Bacteria Associated with Students' Mobile Phones- Caritas University, Enugu State

Abstract

Mobile phones have become indispensable in all walks of life; nevertheless, their potential role in transmission of infections is of great concern. A cross-sectional study (male and female) was done from June to August 2018 at Caritas University, Amorji-Nike, Enugu State, in order to investigate the prevalence of bacterial contamination of mobile phones of students. Swab samples were collected from 50 mobile phones of Caritas University students. These were tested for bacterial contamination in the Microbiology laboratory. Quantification of bacteria was performed using standard streak plate technique. Isolated bacteria were identified using standard microbiological methods which includes: cultural and morphological characterization, and biochemical test. Antimicrobial susceptibility was also done. The microorganism isolated from students' mobile phones and their percentage frequency of occurrence were: *E. coli* (31.9%), *S. aureus*(40.4%), *P. aeruginosa* (8.5%), *K. pneumonia* (4.3%) and *Streptococcus sp.* (14.9%). The result showed that *Staphylococcus sp.* has the highest percentage of occurrence.The antibiotic sensitivity test indicated the varied resistance of isolated bacteria to antibiotics used in this study, although most isolated bacteria were sensitive to erythromycin and chloramphenicol exceptthe isolates of *E. coli* which were the most resistant to the antibiotics used.In conclusion, the high prevalence of bacterial agents isolated from students' mobile phones was attributed to poor hygiene and sanitary practices. It is recommended that students should wash their hands after using mobile phones, before eating or undertaking any venture requiring sepsis.

Introduction

A mobile phone is a portable electronic device for personal telecommunication. Aside the standard voice function of mobile phone, mobile phones can support many additional services such as SMS for text messaging, email, pocket switching for access to the internet and MMS for sending and receiving photos and video (Al-Abdalall, 2010; Ekrakene *et al.*, 2007) and they are widely used by students especially those in the university. Smart phones are widely used to integrate contact information that enable one to keep in touch with friends, family and co-workers much easier. Further it also enables the navigation of important life activities, finding information on health conditions, accessing the educational resources, online banking, reading news, finding driving directions and search for job and employment resources etc. As mobile phone usage has been expanded, there are many concerns about overuse of the technology. Despite the many advantages of the mobile phones, there are certain disadvantages like addiction, hindering real human to human interaction or socialization, leading to serious accidents while using the mobiles during driving, decreasing worker productivity, etc. In certain instances, the mobile phone overuse violates traditional norms of social behavior and is becoming an emerging safety concern. Mobile phone addiction, "***the newest cigarette***" in the world, has affected many people's life quality and the relationship with others and the addiction of children to mobile phones could threaten the very fabric of the society (King *et al*., 2012). Apart from socio-psychological risks, it is important to assess the new or emerging health risks associated or caused by mobile phones use. It is a known fact that the electromagnetic field used by the mobile phones and the radiations emitted by them could harm the human body. Overexposure to electromagnetic waves and/or radiations from mobile phones might cause disturbance in sleep, difficulty in concentration, fatigue, headache, earache, disorientation, muscle and eye strain, dizziness, increase the resting blood pressure, reduce the production of melatonin,

brain tumors, infertility and implicated in DNA strand breaks (Khan, 2008; Samkange-Zeeb & Blettner, 2009; Hardell & Sage, 2008). Moreover, compared to the other stationary objects, mobile phones have become part of so-called emotional technology and are frequently used in the environment with heavy microbial presence. Constant handling of the phone by different users, heat generated by the phones and humid conditions creates a prime breeding ground for many microorganisms. The ability of the microbes to survive on the contact surfaces of the mobile phone makes it one of the important fomites that may play a role in the spread of different microorganisms from user to user. A study to determine the transfer efficiency of micro-organisms by fomites suggests that the Gram-positive bacteria are transmitted most readily followed by viruses and Gram-negative bacteria (Rusin *et al.*, 2002). It has been shown that a significant number of germs could be transferred between the hands of the users of mobile phones, and vice versa (Ulger *et al*., 2009).

With all the achievement of mobile phones, it is easy to overlook the health hazard it might pose to its many users. The constant handling of mobile phones by university students makes it an open breeding place for transmission of microorganisms, this is especially so with those associated with skin due to the moisture and optimum temperature of human body especially our palms. These factors and the heat generated by mobile phones contribute to harboring bacteria on the device at alarming levels.

Apart from the studies on the bacterial contamination of mobile phones among health care workers and non -health care workers, many studies indicate bacterial contamination in mobile phones owned by university students. Studies on bacterial contamination of mobile phones and their antibiotic susceptibility pattern among students of University of Cape coast Ghana revealed that all sampled mobile

phones had high contamination of variety of bacteria with high resistance to common antibiotics (Tagoe *et al.*, 2011). Another study done among the students of Faculty of Health Sciences, University of Ljubljana, Slovenia had shown that there was a statistically significant relationship between gender and microbiological contamination of the mobile phones, such as mobile phones from female users were highly colonized with bacteria compared with those mobile phones from male students (Andrej *et al.*, 2012). A study carried out in an Indian Dental school revealed that the mobile phones may act as an important source of nosocomial pathogens in the dental setting. The most common organisms isolated from the mobiles from the above study were Coagulase-negative *Staphylococcus, Staphylococcus aureus, Bacillus spp., Acinetobacter, Pseudomonas, Micrococci, Staphylococcus citreus*, and *Diphtheroids* (Singh *et al*., 2010).

The aims of this study were:To determine whether mobile phones play a vital role in the spread of bacterial pathogens, to determine the bacterial contamination of Caritas University students' cell phones, to isolate bacteria of medical importance from mobile phones of Caritas University students, to determine the nature of the isolates and to proffer possible control and preventive measures that could constitute to avoid this likely vehicle of infection.

Materials and Methods

Study area and design

Across-sessional study was conducted on students' mobile phones from June to August 2018, at Caritas University,a private University located in Amorji-Nike, Emene, Enugu State, Eastern Nigeria, with a population of over 2500 students, with 4 faculties and 22 departments consisting of both male and female.

Sample Collection

A total of 50 samples were collected using sterile cotton swab frommobile phones of both male and female students in the university. Before taking a swab, both hands were cleaned using an alcohol-based instant hand sanitizer and powder-free disposable gloves were worn per sample throughout the work to prevent cross-contamination.From the 50 swab samples collected from mobile phone, two belonged to two different students in each department who volunteered. The swabs were first moistened with sterile saline solution and the target phones were wiped on the surface of both sides of the mobile; that is, over the keypad and back of the mobile phones. In cases of mobile phones with covers, swab was taken from the outer surfaces of the cover. Then, the mobile phone swab was placed immediately into a sterile normal saline in a sterile container, properly labelled to avoid mistakes and transported to the Microbiology Laboratory within 30 minutes for microbiological analysis as described by Shooriabi *et al*.(2016).

The collected samples were inoculated onto Blood Agar and MacConkey Agar by following the standard streak plate technique (Cheesbrough, 2006). The inoculated plates were incubated aerobically at 37^{O}C for 24 – 48h. Primary isolation of bacteria was made based on their colony characteristics and Gram stain reaction microscopically. Different biochemical tests like indole, citrate, oxidase, urease, catalase and coagulase tests were used for further identification.

Antimicrobial Susceptibility Test

Antimicrobial susceptibility test was done according to the Clinical Laboratory Standards Institute guidelines (CLSI, 2016) using the Kirby-Bauer disc diffusion technique. The pure isolate (about four to five colonies) was added to a sterile tube containing 5ml of normal saline and mixed gently until it forms a homogenous

suspension. The turbidity of bacterial suspension was standardized by using 0.5 McFarland standards. A sterile cotton swab was dipped into the suspension and inoculated the bacterial suspension over the entire surface of Mueller Hinton agar and left at room temperature to dry for 3 – 5 minutes. Furthermore, antimicrobial discs were placed by using a disc dispenser on to the Mueller Hinton agar and incubated at 37^{o}C for 18 – 24h. At the end of the incubation period, the diameter zone of inhibition was measured by using a digital caliper. The growth inhibition zone was interpreted as susceptible, intermediate or resistant after comparison with standard guidelines (CSLI, 2016).

Results

The rate of bacterial contamination on students' mobile phones was very high, out of 50 samples collected, only 3 samples had no microbial growth. A total number of five potential clinically relevant microorganisms were isolated, most isolates gave positive reaction to catalase test hence, belong to *Enterobacteriaciae.* The bacteria isolated from students' mobile phones include; *Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Klebsiella pneumonia and Streptococcus sp*. Their percentage frequency of occurrence was; *E. coli,* 15 (31.9%); *S. aureus,* 19 (40.4%); P. *aeruginosa,* 4 (8.5%); *K. pneumonia* 2 (4.3%) and *Streptococcus sp.* 7 (14.9%).

Table 1:Results of Gram Staining, Biochemical Test and Colonial Morphology of Bacterial Isolates.

Colonial Morphology	Gram Staining	Catalase	Indole	Citrate	Urease	Oxidase	Coagulase	Possible Organism
Regular cocci in clusters	+	+	-	-	-	+	+	*Staphylococcus aureus*
Straight rods in singles and two	-	+	+	-	-	-	-	*Escherichia coli*
Regular rods in pairs	-	+	-	+	-	+	-	*Pseudomonas aeroginosa*
Regular rods in chain	-	+	-	+	-	-	-	*Klebsiella pneumoniae*
Cocci	+	-	-	-	-	-	-	*Streptococcus sp.*

KEY: + = Positive ; - = Negative

Table 2: Percentage of Bacteria Isolated from Student Mobile Phones in Caritas University.

S/N	Bacterial Isolates	Number	Percentage(%)

1	*Escherichia coli*	15	31.9
2	*Staphylococcus aureus*	19	40.4
3	*Pseudomonas aeruginosa*	4	8.5
4	*Klebsiella pneumonia*	2	4.3
5	*Streptococcus sp.*	7	14.9
Total			**100**

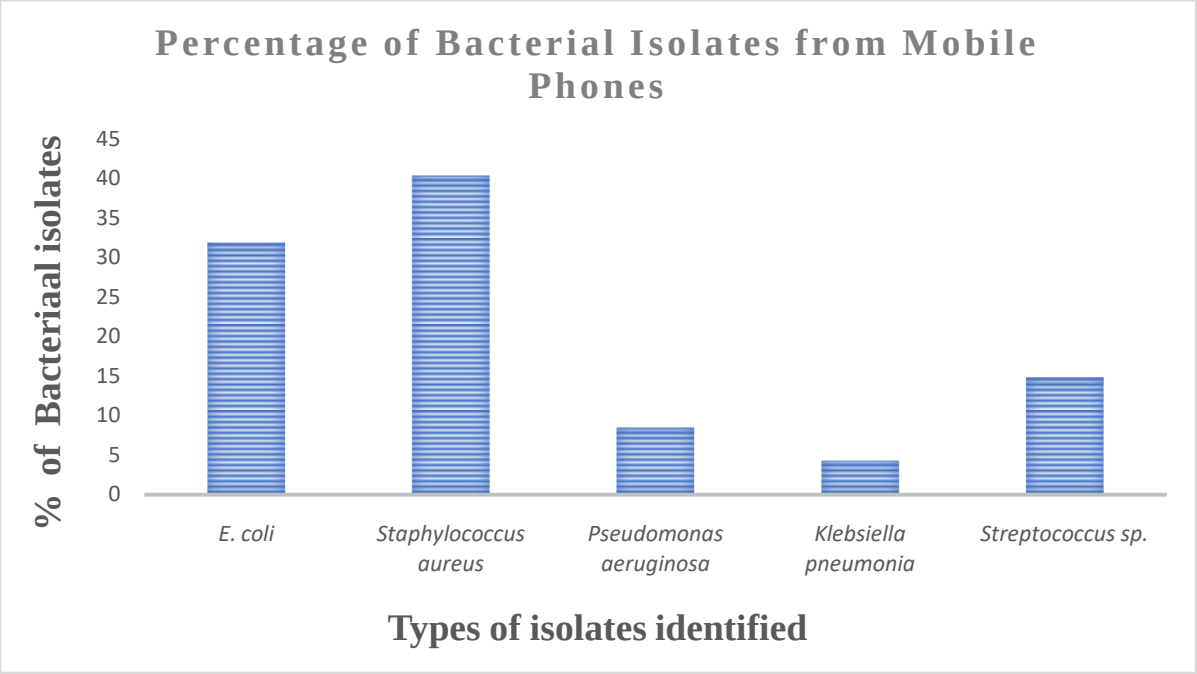

Figure 1: Percentage of bacteria isolated from the Students' mobile phones.

Discussion

In this study of isolating bacteria from students' mobile phones in Caritas University, it was noted that most of the students' mobile phones were contaminated with bacteria, due to the fact that most students are addicted to their phones and most of the times use them in the toilet or rest room which create an avenue for fecal contamination or other sorts of contaminations. This is quite unhealthy. Amadi *et al*., (2010) had similar result with mobile phones of health workers (i.e. Doctors, nurses, technologists, etc).

The world we are living in is a world which is full of microbes, it is not possible to make this world microbe free but microbiological standards and hygiene practices should be adapted by the society for a healthy life. This investigation aimed to isolate and identify bacteria of medical importance on mobile phones and create awareness that mobile phones could also serve as vectors for transfer of diseases from one individual to another. Therefore, personal hygiene and mobile phones' decontamination are much related. The presence of *E. coli,* a member of the coliforms, indicates the possibility of the presence of fecal contamination on the mobile phones, because*E. coli* signifies fecal contamination of hands through poor personal hygiene. This as well stresses the need for better sanitary measures amongst persons. *E. coli* and *P. aeruginosa* have been indicated as the most predominant Gram negative bacteria involved in nosocomial infections (Gaynes and Edward, 2005).

Five potential pathogens were isolated, which are: *E. coli, S. aureus, Streptococcus spp, K. pneumonia and P. aeruginosa.* **Table 1** shows the result of the colonial morphology, gram staining and biochemical tests conducted to identify the isolated bacteria. **Table 2** shows the percentage of the bacteria isolated from students'mobile phones which were: *E. coli,* (31.9%);*S. aureus*, (40.4%);*P. aeruginosa*, (8.5%);*K. pneumonia* (4.3%) and*Streptococcus sp.* (14.9%).

The antimicrobial susceptibility test result showed that the isolated bacteria showed variable sensitivity patterns to different antibiotics tested. The results showed that the isolates of *E.coli* were sensitive to Erythromycin but resistant to other antibiotics that was used. The isolates of *S.aureus* were sensitive to Chloramphenicol, Ceftriaxone, Ciprofloxacin and Erythromycin but resistant to Ampicillin and Gentamicin. *P.aeruginosa* isolates were sensitive to Chloramphenicol and Ceftriaxone, however, were resistant toAmpicillin, Ciprofloxacin, Erythromycin and Gentamicin. The isolates of *K.pneumonia* and *Streptococcus sp* were sensitive to all the antibiotics used in this study.

In a separate study, researchers found that 95% of phones were contaminated with some kind of bacteria, many of which were resistant to multiple antibiotics.By also testing the participants' hands, theresearchers were able to show that a significant number of germs were transferred from their hands to their phones, and vice versa. In fact, about 30% of the bacteria on the phones ended upon the owner's hands (Clean link. Study; 2013).In a study done by (Meadow *et al.*, 2014) they characterized microbial communities on mobile phone touch screens to determine whether there was significant overlap with the skin microbiome sampled directly from their owners. They found that about 22% of the bacterial taxa on participants' fingers were also present on their own phones. (Beckstrom *et al*., 2013) in their study of bacterial contamination of the parent's cell phone in the Neonatal Intensive Care Unit (NICU) and the effectiveness of an anti-microbial gel in reducing transmission to the hands found that all cell phones demonstrated bacterial contamination. 90% had the same bacteria on the cell phone and their cleaned hands and 22% had no growth on their hands after applying anti-microbial gel after they had the same bacteria on the cell phone and hands.

The susceptibility test is important because of the present increasing rate of microbial resistance to antibiotics, because if by chance infected with this organism through mobile phone the drug to inhibit the organism is known. On inanimate objects, (Kramer *et al*., 2006) and (Kampf and Kramer, 2004) have shown that *Staphylococcus spp* is able to persist for 4 weeks to 7 months, *Pseudomonas* for 6 h to 16 months, *Klebsiella* for 2 h to 30 months, and *E. coli* for 5 to 16 months.

Conclusion

These results showed that mobile phones were contaminated with different types of bacteria. Due to their personal nature and proximity to sensitive parts of our bodies in usage, such as faces, ears, lips and hands of users could become veritable reservoirs of pathogens that could result in infections. Hence, personal hygiene and sanitation measures such as hand washing, cleaning of the environment and washing of hand before and after handling of food and phone decontamination should be adopted by people to prevent bacterial infections.These findings substantiate the need for future investigations in order to monitor the transfer of pathogenic bacteria mediated by mobile phones and to educate users on the potential health-risk that may be posed by contaminated fomites such as transmission of infections.

I therefore recommend that it is of utmost necessityto keep mobile phones far from reach of children to prevent transmission of microorganisms. People are also encouraged to put interest to strict personal hygiene and environmental sanitation in order to prevent disease outbreaks and transmission.Developing active preventive strategies like decontamination of mobile phones with alcohol

containing disinfectant might reduce cross-infection.Another way of reducing microbial contamination on mobile phones is by enlightening the public on the microbial colonization of mobile phones and the use of regular cleansing agents and rearranging of their environment.

Using the phone while in the toilet or bathroom and thereafter going to eat food could easily lead to the contamination of the food, despite washing hands after using the toilet hence mobile phones should not be taken to toilets, bathrooms or put on dirty surfaces.Students should avoid sharing their mobile phones to prevent occurrence of different types of bacteria on phone surfaces.

Basol *et al.* (2014) recommended that using either 70% isopropyl alcohol wipes or ethyl alcohol wipes; both were deemed effective in eliminating bacteria on mobile communication devices. Two studies found that due to the uneven surface of a keypad, such devices were able to harbor more bacteria than the smooth surface of touchscreen phones (Pal *et al.*, 2013; Mark *et al.*, 2014).

REFERENCES

Akinyemi, K., Atapu, A., Adetona, O. and Coker, A. (2009). The potential role of mobile phones in the spread of bacterial infections. *Journal of Infection Developing Countries.* **3**(8):628-632.

Al-Abdalall, A. (2010). Isolation and identification of microbes associated with mobile phones in Dammam in eastern Saudi Arabia. *Journal of Family Community Medicine***17**(1):11-14.

Amadi, E.C., Nwagu, T.N. and Emenuga, V. (2013). Mobile phones of health care workers are potential vectors of Nosocomial agents. *African Journal of Microbiology Research.***7**(22): 2276-2781.

Andrej OVCA, Barbara REDNAK, Karmen TORKAR, Mojka Martin (2012). Students' mobile phones- how clean are they?

Basol, R., Beckel, J. and Gilsdorf-Gracie, J. (2014). Bacteria on shared mobile phones can lead to infections. *Nursing in Critical. Care.***9**(4): 57. doi: 10.1097/01.CCN.0000451027.49482.59.

Beckstrom, A, C., Cleman, P.E., Cassis-Ghavami, F.L. and Kamitsuka, M.D. (2013). the isolates of Surveillance study of bacterial contamination of the parent's cell phone in the NICU and the effectiveness of an anti-microbial gel in reducing transmission to the hands. *Journal of Perinatology*.**33**(12):960-3.DOI:10.1038/jp.2013.108.

Beveridge, T. J., Martin, S. A., Kadurugamuwa, J. L. and Li, Z. (1997). Interactions between biofilms and the environment. *FEMS Microbiology Reviews*. **20**(3- 4), 291-303.

Brady R.R., Wasson A., Stirling I., Mcallister C. and Damani N.N. (2006). Is your phone bugged? The incidence of bacteria known to cause nosocomial infection on health care workers' mobile phones. *Journal of Hospital Infection*; **62**, 123-125.

Cheesbrough, M. (2006). District laboratory practice in tropical countries: Cambridge University Press.

CLSI. (2016). Performance standards for antimicrobial susceptibility testing. 26thed. CLSI supplement. M100S. Wayne: Clinical and Laboratory Standrads Institute.

Clean link. Study: Public toilet is cleaner than the average cell phone. 2013 July 18 (cited 2014 May 20). Available from: http://www.cleanlink.com/news/article/Study-Public-Toilet-Is-Cleaner. Than-The-Average-Cell-Phone 15844#sthash. QlwJarRw.dpuf.

Ekrakene, T. and Igeleke, C.L. (2007). Microorganisms associated with public mobile phones along Benin-Sapele express way. *Journal of Applied Science Research*. **3**, 2009- 2012.

Ezhilarasan, R., Suchitra, S., Anaadhi, L. and Kalyani, J. (2010). J*ournal of infection prevention*, **11**, 8790.

Facklam, R. (2002). "What happened to the streptococci: overview of taxonomic and nomenclature changes". *Clinical Microbiology Review***15**(4): 613–30. doi:10.1128/CMR.15.4.613-630.2002. PMC 126867. PMID 12364372.

Gaynes, R. and Edward, J.R. (2005). Overview of nosocomial infections caused by Gram Negative Bacilli. *Clinical Infectious Diseases*. **41**:848-854.

Hardell, L. and Sage, C. (2008). Biological effects from electromagnetic field exposure and public exposure standards. *Biomedicine & Pharmacotherapy = Biomedicine & Pharmacotherapie*, **62**(2), 104-9.

Høiby, N., Ciofu, O. and Bjarnsholt, T. (November 2010). "*Pseudomonas aeruginosa* biofilms in cystic fibrosis". *Future Microbiology*. **5**(11): 1663–74. doi:10.2217/fmb.10.125. PMID 21133688.

Ilusanya, O. A F., Adesanya, O., Adesemowo, O. and Amushan, N. A. (2012) Personal hygiene and microbial contamination of mobile phones of food vendors in Ago-Iwoye town, Ogun State, Nigeria. *Pakistan Journal of Nutrition*, **11**(3), 276-278.

Itah, A. and Essien, J. (2005). "Growth Profile and Hydrocarbon Clastic Potential of Microorganisms Isolated from Tarballs in the Bight of Bonny, Nigeria". *World Journal of Microbiology and Biotechnology*. **21**(6– 7): 1317–22. doi:10.1007/s11274-0046694-z.

Kampf, G. and Kramer, A. (2004). Epidemiologic background of hand hygiene and evaluation of the most important agents for scrubs and rubs. *Clinical Microbiology. Review***17**: 863–893.

Karabay, O., Kocoglu, E. and Tahtaci, M. (2007). The role of mobile phones in the spread of bacteria associated with nosocomial infections. *Journal of Infection in Developing Countries*. **1**(1): 72-73.

Khan, M. M. (2008). Adverse effects of excessive mobile phone use. *International Journal of Occupational Medicine and Environmental Health*, **21**(4), 289-93.

King, D. L., Delfabbro, P. H., Gniffiths, M. D. and Gradisar, M. (2012). Cognitive-behavioral approaches to outpatient treatment of interest addiction in children and adolescents. *Journal of clinical Psychology*, **68**(11), 1185-95.

Kilic, I.H, Ozaslan, M., Karagoz, I.D. and Davutoglu, v. (2009) The microbial colonization of mobile phone used by healthcare staff. *Pakistan journals of biological science*, **78**, 882-884.

Kramer, A., Scwebke, I., Kampf, G. (2006). How long do nosocomial pathogens persist on inanimate surfaces? A systematic review. *BMC Infectious Disease*. **6**:130.

Meadow, J.F, Altrichter, A.E. and Green, J.L. (24 June 2014). Mobile phones carry the personal microbiome of their owners. *Peer Journal*. **2**:e447. DOI:10.7717/peerj.447.

Pal, P., Roy, A., Moore, G., Muzslay, M., Lee, E. and Alder, S. (2013). Keypad mobile phones are associated with a significant increased risk of microbial contamination compared to touch screen phones. *Journal of Infection Preview* **14**(2): 6568. doi: 10.1177/1757177413475903.

Russell, J.B. and Jarvis, G.N. (April 2001). "Practical mechanisms for interrupting the oral-fecal lifecycle of *Escherichia coli*". *Journal of Molecular Microbiology and Biotechnology*. **3**(2): 265–72. PMID 11321582.

Rusin, P., Maxwell, S.S. and Gerba, C. (2002). Comparative surface- to-hand and fingertip-to-mouth transfer efficiency of gram-positive bacteria, gram-negative bacteria, and phage. *Journal of Applied Microbiology*, **93**(4), 585-592.

Ryan, K.J. and Ray, C.G., (2004). An Introduction to Infectious Diseases. *Sherris Medical Microbiology* (4th edition). McGraw Hill.9-53.

Samkange-Zeeb, F. and Blettner, M. (2009). Emerging aspects of mobile phone use. *Emerging Health Threats Journal*. **2**, e5. http:// doi.org/10.3134/ehtj.09.005.

Singh, S., Acharya, S., Bhat, M., Rao, S. K. and Pentapati, K.C. (2010). Mobile Phone Hygiene: Potential Risks Posed by Use in the Clinics of an Indian Dental School. *Journal Dental Education*. **74**(10), 1153-1158.

Soto, R.G., Chu L.G., Goldman, G.M., Rampli, I.J. and Ruskin, K.J. (2006). Communication in critical care environment: mobile telephones improve patient care. *Anesthesia Analgesia*;**102**, 534-541.

Suganya, S. and Judia Harriet Sumathy V. (2012). Isolation and identification of bacteria from covered and uncovered mobile phones. *International Journal of Environmental Sciences*. **3**(1), 44-54.

Sumritivanicha, A., Chintavavilas, K. and Apisarntha, N. (2011). *Infection control and hospital Epidemiology Journal*. **32,** 633-636.

Tagoe, D. N., Gyande, V. K. and Ansah, E. O. (2011). Bacterial Contamination of Mobile Phones: When Your Mobile Phone Could Transmit More Than Just a Call.

Tenaillon, O., Skurnik, D., Picard, B. and Denamur, E. (March 2010). "The population genetics of commensal *Escherichia coli*". *Nature Reviews. Microbiology*. **8**(3):207–17.doi:10.1038/nrmicro2298. PMID 20157339.

Ulger, F., Esen, S., Dilek, A., Yanik, K., Gunaydin, M. and Leblebicioglu, H. (2009). Are we aware how contaminated our mobile phones with nosocomial pathogens? *Annals of Clinical Microbiology and Antimicrobials*. **8**(1): 7.

White, S., Topping, A., Humphreys, P., Rout, S. and Williamson, H. (2012). The cross-contamination potential of mobile telephones. *Journal of Research Nursing*.**17**(6): 582595. doi: 10.1177/1744987112458670.

Yusha'u, M., Bello, M. and Sule, H. (2012). *International Journal of Biomedical and HealthSciences*. **6**(1), 97-102.