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Research Article

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Prevalence of Drug-Resistant Bacteria Isolated from Mobile Phones of Pharmacy Students, Teaching Staff, Laboratory Technicians and Employees at University of Tripoli- Libya

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ABSTRACT

Transmission of microorganisms among university workers represents a major risk factor of microbial contamination raised from handling of mobile phones (MPs) close to the sensitive area in the face. Drug-resistant bacteria causing nosocomial infection such as methicillin-resistant *Staphylococcus aureus* (MRSA) and *Escherichia coli* found to be the most common bacterial isolates of MPs which frequently used by pharmacy college students, teaching staff, laboratory technicians and employees at university of Tripoli. Assessment of risk factors associated with bacterial colonization on MPs of university workers was the core objective of this cross-sectional study. Environmental contacts of MPs to various areas such as studying and dining tables, kitchen surfaces, coffees, restaurants, gyms and toilets expose users of mobile phones to the risk of bacterial contamination. The later condition might be increased due to long survival time of bacterial cells on MPs surfaces leading to increase in the risk of bacterial cross-contamination and occurrence of infectious disease.

Samples from MPs of 86 students and employee in the University of Tripoli were collected using sterile moistened cotton swabs and investigated for their bacterial contamination. Standard microbiological methods, including gram staining, biochemical tests and cultural media were used for isolation and identification of bacteria contaminated MPs. Bacterial isolate then subjected to antibiotic sensitivity test.

Gram positive and gram negative bacterial isolates accounted for 51 (68 %) and 20 (26.6 %) respectively of the study's participants MPs. The number and percentage of most commonly isolated bacteria in descending order were; *Staphylococcus aureus* (*S. aureus*) 26 (34.6%), *Staphylococcus epidermidis* (*S. epidermidis*) 17 (22.7%), *Pseudomonas aeruginosa* (*Ps. aeruginosa*) 10 (13.3%) and *Staphylococcus saprophyticus* (*S. saprophyticus*.) 8 (10.7%). By contrast *Escherichia coli* (*E. coli*) 1 (1.3%), *Citrobacter species* (*C. spp*.) 2 (2.7%), *Enterobacter species* (*Entero. spp*) 3 (4%) and *Citrobacter freundii* (*C. freundii*) 4 (5.3%) were the lowest isolated bacteria. Moreover, results indicated that the majority of bacterial isolates exhibited high percentage of resistant to Erythromycin and Clotrimazole antibiotics. However, some of other isolated bacteria showed sensitivity to antibiotics such as Ceftazidime, Ceftriaxone, and Ciprofloxacin. From demographic point of view, the distribution of MPs among participants exhibited the following pattern in ascending order; for gender (45% females) and (55%% males); for marital state (24% married males), (41 % married females), (43% single females) and (49% single males); for age of 18-25 years (38 % females) and (57.4% males),

In this study prevalence of bacterial colonization covers all MPs used by university workers. Finding of this study indicates that the risk factors for MP associated with different category groups of university (pharmacy college students, teaching staff, laboratory technicians, employees) and the use of stringent standardized disinfection strategy should be taking as priority measures to control bacterial contamination and avoiding any infection might be caused by multidrug-resistant bacteria including MRSA.

Keywords*-Bacterial colonization; Bacterial contamination; University workers; MPs.*

INTRODUCTION

Mobile phone (MP) is easy handling personal device, and affordable to everybody. Today, dependence and increasing use of mobile phones (MPs) by a wide range of public make MPs the most common device used for social communication in our daily life activities worldwide.[1] The invention of MPs was concurred in 1973. Ten years later, the first MP in the name of (Motorola DynaTAC 8000x) was introduced into market in 1983 by John F. Mitchel and Martin Cooper and its use was restricted mainly for making calls. In 1987 the second generation of MPs was invented and since then the manufacturing of MPs are dramatically developed.[2] In recent years, the use of MPs are largely expanded and becomes one of the most

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important tool for public communication, and they are generally used almost everywhere. Despite the important use of MPs in social life, these devices can serve as a vector for transmitting bacteria between individuals who handle them close to sensitive area like face. In the absence of disinfection control, the continuous use of MPs by different personnel specially in health sector make them a big source for occurrence of infectious diseases caused by dangerous pathogens in particular multi-drug-resistant bacteria.[3,4] Our understanding regarding microbial ecology have revolutionized by an important study dealing with transferring of microbes between individuals and their close environment.[5] Transmission of bacteria among people can arise from the use of MPs which come in contact with inanimate objectives almost found everywhere, including houses. Schools, Universities, restaurants, coffees, the gyms and even the toilets. These inanimate objectives can harbour variety of bacteria that can survive on MPs surfaces for long time exposing them to the risk of bacterial contamination.[6,7] Knowledge gained from a research study improved that bacterial cells which colonize surface of MPs are more than the once contaminate toilets, door handle or entire of a shoe sole .[8] Furthermore, handling of MPs in an area of high temperature and humid conditions makes the surface of MPs as suitable medium for bacterial growth resembling growing of thousands of worms in a phenomenon called "technological Petra-dish". [9] The problem of such exposure makes contaminated MPs with highly resistant bacteria as a big health hazard for occurrence of infectious diseases specially when MP comes into close contact with sensitive body ears.[10,11] However, the heavy use of MPs today represent a big concerns regarding transmission of pathogenic bacteria between individuals who using this device.[12,13] A previous study labeled that 90% of contaminated MPs were used by HCWs, and 14% of this contamination caused by the bacteria such as methicillinresistant *Staphylococcus aureus* (MRSA), *Acinetobacter* species vancomycinresistant enterococci, *Pseudomonas* species,and coliforms.[14,15] Therefore, contaminated MPs become as a carrier for potentially hazard bacterial pathogens transmitting them to patients through hands of HCWs causing nosocomial infection.[16-18] Avoiding bacterial contamination of MPs is a big task to be achieved, since knowledge regarding sanitization efficacy of MPs was not well reviewed. In a research study, Schabrun *et. al*., 2006 suggested the use of 70% alcohol as a good agent for disinfecting MPs used by HCWs.[19]

Previous research studies in different countries of the world (Iran, Gholamreza *et. al*., 2009; Nigeria. Kawo and Musa, 2013; India, Praveen and Aswathy, 2014; Iraq. Mohammed, *et. al*., 2019; Nigeria, Ya'aba, *et. al*., 2020,) showed that bacterial pathogens such as *S. aureus, Escherichia coli*, *S. epidermidis*, *Streptococcus pyogenes, Salmonella* species, *Klebsiella* species, *Micrococcus* spp., *Pseudomonas* spp., coagulase-negative *Staphylococci*, MRSA, Acinetobacter, and *Bacillus* species are the most commonly bacteria colonize the surface of MPs, while fungal and viral pathogens are less microbial isolates.[20-25] Furthermore, sensitivity of these isolates toward variety of antibiotics revealed that *S. aureus* was sensitive to Pefloxacin, Ofloxacin, Streptomycin with highest sensitivity to Ciprofloxacin; *Salmonella* to Augmentin, Amoxicillin and *Klebsiella* was sensitive to Gentamicin and Streptomycin. *Salmonella* species were also resistant against Gentamicin, Ciprofloxacin and Streptomycin.[26] Other bacteria resistant to antibiotics include penicillin-resistant Enterococcus, Vancomycin-resistant Enterococcus (VRE), multi-drug resistant *Mycobacterium tuberculosis* (MDR-TB).[27] *Streptococcus epidermidis* was sensitive against Streptomycin, Kanamycin, Amoxicillin; *E. coli* was sensitive to Cetriazone, Ofloxacin, Pefloxacin, Ciprofloxacin.[28-31] *K. pneumoniae* was sensitive against Cetriazone, Gentamicin, Ofloxacin, and Streptomycin. *P. aeruginosa* was sensitive to Ciprofloxacin, Cetriazone, Ofloxacin, and Amoxicillin; *Streptococcus pyogenes* was sensitive against Gentamicin, Ciprofloxacin, Kanamycin.[32,33]

Objective

To isolate and determine the prevalence of drug resistant bacteria which colonize the surface of MPs used by pharmacy students, teaching staff, laboratory technicians and employees at University of Tripoli.

MATERIALS AND METHODS

Study design

This study was conducted at faculty of pharmacy, university of Tripoli during the period of study from October 2024 to January 2025. A self-structured questionnaire (Table 1) and collection of demographic data (Table 2) were involved in this study. A total of 86 swabbed samples were taken from surface and touch screen of MPs and subjected to microbiological investigation. The distribution of these samples as following; (10) from teaching staff, (9) from laboratory technician, (12) from employee, (37) from undergraduate students and (11) from postgraduate students. The remaining (7) samples were randomly collected from the 56 total participants (47 male and 39 female) students.

Collection of samples

Duplicate swabbed samples were taken from the front and back of MPs used by 86 students (47 males and 39 females) who studying in faculty of pharmacy at University of Tripoli. The samples were then transported to the department of microbiology and immunology, faculty of pharmacy, university of Tripoli for microbiological investigation.

Bacterial identification

Swab samples were inoculated into sterilized peptone water and further plated on plates of nutrient agar, mannitol salt agar, mackonkey agar, blood agar and eosin methylene

blue agar. The agar plates were incubated at 35–37 °C for 48 hours. Gram staining technique, biochemical tests and culture media were used for isolation and identification of growing bacterial colonies.

RESULTS

A total of 86 swab samples (47 males and 39 females) were collected from the both surfaces (front and back) of participant's MPs. Table 1 presents the type of participants' characteristics and the questionnaire interpretation showed that majority of participants 37 (55%) males and (28%) females were undergraduate students and 11 (21%) for both male and female postgraduate students, followed by 12 employee (26% males, 21% females), 10 teaching staff members (9% males and 15% females), 9 laboratory technician (19% males and 13% females) and 7 other (13% males and 2% females). From questionnaire interpretation point of view, nearly all participant (male and female) 73 (85%) reported that they use their MP always in different types of locations. Most of participants 68 (81% males) and (77% females) stated that the always use of MP was their primary choice. The always use of MPs during eating was confirmed by 31 participants (41% females and 32% males), while 18 participants confirmed that they use MPs inside toilets and their percentage of use as following; 26% for males and 15% for females.

The results of demographic data (Table 2) revealed that, the use of MPs owned by males 47 (55%) more than females 39 (45%). Furthermore, by looking to contributes age of 18-25 years, MPs used by males accounted for the majority 27 (57%) of the study's participants, while 15 (38%) related to female's use. On other hand, according to marital state, the use of MPs in descending order as following; single male 37 (49%), single female 23 (43%), married female 16 (41%) and married male 10 (24%). Nevertheless, when participants asked if they regularly wash their hands after phone use. A moderate number of participants 47 (60%) males and (49%) females answered that they never wash their hands following MP use. Regarding hand hygiene practice, only 8 participants were always clean their hands after using of MPs 8.5% and 10% of them were males and females respectively.

Out of 86 collected swabs, 75 (87%) MPs colonize bacteria on their surfaces. Of these, 51 (68%) MPs contaminated with gram positive bacteria, 20 (26.6%) grew gram negative bacteria on their surfaces (Table 3). The consequence of gram positive isolates as following; *S. aureus* 26 (34.6%), *S. epidermidis* 17 (22.7%) and *S. saprophyticus* 8 (10.7%). Among all gram positive isolates, MRSA was predominantly and commonly bacterium isolated from MPs 21 (80.76%). In contrast, 64 (85.3%) was the total number of gram negative bacteria isolated from 20 of participant's MPs. Out of these 10 (13.3%), 4 (5.3%), 3 (4%), 2 (2.7%) and 1 (1.3%) isolates of *P. aeruginosa, Citrobacter freundii* (*C. freundii*), *Enterobacter* species (*Entero*. spp), *Citrobacter* species (*C*. spp.) and *E. coli* species, respectively. *Pseudomonas* represents 50% of gram negative isolates.

In the present study antibiotic sensitivity test was done for all bacterial species isolated from mobile phones (Figure 1). All bacterial isolates exhibited complete resistance to Erythromycin and Clotrimazole. In contrast, isolates of *S. aureus* and *E. coli* showed sensitivity to Ciprofloxacin and Gentamicin. While *S. aureus* was resistant to Tetracycline, interestingly, *E. coli* found to be resistant to the remaining of used antibiotics.

Table 1: Participants response to the questionnaire

Description	Parameters	Number	Male	Femal
Participants		86	47	39
Types of participants	ü Teaching staff	10	9%	15%
	ü Laboratory technician	9	19%	13%
	ü Employee	12	26%	21%
	ü Undergraduate student	37	55%	28%
	ü Postgraduate student	11	21%	21%
	ü *Other*	7	13%	2%
Questionnaire interpretation				

Description	Parameters	Number	Male	Femal
Location of MP while use	ü Home	3	6%	0%
	ü Public / Private transport	1	0%	2%
	ü Faculty	6	4%	10%
	ü Others	3	4%	3%
	ü All the above	73	85%	85%
Frequency use of MP	ü Always	68	81%	77%
	ü Often	7	6%	10%
	ü Occasionally	8	8.5%	10%
	ü Rarely	3	4%	3%
	ü Never	0	0%	0%
Hand washing after MP use	ü Always	8	8.5%	10%
	ü Often	9	4%	18%
	ü Occasionally	4	8.5%	0%
	ü Rarely	18	19%	23%
	ü Never	47	60%	49%
Use of MP while eating	ü Always	31	32%	41%
	ü Often	10	11%	13%
	ü Occasionally	10	13%	10%
	ü Rarely	10	4%	21%
	ü Never	25	40%	15%
Frequency use of MP in toilet	ü Always	18	26%	15%
	ü Often	11	9%	18%
	ü Occasionally	4	6%	3%
	ü Rarely / Never	7/ 24	59%	64%

Table 2: Demographic data

Marital state				Sex		Age							
Single		Married		18-25		26-35		36-45		>45			
M	F	M	F	M	F	M	F	M	F	M	F	M	F
37	23	10	16	47	39	27	15	10	10		7	8	7
49%	43%	24%	41%	55%	45%	57%	38%	21%	24%	2 4.3%	18%	17%	18%

Table 3: Pathogenic bacteria isolated from mobile phones

Isolated Bacteria					
Bacterial group	.No	%	**Bacterial strains**	.No	%
Gram positive bacteria	51	68%	*S. aureus*	26	34.6
			S. epidermidis	17	22.7
			S. saprophyticus	8	10.7
Gram negative bacteria	20	26.6	*P. aeruginosa*	10	13.3
			C. freundii	4	5.3
			Entero. spp	3	4
			C. spp	2	2.7
			E. coli	1	1.3

No., Number

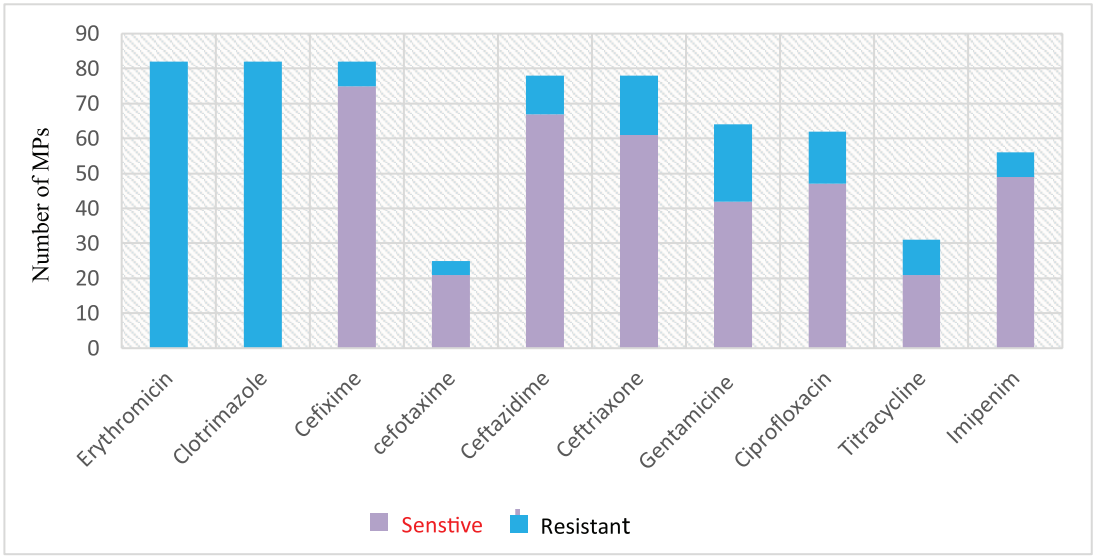


Figure 1: Antibiotic sensitivity of bacterial species isolated from mobile phones

DISCUSSION

Bacteria found everywhere and can contaminate everything, in particular inanimate objects. As bacterial pathogens can colonize on human cells, they usually have ability to colonize on the surfaces of these inanimate objects that found in homes or in working places.[34] Therefore, it was well understood from the published literature that MPs which come in contact with these inanimate objects were highly contaminated with microorganisms and become as one of leading sources of nosocomial infections when they are used by HCWs.[35-38]

Recently, a subsequent risk has developed from the increased use of MPs which may be colonized by multidrug-resistant microorganisms in their surfaces making them as unacceptable devices transmitting bacteria among users. Many bacterial pathogens associated with occurrence of significant nosocomial infection such as *S. aureus*, *E. coli*, *K. pneumoniae*, species's of *Pseudomonas*, *Enterococcus*, and Acinetobacter have been isolated from MPs. Furthermore, 70% of these bacterial isolates were found to be multidrug-resistant gram negative bacteria namely *Pseudomonas* species, *K. pneumoniae*, and Citrobacter species, while 26% was isolates of gram positive pathogen (MRSA).[39] Several researches studies revealed the most of MPs used by university students were contaminated with bacteria.[40, 41] One of these studies conducted at a teaching hospital in Italy showed that Staphylococci were present in 85%, Enterococci in 37%, Coliforms in 6.5% of student's MPs. In contrast with our finding *S. epidermidis* was the most frequently isolated pathogen from (72%) of MPs, followed by *S. capitis* (14%), *S. aureus* (4%) and *S. saprophyticus, S. warneri, and S. xylosus* (6%). Here interestingly to mention that *E. coli* was never detected. In 2017 another study done on medical students at university-affiliated hospital in Tehran showed that 53.3% of MPs were contaminated with the following bacteria; *S. epidermidis* (26.7%), *Bacillus* PSP (13.3%), *Micrococcus* PSP 910%), non-haemolytic *Strept ococcus* and *Enterococcus* (each 6.7%), *Klebsiella* and *S. aureus* (each 3.3%).[42]

In the present study, most of MPs (87%) which collected from pharmacy college students and university staff members colonize microorganisms on their surfaces. MRSA were isolated from (24.4%) of phones. Among all surveyed participants, 85% had used a MP in the university, and 46.5% of them reported using their MP in toilets.

Regarding contamination of MPs in general, the following are the most common bacterial strains isolated from MPs of participants in descending order; *S. aureus* (34.6%), *S. epidermidis* (22.7%) *P. aeruginosa* (13.3%) and *E. coli* (1.3%). By looking to gender, interestingly, *S. aureus* recorded nearly the same percentage (20%) of isolation for both male and female students MPs. In support of our finding, a study by Enass in 2015 conduced at University of Baghdad showed similar findings in which 20.7% was the value of isolation of *S. aureus*.[43] However, in disagreement with our study, 6% of *S. epidermidis* was isolated from male MPs as have been revealed in a study carried out in 2021 by Micheal Olu-Taiwo from University of Ghana.[44] All MPs users must be informed about the frequency and method of cleaning, the concentration of products that have to be used, and the contact time of cleaning. They must be cleaned frequently using wipes containing antiseptics, such as 70% isopropyl alcohol and 5% chlorhexidine, and users should practice good hand hygiene both before and after using their phones. From education point of view, all MPs user have to take in their consideration the importance of regular disinfection of their MPs by using for example; wipes containing antiseptics, such as 70% isopropyl alcohol and 5% chlorhexidine in addition to practice frequent hand hygiene before and after use of their phones. Another important stepses towards a proper use of MPs have to be applied such as avoiding the use of MPs in toilets, putting then on dirty inanimate objects.[45] The duration of viability of bacteria on MPs acts as a major risk factor for its transmission. Thereby, workers of heath sector are usually afflicted with nosocomial infection, so they must be treated with a proper type of antibiotic and must clean their hands with efficient antiseptic agent.[46]

CONCLUSION

The multipurpose use of MPs in our daily life activities exposes them to different pathogens. Such pathogens contamination is almost impossible to be avoided and resistant of bacterial isolates from this contamination to various antibiotics is also detectable. All subjects in University of Tripoli play a major role in the bacteria transmission due to their continuous interaction with possible contaminants of MPs. This puts them at a higher risk of infections. Therefore, to ensure that there is a reduction in the potential of the risks that these pathogens can offer, it is necessary to implement standardized disinfection protocol of hands and MPs to avoid getting infected with MRSA and other multidrug-resistant bacteria transmission. Finally, everyone have to be made aware and taught about adherence to regular application and monitoring of efficient method of MPs disinfection.

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REFERENCES

1. Kõljalg, S., R. Mändar, T. Sõber, T. Rööp, and R. Mändar (2017). High level bacterial contamination of secondary school students' MPs. *Germ*. **7**(2), 73.

2. Lim, L. L., E. S. Lau, A. W. Fu, S. Ray, Y. J. Hung and A. T. Tan, A. T. (2021). Effects of a technology-assisted integrated diabetes care program on cardio metabolic risk factors among

patients with type 2 diabetes in the Asia-Pacific region: the JADE program randomized clinical trial. *JAMA. Network. Open*. **4**(4), e217557-e217557.

3. Selim H.S., A.F. Abaza. (2015). Microbial contamination of MPs in a health care setting in Alexandria, Egypt. *GMS Hyg. Infect. Control*. **10**, 3.

4. Tagoe D.N.., V.K Gyande, E.O. Ansah (2011). Bacterial contamination of MPs: when your MP could transmit more than just a call, *Webmed. Cent. Microbio*. **2**,1e12.

5. Lax, Simon, Hampton-Marcell, T. Jarrad Gibbons, M. Sean, Colares, Geɋrgia Barguil, Smith, Daniel, Eisen, A. Jonathan and Gilbert, A. Jack (2015). Forensic analysis of the microbiome of phones and shoes, *Microbiome,* **3**(21).

6. Brady RR, A.C. Hunt, A.Visvanathan, M.A. Rodrigues, C. Graham, C. Rae (2011). MP technology and hospitalized patients: a cross-sectional surveillance study of bacterial colonization, and patient opinions and behaviors. *Clin. Microbial. Infect*., **17**, 830e5.

7. Mir-shekari and T. Sepehri (2009). Bacterial contamination and resistance to commonly used antimicrobials of healthcare workers' MPs in teaching hospitals, **6**(5), 806– 810. doi:10.3844/ajassp..806.8109.

8. Shahaby A.F., N.S Awad, A.E El-Tarras and A.S Bahobial. (2012) MP as potential reservoirs of bacterial pathogens, *African Journal of Biotechnology* **11**(92), 15896-15904.

9. Martɒnez-Gonzɔles A.N.E., F. Solorzano-Ibarra, E. Cabrera- D ɒaz, P. Gutiɾrrez-Gonzɔlez, I. Martɒnez-Chɔvez, J.A. Pɾrez-Monta ɷo and C. Martɒnez-Cɔrdenas (2017). Microbial contamination on cell phones used by undergraduate students. *Canadian Journal of Infection Control*. **32**(4), 211-216.

10. Chaibenjawong, P., and S. J. Foster (2011). Desiccation tolerance in *Staphylococcus aureus*. *Archives of microbiology*. **193**, 125-135.

11. Zakai Shadi, Mashat Abdullah, Abumohssin Abdulmalik, Samarkandi Ahmad, Almaghrabi Basim, Barradah Hesham and Jiman-Fatani, Asif (2016). Bacterial contamination of cell phones of medical students at King Abdulaziz University, Jeddah, Saudi Arabia, *Journal of Microscopy and Ultrastructure*. 143–146.

12. Ettelt S., E. Nolte, M. McKee, O.A. Haugen, I. Karlberg, N. Klazinga (2006). Evidencebased policy? The use of MPs in hospital, *J. Pub. Health*. **28**, 299–303.

13. Brady R.R, S.F. Fraser, M.G.Dunlop . PatersonBrown S, Gibb AP. (2007). Bacterial contamination of mobile communication devices in the operative environment, *J. Hosp. Infect*. **66**, 397–398.

14. Vilella A, J.M. Bayas, M,T. Diaz, C. Guinovart, C. Diez, D. Simo (2004). The role of MPs in improving vaccination rates in travelers. *Preven.t Med*. **38**, 503–509.

15. Brady RR, A. Wasson, I. Stirling, C, McAllister, N.N. Damani (2006). Is your phone bugged? The incidence of bacteria known to cause nosocomial infection on healthcare workers' MPs. *J. Hosp. Infect*. **62**, 123–125.

16. Manning ML, J. Davis, E. Sparnon, R.M. Ballard (2013). IPads, droids, and bugs: infection prevention for mobile handheld devices at the point of care. *Am. J. Infect. Control*. **4**, 1073–1076.

17. Brady RR, J. Verran, N.N. Damani, A.P. Gibb (2009). Review of mobile communication devices as potential reservoirs of nosocomial pathogens, *J. Hosp. Infect*. **4**(71), 295-300

18. Jeske HC, W. Tiefenthaler, M. Hohlrieder, G. Hinterberger, A. Benzer (2007). Bacterial contamination of anaesthetists' hands by personal MP and fixed phone use in the operating theatre. *Anaesthesia*. **62**, 904–906.

19. Schabrun S. and L. Chipchase (2006). Healthcare equipment as a source of nosocomial infection: a systematic review, *J. Hosp. Infect*. **63**, 239–245.

20. Gholamreza S., T. Nooshin, M. Ali, M. Touraj-Reza, and S. Ehsan (2009). Bacterial Contamination and Resistance to Commonly Used Antimicrobials of Healthcare Workers' MPs in Teaching Hospitals, Kerman, Iran. *American Journal of Applied Sciences* **6** (5), 806-810.

21. Praveen K. and M.L. Aswathy (2014). Identification of MP associated Pathogens, *Kerala Journal of Orthopaedics*. **1**(27), 69-72.

22. Mohammed, T.K., M.A. Jwad, O. Kamal, A.H. Abbas, and A. Shallal (2019). Isolation of some pathogenic bacteria and fungi from student' s MPs (Part I). *Indian Journal of Public Health*. **10**(10), 2109.

23. Ya'aba Y.,A. Chuku, U.S. Okposi, N.S. Hadi and S.A. Ramalan (2020). Bacterial Contamination Associated with Mobile Cell Phones among Undergraduate Students of Federal University of Lafia, Nasarawa State, Nigeria, *Nigeria Journal of Basic and Applied Science*. **28**(2), 36-42.

24. Olsen M., M. Campos, A. Lohning, P. Jones, J. Legget, A. Bannach Brown, S. McKirdy, R. Alghafri, and L. Tajouri (2020). MPs represent a pathway for microbial transmission: a scoping review, *Travel Med. Infect. Dis*. **35**, 101704.

25. Cavari Y., O. Kaplan, A. Zander, G. Hazan, Y. Shemer-Avni, and A. Borer (2016). Healthcare workers' MP usage: A potential risk for viral contamination. Surveillance pilot study, *Infect. Dis*. (Lond.) **48**, 432-435.

26. Kawo A.H. and A.M. Musa (2013). Enumeration, Isolation and Antibiotic Susceptibility Profile of Bacteria Associated With Mobile Cell Phones in a University Environment. *Nigerian Journal of Basic and Applied Science* **21**(1), 39-44.

27. Marianne F., K. Krishan, and B. Anthony (2016). Antibiotic resistance, *Journal of Infection and Public Health* **10**, 369-378

28. TMengchen L., L. Qiaoli, T. Yanli, O. Liuyang, X. Yuanlin, C. Shuaiyin, and D. Guangcai (2019). The resistance mechanism of Escherichia coli induced by ampicillin in the laboratory, I*nfection and Drug Resistance* **12**, 2853-2863.

29. Laurent P., M. Jean-Yves, L. Agnese, S. Anne-Kathrin, K. Nicolas, N. Patric and S. Stefan (2018). Antimicrobial Resistance in *Escherichia coli*, *Microbiology Spectrum*. **6**, 1-7.

30. Boas C. L., R. Daniel, P. Giovanni, A.J. Victoria, M. Sebastine and S. Constance (2019). Quantifying the contribution of four resistance mechanisms to Ciprofloxacin MIC in Escherichia coli: a systematic review, *Journal of Antimicrobial chemotherapy* **74**(2), 298310.

31. Enass G. S. (2015) Isolation, Identification and Determination Antimicrobial Susceptibility of Bacteria Isolated from MPs of

Students, *Journal of University of Ambar of Pure Science* **9**(3), 6-9.

32. Peterson E. and P. Kaur (2018). Antibiotic Resistance Mechanisms in Bacteria: Relationships Determinants of Antibiotic Producers, Environmental Bacteria and Clinical Pathogens, *Frontiers Microbiology* **9**, 2928.

33. Wanda C. R. (2018). An Overview of the antimicrobial resistance mechanisms of bacteria. *African Institute for Mathematical Sciences* **4**(3), 482-501.

34. 34 Jaya Madhuri R., M. Saraswathi, G. Mahitha, M. Bhargavi, S. Deepika, G. Vijaya Lakshmi (2015). Bacterial contamination of MPs and computers in microbiological laboratories. *European Journal of Biotechnology and Bioscience*. **3**(9), 51-55.

35. Cantais A,F. Grattard, J. Gagnaire, O. Mory, A. Plat, M. Lleres Vadeboin, P. Berthelot, T. Bourlet, E. Botelho-Nevers, B. Pozzetto, and S. Pillet (2020). Longitudinal study of viral and bacterial contamination of hospital pediatricians' MPs, *Microorganisms* **8**, 2011.Z

36. Brown N.M., M. Reacher, W. Rice, I. RoddickL, L. Reeve, N.Q. Verlander, S. Broster, A.L. Ogilvy-Stuart, A. D'Amore, J. Ahluwalia, S. Robinson, R. Thaxter, C. Moody, A. Kearns, J. Greatorex, H. Martin, M, M.E. Török, and D.A. Enoch (2019). An outbreak of meticillin-resistant *Staphylococcus aureus* colonization in a neonatal intensive care unit: Use of a case control study to investigate and control it and lessons learnt, *J. Hosp. Infect*. **103**, 35-43.

37. Chaoui L, R. Mhand, F. Mellouki, and N. Rhallabi (2019). Contamination of the surfaces of a health care environment by multidrug-resistant (MDR) bacteria, *Int. J. Microbiol*. 3236526.

38. Pal S. and D. Juyal, S. Adekhandi, M. Sharma, R. Prakash, N. Sharma, A. Rana, and Parihar (2015). MPs: reservoirs for the transmission of nosocomial pathogens, *Adv. Biomed. Res*. **4**, 144.

39. Loyola S, L. Gutierrez, E. Avendaño, N. Severino, and Tamariz (2018). Multidrug-resistant bacteria isolated from cell phones in five intensive care units: *Exploratory dispersion analysis, Germs* **8**, 85-91.

40. Otegwu, T.C. and F.B. Abdullahi (2024). Microbial Contamination of MPs amongst Pharmacy Students in Gombe State University, *Bima Journal of Science and Technology* (2536-6041), **8**(3A), 56-64.

41. Elmanama, A., I. Hassona, A. Marouf, G. Alshaer, and E. Ghanima (2015). Microbial load of touch screen MPs used by university students and healthcare staff, *Journal of the Arab American University* **1**(1), 1-20

42. Jalalmanesh, S., M. Darvishi, M. Rahimi, and Akhlaghdoust (2017). Contamination of senior medical students' cell phones by nosocomial infections: a survey in a university-affiliated Hospital in Tehran. Shiraz, *E-Medical Journal*, **18**(4). e59938.

43. Enass G. S. (2015). Isolation, Identification and Determination Antimicrobial Susceptibility of Bacteria Isolated from MPs of Students, *Journal of University of Ambar of Pure Science*. **9**(3), 6-9.

44. Micheal O., A. Christian, K. David and O. Akua (2021). Multidrug-Resistant Bacteria on the MPs and Computer Keyboards of Healthcare University Students in Ghana, *Canadian Journal of Infectious Diseases and Medical Microbiology*. Doi: 10.1155/2021/6647959

45. Lindsley J.A., C.D. Reynolds, T. Williams, J. Underwood, A.N. Ingram, J. Jowitt, L.S. Gelinas (2020). How dirty is your phone? Evaluating restroom behavior and cell phone surface contamination, *Jt. Comm J Qual Patient Saf*. **46**, 588–590.

46. Lindsley J.A., C.D. Reynolds, T. Williams, J. Underwood, A.N. Ingram, J. Jowitt, and L.S. Gelinas (2022). Viability of hospital pathogens on MP. Simmonds-Cavanagh R, *Am J Infect Contro*l. **50**, 787–791.