ISSN 2348 – 0319 International Journal of Innovative and Applied Research (2017)
Volume 5, Issue 5
82-88

Journal home page: http://www.journalijiar.com

INTERNATIONAL JOURNAL OF INNOVATIVE AND APPLIED RESEARCH

RESEARCH ARTICLE

VENDING MACHINE BUTTONS AND TOUCH SCREENS: A SURFACE COLONIZED BY PATHOGENIC BACTERIA.

Rozan Dakroub and *Tarek Nawas
Natural Sciences Department, Lebanese American University, Beirut – Lebanon.

***Corresponding Author:-* Tarek Nawas.**

Abstract:

As potentially pathogenic organisms were previously isolated from different inanimate objects, it was decided to investigate, in this study, the extent of contamination of the press buttons or touch screens of public vending machines, that have now become so diverse and distributed in almost all public areas in any community. Twelve vending machines located in different places in public areas in the Ras-Beirut area were included in the study. Standard microbiology laboratory techniques were conducted and several bacterial species were isolated from the tested sites of the machines in the following frequencies: *S. aureus* (67%), coagulase-negative staphylococci. (33 %), *Enterobacter cloacae* (25%), *Klebsiella pneumoniae* (17 %), *Citrobacter freundii* (17%), *Serratia ficaria* (17%), *Rahnella aquatilis* (17%), *Escherichia vulneris* (8 %), *Pantoea* sp. (8 %), *and Serratia plymuthica*(8 %). Vending machine buttons or touch screens were proved to act as vehicles of potential pathogens, unintentionally having a significant impact on the general health of the community. The results of this study suggest the need for improved sanitization of the vending machine buttons or touch screens. However, in order to minimize the exposure to pathogens and transmission of any microbial infections among users of the vending machines, it is also recommended that proper individual hygienic precautionary measures be always taken.

Key Words:- Bacterial contamination, *Enterobacteriaceae*, Pathogenic bacteria, *Staphylococcus aureus*, Vending machine buttons.

Introduction:-

The most common mode of transmission of infectious agents in a community is contact. The spread of pathogenic microorganisms is possible either through direct physical contact among people or through contact with contaminated inanimate objects (fomites) and surfaces (Memišević et al., 2013). Studies have revealed that contaminated fomites are involved in the spread of infectious diseases (Scott and Bloomfield, 1990; Rusin et al., 2002; Memišević et al., 2013). Many people are not aware of the fact that microbes are found on many common outdoor objects, in their offices, and even their own homes. Such objects include escalator handrails, shopping carts handles in supermarkets, office desks, computer keyboards or mice, elevator buttons, kitchen sinks, etc. (Joshaline, 2014; Hamze and Na'was, 2015). ATM devices were, as well, shown to potentially accumulate pathogenic bacteria and play a role in their transmission in the community (Mehmet et al., 2013). ATM machines were shown to potentially pathogenic organisms including: *Escherichia coli, Staphylococcus aureus, Klebsiella* spp. and *Serratia* spp. (Joshaline, 2014). A study by Memišević et. al. (2013) proved that public telephones acted as vehicles of disease transmission, since they are handed by many different people. Many potential pathogens including *S.aureus*, coagulase-negative staphylococci, *E. coli, Klebsiella* spp. and *Pseudomonas aeruginosa.* were isolated from the phones the team examined (Memišević et. al., 2013). Another study by Bures et al. (2000), also confirmed that computer keyboards and faucet handles are significant reservoirs of nosocomial pathogens (Bures et al., 2000). Also, a study by Itah and Ben (2004) revealed the presence of enteric bacteria and *S. aureus* in varying proportions on door handles, chairs, children's tables, and many more objects found in day care centers. Some of the organisms encountered in that study were: *S. aureus, E*scherichia *vulneris, Klebsiella* spp .and *Citrobacter* spp.. These and other bacteria encountered in that work are known to be opportunistic pathogens of man (Itah and Ben, 2004). Hamze and Na'was (2015) proved that computer mice, in public centers, can be contaminated by common pathogens like *S. aureus* and *E. coli* and can help in the transmission of the organisms in the community.

A vending machine is an operational machine found at a client site or in a public place designed specifically for the supply of food, drinks, and other goods. Manufacturers of vending machines design machines that dispense food, water, juices and other items such as hygienic products, electronic goods and many more. It is estimated that, only in Europe, there are about 295 million consumers who use vending machines at least once a week. (European Vending Association, 2014; Cardaci et al., 2016). The total number of vending machines in the U.S is much greater than that in Europe (6,900,000 vending machines), of which 56 % are those that dispense soda and cold drinks (Statistic Brain Writer, 2017). Japan today, however, has the highest per capita rate of vending machines in the world with the great majority still being drink machines (Aschcraft, 2016).

Nowadays, vending machines can be found in almost all public settings like schools, universities, malls, etc. Vending machine companies, do not cease to introduce newer items for sale and newer models of the machines. Some of the newer models use advanced technology and require internet connectivity and the use of large touchscreens to interact better with the consumer (European Vending Association, 2014). The fact remains, however, that vending machines have multiple users, in addition to technical workers, who continuously handle these machines, a reason for assuming that bacterial contamination of their parts is very likely. The aim of this study was to investigate and define the bacterial contamination of the buttons or touch screens of twelve different vending machines located in public areas.

Materials and Methods:-

I-Vending machines:-

In the study, 12 public vending machines available for university students and other members of the Ras Beirut community were included in the study. Five were coffee machines, four dispensed food, one dispensed water bottles and the remaining two dispensed both food and drink.

II- Sample collection:-

Single sterile cotton swabs immersed in Trypticase Soy Broth (TSB) were used to obtain samples from the order press buttons or touch screen of each machine by slowly, but firmly, rotating the swab on the different buttons (or touchscreen) of the same machine. The swabs were then re-immersed in the TSB broth to ensure that they will not dry and were taken immediately to the microbiology laboratory for processing.

III- Processing:-

Upon receipt of the specimens, the swabs were directly used to inoculate the following media: Mannitol Salt Agar (MSA), MacConkey Agar (MA), Salmonella-Shigella Agar (SS), Cetrimide Agar (CA), and Trypticase Soy Agar (TSA). The swabs were returned to the TSB tubes that were then incubated. The inoculated plates were properly streaked and incubated for 24 hrs. at 35ºC, along with the TSB tubes containing the original swabs. After the incubation period, any growth on any of the plates was isolated for identification. If no growth was seen after the initial period of incubation, the plates were re-incubated for 24 more hours after which they were discarded if no growth appeared on their surfaces. The TSB tubes which contained the original sample swabs were, after the incubation period used to inoculate the same set of plates following the same procedure above. All isolated organisms were kept on TSA slants for definitive identification.

IV- Identification of isolates:-

All isolated organisms from all media were streaked again on TSA plates to ensure their purity and were then Gram stained. The following tests were done for Gram positive organisms: catalase, DNase and coagulase using rabbit plasma. The following standard tests were initially done for the isolated Gram negative organisms: catalase, oxidase, growth on Kligler's iron agar (KIA). After the preliminary set of tests, the confirmation of the identity of the Gram-negative isolates was done using the Api20E strips (Biomerieux- France).

Results:-

The results of this study are summarized in Table 1 which shows the type of vending machine, its location and the organisms isolated from its buttons/touch screen. Although it was expected that the samples will grow some organisms, yet the results demonstrated in Table 1 were very informative. It was noted that bacteria were isolated from the buttons of all machines with no preference as to the location of the machine. Moreover, the buttons from all the machines grew more than one organism except for 3 machines that only grew *S. aureus*. *Staphylococcus* spp. grew from the buttons of all machines and it was notable that the most pathogenic species in the genus, *S. aureus*, grew

from 67% of the samples. The other organisms isolated, in order of frequency of isolation from the different machines, were the following: coagulase-negative staphylococci. (33 %), *Enterobacter cloacae* (25%), *Klebsiella pneumoniae* (17 %), *Citrobacter freundii* (17%), *Serratia ficaria* (17%), *Rahnella aquatilis* (17%), *Escherichia vulneris* (8 %), *Pantoea* sp. (8 %), *and Serratia plymuthica* (8 %).

Table 1:- A summary of the types of vending machines tested, their location and the organisms isolated from their buttons / touch screen.

Machine number	Type of Machine	Location	Isolated organisms
1	Food and drink	Lobby	*Klebsiella pneumoniae* *Serratia plymuthica* *Citrobacter freundii* Coagulase-negative *Staphylococcus*
2	Water	Lobby	*Rahnella aquatilis* *Staphylococcus aureus*
3	Food	Lobby	*Serratia ficaria* *Staphylococcus aureus*
4	Food	Hallway near toilets	*Escherichia vulneris* Coagulase-negative *Staphylococcus*
5	Food	Hallway near toilets	*Enterobacter cloacae* *Staphylococcus aureus*
6	Food	Lobby	*Rahnella aquatilis* *Serratia ficaria* *Staphylococcus aureus*
7	Food and drink	Hallway near toilets	*Staphylococcus aureus*
8	Coffee	Lobby	*Staphylococcus aureus*
9	Coffee	Lobby	*Staphylococcus aureus*
10	Coffee	Hallway near toilets	*Enterobacter cloacae* *Citrobacter freundii* Coagulase-negative *Staphylococcus*
11	Coffee	Hallway near toilets	*Enterobacter cloacae* *Staphylococcus aureus*
12	Coffee	Lobby	*Klebsiella pneumoniae* *Pantoea* sp. Coagulase-negative *Staphylococcus*

Discussion:-

Vending machines provide convenience, speed, and 24/7 opening. They are very useful and can sell almost any product. The research and development departments of vending machine companies continue to develop new and "tasty" products that are also reported as "healthy". In addition to providing hydration and energy products, machines offer social benefits as they are a natural place to meet with colleagues or friends (European Vending Association, 2014). What has made these machines more important is the tendency of professionals to save time, when possible, a reason why many have become dependent on them to, without delay, get their needs of food or drink and other necessary items, whenever needed.

Bacterial contamination of certain parts of vending machines has already been assessed. A study by Nelms and Barnes (1997), which investigated the contamination of the dry mix, water, and drink samples of hot chocolate dispensing machines, concluded that 7 out of 39 hot chocolate machines were positive for *Bacillus cereus*, with the drinks of 2 highly contaminated making those likely to cause illness. The study showed how the machines can be a source of unreported illnesses and therefore signifies the importance of testing vending machines every once in a while, especially in settings involving those who are susceptible to illnesses, such as the aged and immunosuppressed population (Nelms and Barnes, 1997). Another, more recent study (Cardaci et al., 2016) examined the contamination of the dispensing area, the nozzle, and the glass-holder of coffee vending machines. The study was carried out on four hot-drinks vending machines. The results revealed that nozzles were significantly more contaminated than the dispensing area and the glass-holder (Cardaci et al., 2016). This study recommended further examinations to be

conducted on vending machines, since they were seen to constitute a potential threat for the consumer's health. The present study investigated another section of the vending machines, namely the press buttons or the touch screens, but also confirmed the results of the previous reports (Nelms and Barnes, 1997; Cardaci et al., 2016) which implied that vending machines can be heavily contaminated with bacteria and can be related to illnesses.

There were many bacterial species isolated from the press buttons and touchscreens of the vending machines included in this study. The Gram-positive organisms were all members of the genus *Staphylococcus*. Every one of the machines grew members of this genus. Whereas 8 machines (67 %), grew *Staphylococcus aureus*, the other 4 (33 %), grew coagulase negative staphylococci. Whereas *Staphylococcus aureus* is known to be both a commensal bacterium and a human pathogen it was recognized as a leading cause of bacteremia and infective endocarditis as well as osteoarticular, skin and soft tissue, pleuropulmonary, and device-related infections in addition to being a primary nosocomial pathogen (Lowy, 1998; Itah and Ben, 2004, Wertheim et al. 2005, Tong et al. 2015). The coagulase-negative staphylococci, on the other hand, many of which are members of the normal microbial flora of humans, also represent a major group of nosocomial pathogens and were found to be the predominant pathogens in primary bloodstream, foreign body-related and other nosocomial infections worldwide, especially in developing countries (Becker et al., 2014; Rogers et al., 2009; Rubino et al. 2014).

The Gram-negative organisms, isolated in this study, were all members of the family *Enterobacteriaceae*. Most members of this family are known to be ubiquitous and found in the environment and gastrointestinal tract of humans and animals, but may can also cause serious diseases, such as pneumonia, wound infections, meningitis and foodborne diseases in man (Wang et al., 2000; Sharma et al., 2003, Go Pets America, 2017; Yu and Chuang, 2017).

The following genera, which were among those isolated in this study, *Escherichia, Klebsiella, Enterobacter, Serratia,* and *Citrobacter*are known to include opportunistic pathogens responsible for a wide range of infections (Itah and Ben, 2004). *Klebsiella* and *Enterobacter* species are known to be common urinary tract pathogens. *Klebsiella pneumoniae* specifically causes severe pneumonia. These same genera are responsible for around 50% of nosocomial infections, of which *Enterobacter* and *Klebsiella* species are of the most common pathogens in causing nosocomial pneumonias (Guentzel, 1996; Davin-Regli and Pagès, 2015). *Citrobacter freundii*is an opportunistic pathogen that is responsible for a number of significant infections including urinary, blood, peritoneal and intraabdominal and respiratory tract infections(Shih et al., 1996; Sharma et al., 2003). *Serratia* species are also opportunistic bacteria that can grow well in diverse environments and in the digestive tracts of various animals and can cause severe infections (Climaco, 2017). *Serratia ficaria* was reported to cause gallbladder and bile duct infections, empyema, septicemia and many other infections (Gill et al., 1981; Pien and Farmer, 1983; Brouillard et al., 1984; Anahory et al. 1998); while, *Serratia plymuthica* is also considered a potential opportunistic pathogen for animals and humans and was a cause of human infections (Zbinden and Blass, 1988; Carrero et al., 1995; Vivas et al., 2000).

Even organisms that were isolated in low frequencies in this study also turned out to be significant potential pathogens. *Rahnella aquatilis*is associated with human disease mainly in immunosuppressed individuals. It was reported to cause various infections including: bacteremia, sepsis, respiratory, and urinary tract infections (Alballaa et al. 1992; Maraki, et al., 1994; Chang et al., 1999; Tash, 2005). *Escherichia vulneris,* on the other hand, is an organism that can colonize the respiratory tract, female genital tract, urinary tract, and stool of humans, but was also associated with opportunistic but very serious human infections (Brenner et al., 1982, Jepsen et al., 1997; Mohanty et al., 2005; Senanayake et al., 2006, Jain et al., 2016).Moreover, the isolated *Pantoea* sp., which was recently removed from the genus *Enterobacter*, is also reported to be a cause of numerous infections in humans (Delétoile et al., 2009; Laporte et al., 2002; Kratz et al., 2003; Lim et al., 2006).

There may have been many reasons for the presence of the isolated organisms on the press buttons and touch screens of the tested machines, ranging from possible shedding from the body, clothing, beddings, and nostrils of customers, and even be carried from (or to) there by dust particles. *S. aureus*, for example is known to colonize approximately 30% of the human population (Wertheim et al. 2005) and is known to be a main component of their normal flora of the skin and nostrils. Therefore, it can be easily discharged through their normal human activities including sneezing, talking, and contact with moist skin (Itah and Ben, 2004). Another as probable a reason for the presence of these organisms is related to hygiene and sanitization. It was reported that across Europe, vending employs people with low qualifications and offers them with training on sanitization and/or technical issues (European Vending Association, 2014). This training, however, may not be sufficient to prevent avoidance of cross contamination.

Moreover, due to the urge of companies to attract more consumers, vending machines were placed in public toilets, to sell different items and outside toilets for convenience to sell food and drink. Accordingly, failure of an individual to properly wash his/her hands properly makes the vending machine buttons, which they may turn to, prone to become contaminated. The isolation of the enteric organism, *E. cloacae*, in this study only from machines placed near toilets supports this assumption. However, the isolation of other enteric organisms like *K. pneumoniae*, only from machines located in lobbies, indicates that the issue is more than mere contamination near toilets. Many different individuals with different hygienic practices use these machine, a cause of possible cross contamination with different microorganisms and spores. What magnifies the problem more, is the absence of regular and proper sanitization procedures to clean the machines that are placed in the different public locations (Hall et al., 2007), not overlooking, however, the fact that some species like those of *Klebsiella*, *Enterobacter*, and *Serratia* have shown, over time, increased resistance to disinfectants (Guentzel, 1996).

The investigation of the bacterial load on vending machine press buttons and touch screens is valuable to increase awareness about the possible transmission of pathogens to the public. In addition to highlighting the fact that contact between the external surfaces of the machine and food or beverage taken from the machine, can lead to the transmission of microorganisms or spores, thus threatening the consumer's health. For this reason, frequent disinfection of vending machine buttons and touch screens using disinfectant wipes before and after use may be beneficial in limiting the bacterial accumulation and their transmission. Personal hygiene and good hand washing were found to be effective methods for preventing pathogen transmission through fomites, since it is extremely difficult to completely eliminate all bacteria from surfaces (Nwankwo and Offiah, 2016). Users of vending machines are requested to strictly adhere to proper hand washing and disinfection after using the vending machine, thus reducing the possibility of their acquiring or spreading infectious agents.

In conclusion, this study shows that the press buttons or touch screens of vending machines can harbor a considerable number of microorganisms that are considered potential pathogens that can endanger the health of the consumers. Proper hand washing by individual consumers after using the machines and proper and regular sanitization of the machines are expected to be effective in minimizing the possible danger associated with the use of these machines.

References:-

1. Alballaa SR, Qadri SMH, Al-Furayh O and Al-Qatary K. 1992. Urinary tract infection due to *Rahnella aquatilis* in a renal transplant patient. J. Clin. Microbiol. 30:2948–2950
2. AnahoryT, Darbas H, Ongaro O, Jean-Pierre H and Mion P. 1998. *Serratia ficaria*: a Misidentified or Unidentified Rare Cause of Human Infections in Fig Tree Culture Zones. Journal of Clinical Microbiology 36(11):3266-3272.
3. Aschcraft, B. 2016. The World of Japanese Vending Machines. [KotakuEast - Weblog]. Available online at: http://kotaku.com/the-world-of-japanese-vending-machines-5988536
4. Becker K, Heilmann C and Peters G. 2014. Coagulase-Negative Staphylococci. Clinical Microbiology Reviews 27(4):870–926.
5. Brenner DJ, McWhorter AC, Knutson JKL and Steigerwalt AG.1982. *Escherichia vulneris*: a new species of *Enterobacteriaceae* associated with human wounds. Journal of Clinical Microbiology 15(6):1133–1140.
6. Brouillard JA, Hansen W, Compere A. 1984. Isolation of *Serratia ficaria* from human clinical specimens. J Clin Microbiol. 19:902–904.
7. Bures S, Fishbain JT, Uyehara CF, Parker JM and Berg BW. 2000. Computer keyboards and faucet handles as reservoirs of nosocomial pathogens in the intensive care unit. American Journal of Infection Control 29(2):131-132.
8. Cardaci R, Burgassi S, Golinelli D, Nante N, Battaglia MA, Bezzini D and Messina G. 2016. Automatic vending-machines contamination: a pilot study. Global Journal of Health Science 9(2), 63.
9. Carrero P, Garrote JA, Pacheco S, García AI, Gil R and Carbajosa SG. 1995. Report of six cases of human infection by *Serratia plymuthica*. *Journal of Clinical Microbiology* 33(2):275-276.
10. Chang, CL, Jeong, J, Shin JH, Lee EY, Son HC. 1999. *Rahnella aquatilis* Sepsis in an Immunocompetent Adult**.** J. Clin. Microbiol. 37(12):4161-4162
11. Climaco AB. 2017. *Serratia*. *Medscape*. Available online at: http://emedicine.medscape.com/article/228495-overview
12. Davin-Regli A and Pagès JM. 2015. *Enterobacter aerogenes* and *Enterobacter cloacae*; versatile bacterial pathogens confronting antibiotic treatment. Frontiers in Microbiology 6: 392.

13. Delétoile A, Decré D,Courant S, Passet V, Audo J, Grimont P, Arlet G and Brisse S. 2009.Phylogeny and identification of *Pantoea* species and typing of *Pantoea agglomerans* strains by multilocus gene sequencing. Journal of Clinical Microbiology 47(2), 300-310.
14. European-Vending-Association. 2014. Telling the good story of coffee service and vending. EVA-alsbl. Available online at: file:///C:/Users/Sanford/Downloads/an_introduction_to_vending-update-2014%20(1).pdf
15. Gill VJ, Farmer III JJ, Grimont PAD, Asbury MA and McIntosh CL. 1981. *Serratia ficaria* isolated from human clinical specimen. J Clin Microbiol. 14:234–236.
16. Go Pets America. 2017. Infections associated with *Pantoea* bacteria. (n.d.). *Go Pets* America. Available online at: http://gopetsamerica.com/bio/bacteria/pantoea.aspx
17. Guentzel MN. 1996. *Escherichia*, *Klebsiella*, *Enterobacter*, *Serratia*, *Citrobacter*, and *Proteus*. In: Medical Microbiology. Chapter 26. (4rth ed.). The University of Texas Medical Branch at Galveston. Bookshelf ID: NBK8035. PMID: 21413290
18. Hall A, Short K, Saltmarsh M, Fielding L and Peters A. 2007. Development of a microbial population within a hot-drinks vending machine and the microbial load of vended hot chocolate drink. Journal of Food Science 72(7):263-266.
19. Hamze F and Na'wasT. 2015. Computer Mice in Public Centers: A Source of Pathogenic Bacteria. ARPN Journal of Science and Technology 5(11): 537-539.
20. Itah AT, Ben AE. 2004. Incidence of enteric bacteria and *Staphylococcus aureus* in day care centers in Akwa-Ibom state, Nigeria. Southeast Asian Journal of Tropical Medicine and Public Health 35(1):202.
21. Jain S, Nagarjuna D, Gaind R, Chopra S, Debata PK, Dawar R, Sardana R and Yadav M. 2016. *Escherichia vulneris*: an unusual cause of complicated diarrhoea and sepsis in an infant. A case report and review of literature. New Microbes and New Infections 13:83-86. doi:10.1016/j.nmni.2016.07.002.
22. Jepsen CF, Klebe TM and Prag J. 1007. *Escherichia vulneris* in a Danish soccer wound. Scand J Infect Dis. 29:313–314.
23. Joshaline CM. 2014. Automated teller machine (ATM) - a "pathogen city" – a surveillance report from locations in and around Madurai city,Tamil Nadu, India. International Journal of Public Health Science (IJPHS) 3(1):51-56.
24. Kratz A, Greenberg D, Barki Y, Cohen E and Lifshitz M. 2003. *Pantoea agglomerans* as a cause of septic arthritis after palm tree thorn injury; case report and literature review. Arch. Dis. Child. 88, 542-544.
25. Laporte C, Demachy MC and Thevenin-Lemoine C. 2002. Tibial osteitis caused by *Pantoea agglomerans* after open grade IIIB tibial shaft fracture. Rev. Chir. Orthop. Reparatrice Appar. Mot. 88, 625-627.
26. Lim PS, Chen SL, Tsai CY and Pai MA. 2006. *Pantoea* peritonitis in a patient receiving chronic ambulatory peritoneal dialysis. Nephrology (Carlton). 11:97-99.
27. Lowy FD. 1998. *Staphylococcus aureus* infection. N Engl J Med 339:520-532
28. Maraki S, Samonis G, Marnelakis E and Tselentis Y. 1994. Surgical wound infection caused by *Rahnella aquatilis*. J. Clin. Microbiol. 32:2706-2708.
29. Mehmet ST, Yusuf Y, Baris O, Yucel D, and Nilay G. 2013. Bacteria found on banks automated teller machines (ATMs). African Journal of Microbiology Research 7(16):1619-1621.
30. Memišević S., Jerković-Mujkić A and Bešta R. 2013. Bacterial contamination of public telephones in the downtown area of Sarajevo.African Journal of Microbiology Research7(17):1664-1667.
31. Mohanty S, Chandra SP, Dhawan B, Kapil A and Das B.K. 2005. Meningitis due to *Escherichia vulneris*. Neurol India. 53:122–123.
32. Nelms L and BarnesJ.1997. Time to *B. cereus* about hot chocolate. Public Health Rep. 112(3): 240-244.
33. Nwankwo EO and Offiah JC. 2016. Bacterial contamination of user interface of automated teller machines (atm) of various banks in Umuahia Metropolis, AbiaState, Nigeria. International Journal of Tropical Disease & Health 13(3): 1-9.
34. Pien FD amd Farmer J J., III. 1983. *Serratia ficaria* isolated from a leg ulcer. South Med J. 76:1591–1592.
35. Rogers KL, Fey PD, Rupp ME. 2009. Coagulase-negative staphylococcal infections. Infect Dis Clin North Am 23:73- 98.
36. Rubino C, Brongo S, Pagliara D, Cuomo R, Abbinante G, Campitiello N, Santanelli F, Chessa D. 2014. Infections in breast implants: a review with a focus on developing countries. J Infect Dev Ctries 12: 1089-1095. doi: 10.3855/jidc.3898
37. Rusin P, Maxwell S and Gerba C. 2002. Comparative surface-to-hand and fingertip-to- mouth transfer efficiency of Gram-positive, Gram-negative bacteria and phage. J. Appl. Microbiol. 93:585-592.
38. Scott E and Bloomfield SF. 1990. The survival and transfer of microbial contamination via cloths, hands and utensils. J. Appl.Bacteriol.68:271-278.

39. Senanayake SN, Jadeer A, Talaulikar GS and Roy J. 2006. First reported case of dialysis-related peritonitis due to *Escherichia vulneris*. *Journal of Clinical Microbiology* 44(11):4283-4284.
40. Sharma RK, Kumar J, Gupta A and Gulati S. 2003. Peritoneal infection in acute intermittent peritoneal dialysis. Ren Fail 25:975–980.
41. Shih CC, Chen YC, Chang SC, Luh KT and Hsieh WC. 1996. Bacteremia due to *Citrobacter* species: significance of primary intraabdominal infection. Clin Infect Dis 23:543-549.
42. Statistic Brain Writer. STATS. 2017. Vending machine industry statistics. *Statistic Brain Research Institute*. USA.
43. Tash, K. 2005. *Rahnella aquatilis* bacteremia from a suspected urinary source. J Clin Microbiol. 43(5):2526-2528.
44. Tong SYC, Davis JS, Eichenberger E, Holland TL, Fowler VG. 2015. *Staphylococcus aureus* Infections: Epidemiology, Pathophysiology, Clinical Manifestations, and Management. Clinical Microbiology Reviews 28(3):603-661. doi:10.1128/CMR.00134-14.
45. Vivas J, González JA, Barbeyto L and Rodríguez LA.2000. Identification of environmental *Serratia plymuthica* strains with the new combo panels type 1s. Mem Inst Oswaldo Cruz. 95(2):227-229.
46. Wang JT, Chang SC, Chen YC, Luh KT. 2000. Comparison of antimicrobial susceptibility of *Citrobacter freundii* isolates in two different time periods. J Microbiol Immunol Infect 33(4): 258-262.
47. Wertheim HF, Melles DC, Vos MC, van Leeuwen W, van Belkum A, Verbrugh HA, Nouwen JL. 2005.The role of nasal carriage in *Staphylococcus aureus* infections. Lancet Infect Dis 5:751–762. doi:10.1016/S1473-3099(05)70295-4
48. Yu WL and Chuang YC. 2017. Clinical features, diagnosis, and treatment of *Klebsiella pneumoniae* infection. UpToDate. Wolters Kluwer. Calderwood, SB (editor).
49. Zbinden R and Blass R. 1988. *Serratia plymuthica* osteomyelitis following a motorcycle accident. J Clin Microbiol. 26(7):1409–1410