biosciences

Peer-Reviewed, Refereed, Open Access Journal

Research Article

Bacterial Contamination of Automated Teller Machine in Sakaka City, Kingdom of Saudi Arabia

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Received: 3.01.2021 | Revised: 9.02.2021 | Accepted: 16.02.2021

ABSTRACT

This study was under taken to identify and quantify bacterial contamination on the surface of ATMs in Sakaka city. Swabs were aseptically collected from ATM screens and keyboards then processed for enumeration and identification of contaminant bacteria. The results revealed those ATMs were highly contaminated with pathogenic, non-pathogenic and opportunistic bacteria especially on numeric keys. Studies on antimicrobial sensitivity of isolated bacteria showed that most of gram positives showed wide range of sensitivity to several antibiotics: Ciprofloxacin, Clindamycin, Fusidic Acid, Gentamicin, Levofloxacin, Linezolid, Moxifloxacin, Rifampin, Synercid, Teicoplanin, Tetracycline, Trimeth/Sulfa and Vancomycin, and were more resistant to Mupirocin and Azithromycin. Whereas gram negatives were mostly sensitive to Amikacin, Amox/K Clav, Gentamicin, Imipenem and Pip/Tazo and least to Ampicillin.

Keywords: *ATM, Contamination, Bacteria, Sakaka city.*

INTRODUCTION

Due to the continuous development and urbanization, as well as the growing population, you do not have time to use traditional banking services and have embraced the new developments in electronic banking services, such as the Automated Teller Machine (ATM) (Al-Muhammadi et al., 2017). Today, the widespread use of electronic technologies is the source of bacterial contamination. In general, microbes can persist or grow on many surfaces, such as those found in ATMs today, they have been an important tool in the banking sector and other financial institutions.

Cross contamination is defined as the physical movement or transfer of harmful bacteria from one person, thing, or place to another. It is a major factor in food poisoning, and has four common sources: food, people, equipment, and work surfaces (Reynolds et al., 2005).

Cite this article: Althari, Y. A., Almazyad, T. M., Albedaiwi, S. A., Al-moamar, R. J., Alabdullah, R. Z., Alhutheil, K. K., & Hamza, M. A. (2020). Bacterial Contamination of Automated Teller Machine in Sakaka City, Kingdom of Saudi Arabia, *Ind. J. Pure App. Biosci.* *9*(1), 471-480. doi: http://dx.doi.org/10.18782/2582-2845.8573

Stephen Aban and Kwaku Tanu Debra in their study indicated the ability of food-borne pathogens to contaminate fingers from metal keyboards in ATMs, where a contaminated finger was used to touch the surface of a feeder agar plate, at several points to transfer contaminants from the switches. Then another disinfected finger of your choice was used to touch the surface of another nutrient agar plate classified as a control (Abban & Tano, 2011).

In crowded ATMs, the number of bacteria and fungi was increased, whereas in non-crowded ATMs the level was inconsistent and indicated to be lower (Mabel et al., 2014). In addition, (Oluduro et al., 2011) reported that ATM keyboards contain more bacteria than computer keyboards and this may be because ATMs are usually out in the open and exposed to wind and rain. However, this is not very accurate as there are two types of ATMs across Sakaka city; it is possible to drive through the machines and ATM rooms. In this study, samples were taken from both engines through an in-room ATM machine. As a result, differences are expected as the temperature, humidity and exposure to sunlight differ between the two types of ATMs. This study aimed to determine the bacterial contamination of the keyboards and screens of automatic teller machines, to identify the pathogenic bacterial species that can be transmitted through the ATMs and to compare the degree and type of contamination between the payment machines through the rooms of the ATMs.

MATERIALS AND METHODS

Sample collection

Samples collection were performed using sterile cotton swabs moistened with sterile normal saline then used to swap ATM's keyboard and touch screens then transferred to screw-cap tubes that contain sterile normal saline to prevent dryness. Samples were transferred and processed immediately in the laboratory within one hour of collection.

Isolation of bacteria

Each sample were inoculated on both Blood Agar and MacConkey Agar culture media. Culture were performed in Lawn method under aseptic condition then plates were incubated at 37ºC under aerobic condition for 24-48 hrs. After that, colonies with significant growth were selected for further isolation. According to the manufacturer instruction, the purified isolates were processed after confirmation of Gram nature by the automated microbiology system –Micro Scan WalkAway-96 plus, Siemens Healthcare Diagnostics- Germany.

Statistical analysis

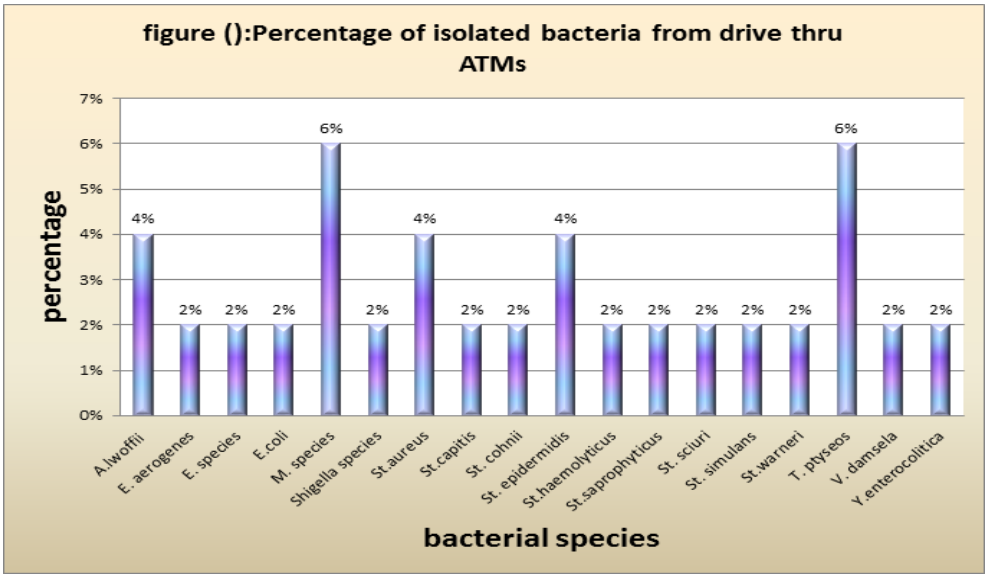
The numerical data were collected and computerized using SPSS program version 16, 2007. The description of the data was done in the form of frequencies and percentages for normally distributed quantitative data. The analysis of data was done to test statistical significant differences between groups by Independent sample t- test; to compare between two groups. One Way ANOVA test was used to compare between more than two groups by Post Hoc test LSD (Least significant difference) to compare intergroup.

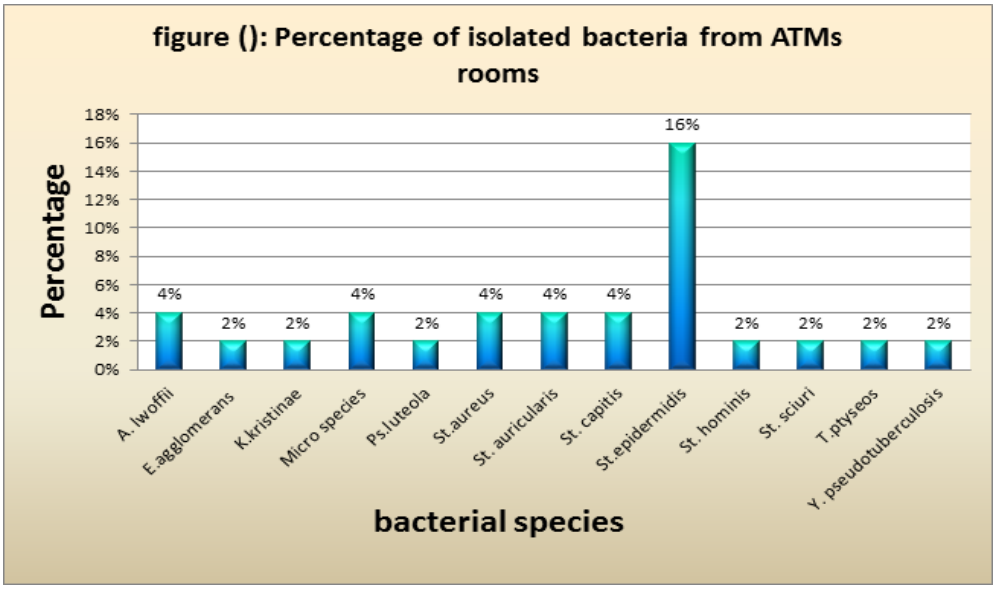
RESULTS AND DISCUSSION

This study identified some most microorganisms on the surface of ATMs. Overall, spore forming aerobic *Bacillus spp.* was predominant isolates. This confirms the ubiquitous nature of these bacteria giving it greater colonization ability as well as the ability of its spores to resist environmental changes, withstand dry, heat and certain chemical disinfectants for moderate periods (Tagoe & Kumi-Ansah, 2011). In addition, coagulase negative Staphylococcus appeared in almost all samples confirming results of (Mehmet, et al., 2013).

Table (1): Percentage of isolated bacteria from drive thru ATMs and ATM's rooms

Bacteria isolated from drive thru ATMs	F	%	Bacteria isolated from ATM's rooms	F	%
Acinetobacter lwoffii	2	4%	*Acinetobacter lwoffii*	2	4%
Enterobacter aerogenes	1	2%	*Enterobacter agglomerans*	1	2%
Enterobacter species	1	2%	*Kocuria kristinae*	1	2%
Escherichia coli	1	2%	*Micrococcus species*	2	4%
Micrococcus species	3	6%	*Pseudomonas luteola*	1	2%
Shigella species	1	2%	*Staphylococcus aureus*	2	4%
Staphylococcus aureus	2	4%	*Staphylococcus auricularis*	2	4%
Staphylococcus capitis	1	2%	*Staphylococcus capitis*	2	4%
Staphylococcus cohnii	1	2%	*Staphylococcus epidermidis*	8	16%
Staphylococcus epidermidis	2	4%	*Staphylococcus hominis*	1	2%
Staphylococcus haemolyticus	1	2%	*Staphylococcus sciuri*	1	2%
Staphylococcus saprophyticus	1	2%	*Tatumella ptyseos*	1	2%
Staphylococcus sciuri	1	2%	*Yersinia pseudotuberculosis*	1	2%
Staphylococcus simulans	1	2%			
Staphylococcus warneri	1	2%			
Tatumella ptyseos	3	6%			
Vibrio damsel	1	2%			
Yersinia enterocolitica	1	2%			
Total	25	50%	—	25	50%





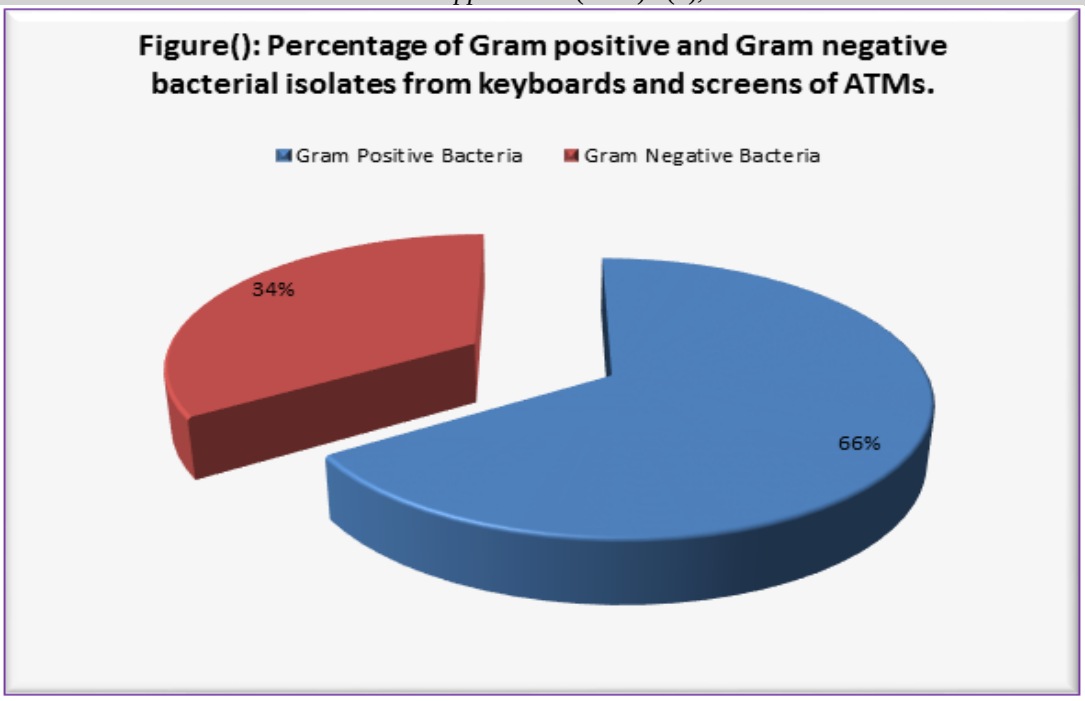
Similar to (Anesa, et al., 2013) the commonest isolate of this study was *S.epidermidis*, a major component of normal flora on the skin, which probably explains its high prevalence as a contaminant. *S.epidermidis* can occasionally assume an opportunistic pathogenic role causing human infection such as endocarditis (Anastasiades et al., 2009). Of particular interest was the isolation of *Staphylococcus aureus* as it is linked to many human diseases. Many previous studies indicated *S.aureus* as a pathogen isolated from public sites (Zhang, et al., 2012) (Walkey et al., 2011) and (Seuli, et al., 2013). This may be attributed to their ability to show greater survival on hands (Gontijo, et al., 1985). In this study, S. aureus isolates showed resistance to 20% of tested antibiotics: Imipenem, Azithromycin, Rifampin and erythromycin.

In this study, *Enterobacter agglomerans*, which is recognized as a plant pathogen, has been isolated from ATM near to institution of grain silos& flourmills. These opportunistic pathogens of animals and humans have been isolated from clinical specimens including blood, wounds, urine, throat, and internal organs. Hospital outbreaks has been recorded due to *E. agglomerans* contamination of anesthetic agent propofol, blood products, parenteral nutrition, and transference tubes used for intravenous hydration have been demonstrated (Mardaneh & Dallal, 2013). Likewise, and parallel to previous study of (Veerappan, et al., 2013), *Vibrio damselae* a pathogenic marine bacteria associated with wound infections in humans has been isolated near to a fish market (Belen, et al., 1992). Furthermore, ATMs from crowed areas such as markets showed increased degree of contamination. This is to be supported with the previous study of (Mabel et al., 2014).

The result of studying the gram nature of isolated bacteria indicated higher percentage of gram +ve compared to gram -ve spp. (66%) (34%) respectively. This result might be because most of skin commensals are gram +ve species (Oluduro et al., 2011). In addition, as the degree of hydration affects the survival of microorganism it is known that gram -ve bacteria are more sensitive to drying than gram +ve one (Gontijo, et al., 1985) .In addition, the survival of gram +ve species on laminate surfaces is said to be greater than gram -ve organisms (Scott & Bloomfield, 2008).

Table (2): Percentage of Gram positive and Gram negative bacterial isolates from keyboards and screens of ATMs

Gram Positive Bacteria	**F**	**%**	**Gram Negative Bacteria**	**F**	**%**
Kocuria kristinae	1	2%	*Acinetobacter lwoffii*	4	8%
Micrococcus species	5	10%	*Enterobacter aerogenes*	1	2%
Staphylococcus aureus	4	8%	*Enterobacter agglomerans*	1	2%
Staphylococcus auricularis	2	4%	*Enterobacter species*	1	2%
Staphylococcus capitis	3	6%	*Escherichia coli*	1	2%
Staphylococcus cohnii	1	2%	*Pseudomonas luteola*	1	2%
Staphylococcus epidermidis	10	20%	*Shigella species*	1	2%
Staphylococcus haemolyticus	1	2%	*Tatumella ptyseos*	4	8%
Staphylococcus hominis	1	2%	*Vibrio damsel*	1	2%
Staphylococcus saprophyticus	1	2%	*Yersinia enterocolitica*	1	2%
Staphylococcus sciuri	2	4%	*Yersinia pseudotuberculosis*	1	2%
Staphylococcus simulans	1	2%			
Staphylococcus warneri	1	2%			
Total	33	66%	—	17	34%



A pioneering aspect has been a combined in this study to detect if there are any differences in the degree of contamination between drive thru and ATMs rooms. Because air conditionings reduces heat, keep moist inside rooms, and consequently favor the growth of bacteria, it was expected to find rooms more contaminated. Unexpectedly, both types of machines showed equal degree of contamination, (50%) for each. This could be a due to more frequent use of drive thru machines than rooms as it is easiest and more convenient to use making them suspected to contamination very frequent; overcoming heat and dry effects.

The pathogenicity also has been studied in both types of machines. In ATM's rooms, pathogenic bacteria comprise (12%) and opportunistic bacteria (80%). Whereas in drive thru machines, pathogenic bacteria was (24%) and opportunistic are (60%). Again, these results also may be attributed to more frequent use of drive thru machines making these machines more suspected to contamination and harboring of infectious agents.

Table (3): Pathogenicity of isolated bacteria isolated from drive thru machines

Pathogenic bacteria	**F**	**%**	**Non-pathogenic bacteria**	**F**	**%**	**Oppertunisic bacteria**	**F**	**%**
Yersinia enterocolitica	1	4%	*Staphylococcus saprophyticus*	1	4%	*Staphylococcus pidermidis*	2	8%
Enterobacter species	1	4%	*Micrococcus species*	3	12%	*Acinetobacter lwoffii*	2	8%
Vibrio damsela	1	4%				*Tatumella ptyseos*	3	12%
Staphylococcus aureus	2	8%				*Escherichia coli*	1	4%
Shigella species	1	4%				*Enterobacter aerogenes*	1	4%
						Staphylococcus haemolyticus	1	4%
						Staphylococcus cohnii	1	4%
						Staphylococcus capitis	1	4%

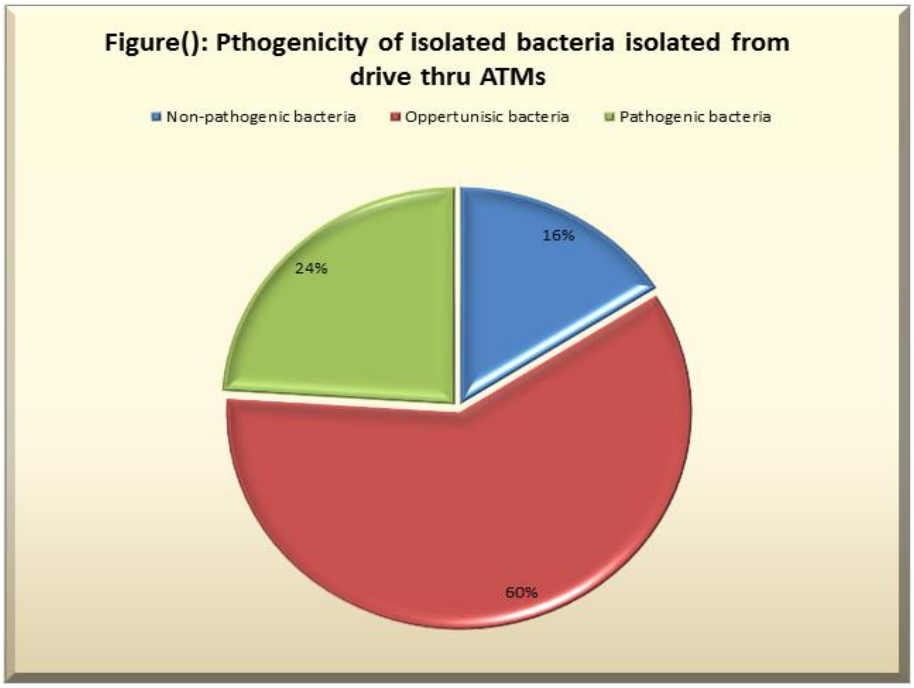
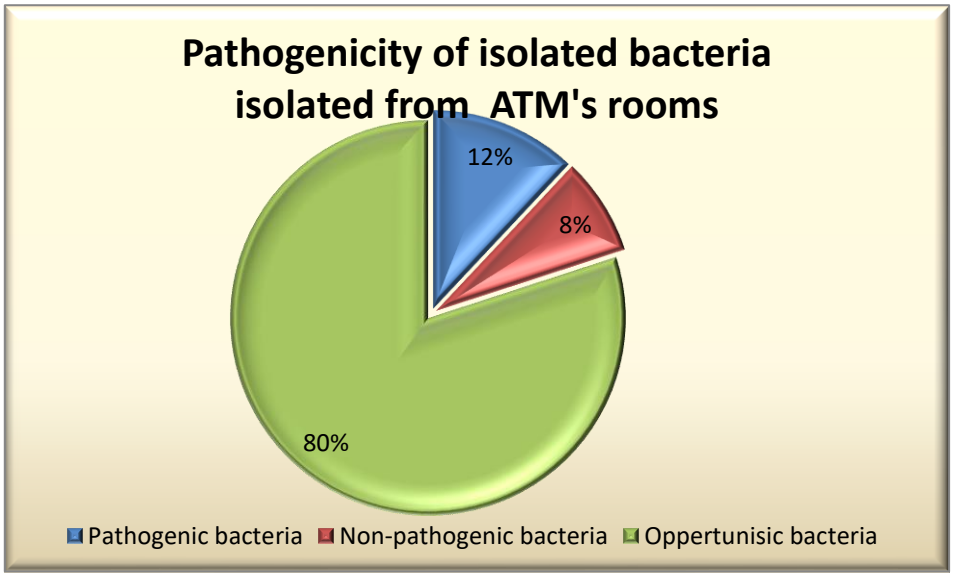


Table (4): Pathogenicity of isolated bacteria isolated from ATM's rooms

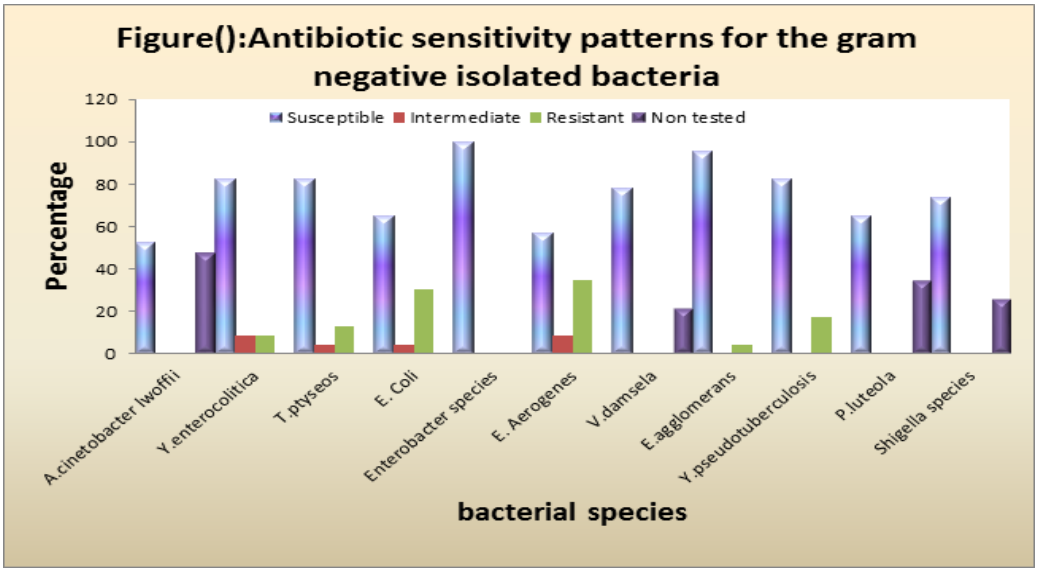
Pathogenic bacteria	**F**	**%**	**Non-pathogenic bacteria**	**F**	**%**	**Oppertunisic bacteria**	**F**	**%**
Staphylococcus aureus	2	8%	*Micrococcus species*	2	8%	*Staphylococcus epidermidis*	8	32%
Yersinia pseudotuberculosis	1	4%				*Acinetobacter lwoffii*	2	8%
						Tatumella ptyseos	1	4%
						Staphylococcus hominis	1	4%
						Pseudomonas luteola	1	4%
						Staphylococcus auricularis	2	8%
						Kocuria kristinae	1	4%
						Staphylococcus capitis	2	8%
						Enterobacter agglomerans	1	4%
						Staphylococcus sciuri	1	4%
Total	3	12%	—	2	8%	—	20	80%



The result of this study showed that some antibiotics show a wide range of resistance, (60%) to mupirocin, (50%) to azithromycin, (40%) to erythromycin, (27.27%) to cefazolin, cefoxitin, cefuroxime, ertapenem & moxifloxacin and (20). %) For all: Amox / K Clav, Imipenem, and Oxacillin. *E. coli* bacteria isolated showed resistance to (30.4%) of tested antibiotics while *E. aerogenes* resistance to (34.7%) and (20%) by *S. aureus*. In general, Synercid, Teicoplanin, Tetracycline, Trimeth / Sulfa, and Vancomycin were the most effective antibiotics, while Mupirocin, Azithromycin, and Erythromycin were the least effective. It has been observed that the sensitivity of bacterial isolates to antibiotics is not static but dynamic and varies with time and environment (Hassan, 1995).

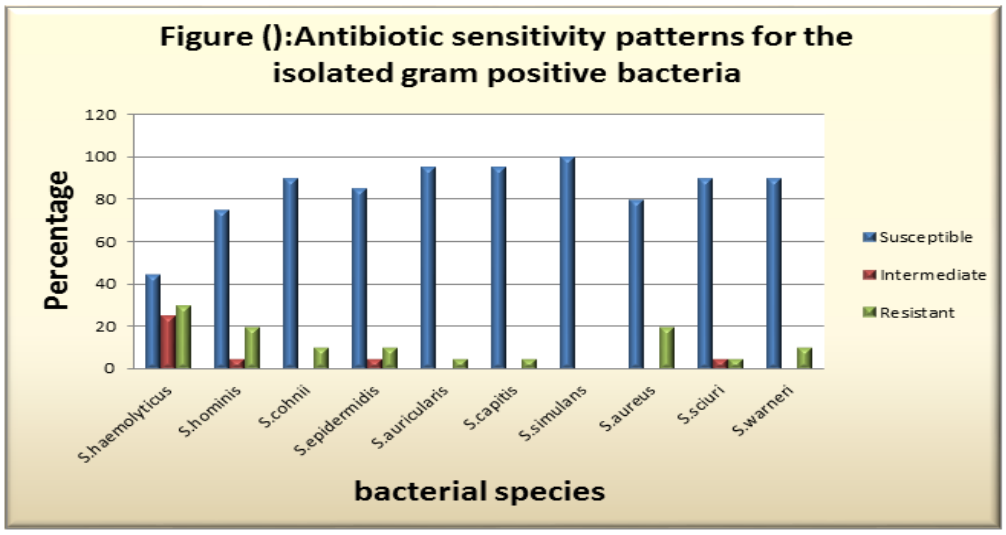
Table (5): Antibiotic sensitivity patterns for the gram negative isolated bacteria

Antibiotic	*A.cinetobacter lwoffii*	*Y.enterocolitica*	*T.ptyseos*	*E. coli*	*Enterobacter species*	*E. aerogenes*	*V.damsela*	*E.agglomerans*	*Y.pseudotubercu-losis*	*P.luteola*	*Shigella species*
Amikacin	S	S	S	S	S	S	S	S	S	S	–
Amox/K Clav	–	S	S	S	S	S	S	S	S	–	S
Ampicillin	–	S	R	R	S	R	S	S	R	–	S
Cefazolin	–	I	S	R	S	S	S	S	S	–	–
Cefepime	S	S	S	R	S	S	S	S	R	S	S
Cefotaxime	S	S	S	R	S	S	S	S	S	S	S
Cefoxitin	–	R	S	S	S	R	S	S	R	–	–
Cefuroxime	–	S	S	R	S	S	S	S	R	–	–
Ciprofloxacin	S	S	S	S	S	R	S	S	S	S	S
Ertapenem	–	S	S	S	S	R	–	S	S	–	S
Fosfomycin	–	R	R	S	S	S	–	R	S	S	S
Gentamicin	S	S	S	S	S	S	S	S	S	S	–
Imipenem	–	S	S	S	S	S	S	S	S	S	S
Levofloxacin	S	S	S	S	S	R	S	S	S	S	S
meropenem	S	S	S	S	S	R	S	S	S	S	S
mezlocilin	S	S	R	R	S	I	–	S	S	S	S
Moxifloxacin	–	S	S	S	S	R	–	S	S	–	S
Pip/Tazo	–	S	S	S	S	S	S	S	S	S	S
Piperacillin	S	S	I	R	S	I	S	S	S	S	S
Tetracycline	S	S	S	S	S	R	S	S	S	S	S
Tigecycline	–	S	S	S	S	S	S	S	S	–	S
Tobramycin	S	I	S	I	S	S	–	S	S	S	–
Trimeth/Sulfa	S	S	S	S	S	S	S	S	S	S	S
Susceptible F	12	19	19	15	23	13	18	22	19	15	17
%	52.17	82.6	82.6	65.2	100	56.5	78.26	95.6	82.6	65.21	73.9
Intermediate	0	2	1	1	0	2	0	0	0	0	0
%	0	8.69	4.34	4.34	0	8.69	0	0	0	0	0
Resistant F	0	2	3	7	0	8	0	1	4	0	0
	0	8.69	13.04	30.4	0	34.7	0	4.34	17.39	0	0
Non tested F	11	0	0	0	0	0	5	0	0	8	6
%	47.82	0	0	0	0	0	21.73	0	0	34.78	26.08



(6): Antibiotic sensitivity patterns for the isolated gram-positive bacteria.

Antibiotic		*S.haemolyticus*	*S.hominis*	*S.cohnii*	*S.epidermidis*	*S.auricularis*	*S.capitis*	*S.simulans*	*S.aureus*	*S.sciuri*	*S.warneri*
Amox/K Clav		R	R	S	S	S	S	S	S	S	S
Azithroycin		R	S	R	R	S	S	S	R	S	R
Ciprofloxacin		I	S	S	S	S	S	S	S	S	S
Clindamycin		S	I	S	S	S	S	S	S	I	S
Erythroycin		I	S	R	R	S	S	S	R	S	R
Fosfomycin		R	S	S	S	S	S	S	S	S	S
Fusidic Acid		S	S	S	I	S	S	S	S	S	S
Gentamicin		S	S	S	S	S	S	S	S	S	S
Imipenem		R	R	S	S	S	S	S	S	S	S
Levofloxacin		I	S	S	S	S	S	S	S	S	S
Linezolid		S	S	S	S	S	S	S	S	S	S
Moxifloxacin		I	S	S	S	S	S	S	S	S	S
Mupirocin		R	R	S	S	R	R	S	R	R	S
Oxacillin		R	R	S	S	S	S	S	S	S	S
Rifampin		I	S	S	S	S	S	S	R	S	S
Synercid		S	S	S	S	S	S	S	S	S	S
Teicoplanin		S	S	S	S	S	S	S	S	S	S
Tetracycline		S	S	S	S	S	S	S	S	S	S
Trimeth/Sulfa		S	S	S	S	S	S	S	S	S	S
Vancomycin		S	S	S	S	S	S	S	S	S	S
Susceptible %	**F**	9	15	18	17	19	19	20	16	18	18
	%	45	75	90	85	95	95	100	80	90	90
Intermediate %	**F**	5	1	–	1	–	–	–	–	1	–
	%	25	5	0	5	0	0	0	0	5	0
Resistant %	**F**	6	4	2	2	1	1	–	4	1	2
	%	30	20	10	10	5	5	0	20	5	10



CONCLUSION

This study ascertained that the screens and metallic keyboards of ATMs could act as vehicles of infectious diseases, therefore hand washing and good hygiene practice should be adopted before and after using of ATMs. Furthermore, ATMs screens and keyboards should be cleaned regularly with an appropriate disinfectant. All these precautions must be considered to reduce the population of microbes, which play an important role in diseases transmission.

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