BJHS
Birat Journal of Health Sciences

ISSN:

2542-2758 (Print) 2542-2804 (Online)

ARTICAE INFO:

Received Date: 24 December 2024
Accepted Date: 14 March, 2025
Published Date: 30 April, 2025

KEYWORDS:

Antibiotic susceptibility test, cell phones, healthcare-associated infection, staphylococcus aureus

CORRESPONDING AUTHOR:

Dr. Kumari Ragani Yadav
Assistant professor
Department of Microbiology, Nobel Medical College Teaching Hospital, Biratnagar, Nepal
Email: raginiy385@gmail.com
Orcid ID: 0000-0003-0038-473X

Access the article online

DOI: 10.62065/bjhs639

CITATION:

Yadav KR, Shrestha K, Yadav R, Yadav B, Singh GK, Kumar P. Study Of Aerobic Gram-Positive Cocci And Gram-Negative Bacilli And Their Antibiotic Susceptibility Pattern Associated With Mobile Phones Of Healthcare Workers In A Tertiary Care Hospital. 2025; 9 (2): 75-82.

Study of Aerobic Gram-Positive Cocci and Gram-Negative Bacilli and Their Antibiotic Susceptibility Pattern Associated with Mobile Phones of Healthcare Workers in A Tertiary Care Hospital

Kumari Ragani Yadav[1]*, Kewal Shrestha[1], Rajiv Yadav[1], Bikram Yadav[2], Ganesh Kumar Singh[1] Prabhat Kumar[1]

[1] Department of Microbiology, Nobel Medical College Teaching Hospital, Biratnagar, Nepal
[2] Minimally Invasive Diagnostic and Therapeutic Hospital, Lagankhel Kathmandu, Nepal

ABSTRACT

Introduction: Mobile phones are an often-overlooked source of microbial contamination in healthcare settings and pose a serious risk for the spread of hospital-acquired infection.

Objectives: The objective of this study was to isolate the aerobic gram-positive cocci and gram-negative bacilli and their antibiotic susceptibility pattern from healthcare workers' mobile phones in a hospital.

Methodology: The hospital-based descriptive cross-sectional study was conducted in the Clinical Microbiology Laboratory of Nobel Medical College Teaching Hospital, Biratnagar, Nepal, from May 2024 to October 2024. Identification of pathogenic aerobic gram-positive cocci and gram-negative bacilli from mobile phones of healthcare workers (HCW) was done by standard protocol, and antimicrobial susceptibility testing was done by Kirby- Bauer disc diffusion method following Clinical Laboratory Standard Institute guidelines.

Results: A total of 215 (100%) swab samples were collected from healthcare workers' mobile phones, 152 (70.6%) samples showed significant bacterial growth by culture, and 63 (29.3%) mobile phone samples showed no growth. The most common organisms isolated were Staphylococcus aureus, followed by Escherichia coli and coagulase-negative Staphylococcus (CONS). All the gram-positive cocci were sensitive to linezolid, teicoplanin, and vancomycin, and gram-negative aerobic bacteria other than Pseudomonas were sensitive to gentamycin, cephalosporins, and Extended-Spectrum Beta-Lactamase (ESBL) producing gram-negative aerobes were sensitive to meropenem, piperacillin/tazobactam and cefepime.

Conclusion: The present study highlights that healthcare workers' mobile phones carry pathogenic organisms, the most common in our setting was Staphylococcus aureus. This study also showed that gram-positive cocci were sensitive to linezolid, teicoplanin, and vancomycin, and gram-negative aerobic bacilli other than Pseudomonas were sensitive to gentamycin, cephalosporins, and Extended-Spectrum Beta-Lactamase (ESBL) producing gram-negative aerobes were sensitive to meropenem, piperacillin/tazobactam and cefepime.

INTRODUCTION

The global mobile telecommunication (GSM) system was established in 1982 in Europe to provide and improve communication networks. Cell phones have become one of the most indispensable accessories for professional and social life. Mobile phones are now being used almost everywhere, whether at the dining

table, the kitchen, a restaurant, the gym, or even the toilet, resulting in continuous exposure of cellular phones to different types of microorganisms. Being an electronic gadget, cellular phones are seldom cleaned.[1] Mobile phones have revolutionized how people communicate, work, and entertain themselves. Mobile phones are seldom cleaned after use and may spread microorganisms, including drug-resistant types, following contact with patients, making them a potential source of bacterial cross-contamination.[3] There are no restrictions on the use of mobile phones in the hospital setting, and no guidelines have been formulated on the cleanliness of mobile phones in the healthcare settings.[4] These cell phones can harbor various potential pathogens and become exogenous sources of infection for the patients, as well as possible health hazards for self and family members.[5] Further, sharing cell phones between HCWs and non-HCWs may directly facilitate the spread of potentially pathogenic bacteria to the community.[6]

HCWs are unaware that mobile phones act as the vector for transmission of hospital-acquired infection to patients and healthcare workers.[7,8] The risk of transmission is directly related to the survival of microorganisms on the colonized objects. An enormous financial burden is being placed on hospitalized patients due to the rising rates of infection, which also result in higher morbidity and mortality rates.[9] Studies worldwide have shown that HCWs phone are frequently contaminated and in our country like Nepal, mobile phone use in clinical area is common, but awareness and cleaning practice are limited. Smartphones can be successfully incorporated into healthcare practice by implementing extensive policies and training initiatives.[10] So this study addresses a critical gap in local infection control efforts and contribute to the growing global evidence on fomite- based transmission within healthcare environments and to isolate the aerobic gram-positive cocci and gram-negative bacilli and their antibiotic susceptibility pattern from healthcare workers' mobile phones in a hospital.

METHODOLOGY

The hospital-based descriptive cross-sectional study was conducted in the Clinical Microbiology Laboratory of Nobel Medical College Teaching Hospital, Biratnagar, Nepal, with effect from May 2024 to October 2024, after taking approval of the Institutional Review Committee (Ref no- IRC-NMCTH 32/2024). The study included healthcare workers from all departments who had worked in the hospital for at least one month using any mobile phone. Participants without consent, those temporarily posted from other institutions, and recently cleaned mobile phones were excluded from the study. Convenient sampling was done, and the sample size (n) was calculated as:

$n = z^2 pq/e2$

$n = (1.96)^2 \times 0.71 \times 0.29 / (0.071)^2$

Where, Z = 1.96 at a 95% confidence interval

n = sample size

p = prevalence [7], 71.8% = 0.71

q = 1-p= 0.29

e = margin error, 10%= 0.071

The sample size was calculated to be 158. However, a total of 215 healthcare workers were enrolled in this study. After obtaining verbal consent, each healthcare worker was asked the following questions:- how often do you clean your mobile phone, what is the method of cleaning your mobile phone and are you using your cellphone in the bathroom? A total of 215 samples were collected aseptically by rolling sterile cotton swabs moistened with sterile normal saline surface of the mobile phones, and swabs were quickly transferred to the lab and placed into test tubes with cotton plugs. Samples were aerobically inoculated on brain heart infusion broth for 18-24 hours at 370 C. Followed by subculture on nutrient agar, blood agar, and MacConkey agar, and all the plates were incubated at 370 C for 18-24 hours aerobically into the incubator. Identification of bacteria was done by colony characteristics, hemolysis on blood agar, pigment on nutrient agar, a pink color colony on MacConkey agar, gram staining, and different biochemical tests. The antibiotic susceptibility test of the isolated strains was carried out according to the Kirby-Bauer disc diffusion method as per the Clinical and Laboratory Standards Institute (CLSI) guidelines.11 With the help of straight inoculating wire, 1-2 well-isolated colonies were picked and inoculated into a tube containing 5ml peptone water and incubated into the incubator at 370C for 2-4 hours and then compared with the turbidity of 0.5 McFarland standard solutions in adequate light against a card with a white background and contrasting black lines. After the turbidity was maintained, a sterile cotton swab was dipped into the peptone water containing bacterial solution, and any excess solution was removed by pressing the swab on the inside wall of the tube. Followed by lawn culture on Mueller Hinton agar and thereafter antimicrobial discs supplied by HiMedia Laboratories, India, were placed onto the surface of the inoculated agar plate, and the plate was incubated in the incubator at 370 C for 18-24 hr. Eventually, the result was read and interpreted. Zone of inhibition was measured by using a Vernier caliper, and results were interpreted based on zone size inhibition as sensitive and resistant. [11]

The antibiotic discs and concentration used for both gram-positive and gram-negative aerobic bacteria were as follows: penicillin (P) 10 units, erythromycin (E) 15µg, cefoxitin (CX) 30µg, clindamycin(CD) 2µg, cotrimoxazole (COT) 5µg, chloramphenicol (C) 30µg, linezolid (LZ) 30µg, teicoplanin (TEI) 30µg, high-level gentamycin (HLG) 120µg, vancomycin (VA) 30µg, ceftriaxone (CTR) 30µg, high-level streptomycin (HLS) 10µg, ampicillin (AMP) 10µg, cefuroxime (CXM) 30µg, ceftazidime (CAZ) 30µg, cefotaxime (CTX) 30µg.

According to CLSI guidelines11 the organisms (Escherichia coli, Acinetobacter species, Enterobacter aerogenes, and Klebsiella pneumoniae) were screened for ESBL production using ceftazidime (30µg), cefotaxime (30µg) and ceftriaxone (30µg). The organisms showing reduced susceptibility to at least one of these antibiotics with a zone of inhibition on Mueller Hinton Agar for ceftazidime (30µg) ≤22mm, ≤25mm with ceftriaxone (30µg), and ≤27mm with cefotaxime (30µg) were considered as potential ESBL producing organisms and selected for phenotypic

confirmatory test for ESBL.[12]

The collected data were entered in Microsoft Excel and data was analyzed in a statistical package for the social science for Windows using the SPSS version.

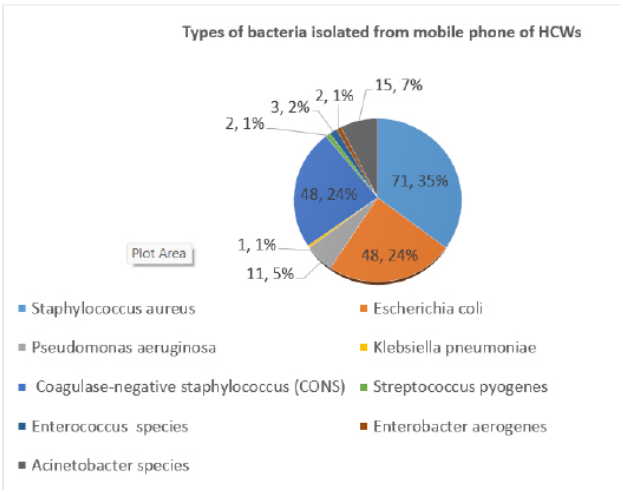
RESULTS

A total of 215 (100%) swab samples were collected from mobile phones of HCW, 152 (70.6%) samples showed significant bacterial growth by culture, and 63 (29.3%) mobile phone samples showed no growth. A higher rate of contaminated mobile phones was found in 41-60 years of age and contamination rates were almost the same in male and female mobile phones (male and female ratio 1.03:1). The mean age of study participants was 44.6 years. 62 (40.8%) HCWs used alcohol to clean their mobile phone and all the HCWs were using mobile phones in the bathroom shown in table 1.

Table 1: Baseline characteristics of the study population

Characteristics	Categories	No of HCWs	Percentage
Age in years	≤ 20	0	0
	21 – 40	41	26.97
	41 – 60	104	68.42
	>60	7	4.60
Gender	Female	75	49.3
	Male	77	50.7
Method of cleaning mobile phone	Alcohol	62	40.8
	Cloth	6	3.9
	Paper wiper	29	19.1
Frequency of cleaning mobile phone	Wet cloth	55	36.2
	Daily	12	7.9
	Weekly	103	67.8
	Monthly	23	15.1
	Rarely	14	9.2
HCW	Cleaning staff	42	27.6
	Doctor	67	44.1
	Lab staff	17	11.2
	Nursing staff	23	15.1
	OPD staff	1	0.7
	Reporting typing staff	1	0.7
	Surgery OT staff	1	0.7
Microbial growth	Polymicrobial growth	47	30.9
	Monomicrobial growth	104	68.4
	More than two types of bacteria	1	0.6
	Total	152	100.0

Pie chart 1 showed the most predominant bacteria isolated from mobile phones of HCWs were Staphylococcus aureus 71 (35.3%) and the least predominant bacteria was Klebsiella pneumoniae 1 (0.4%).



A higher number of mobile phone samples were taken from obstetrics and gynecology 10 (6.6%) and the least number of mobile phone samples from ENT and NICU 4/4 (2.6/2.6%) which was shown in Table 2.

Table 2: Sample distribution according to the department of the hospital

Name of department	No of participant	Percentage
Anatomy	5	3.3
Biochemistry	5	3.3
Cardiovascular	5	3.3
Community medicine	8	5.3
Dental	7	4.6
ENT	4	2.6

Forensic medicine	5	3.3
ICU	9	5.9
Medicine	7	4.6
Microbiology	5	3.3
Neuro medicine	8	5.3
Neurosurgery	9	5.9
NICU	4	2.6
Obstetrics and Gynecology	10	6.6
Ophthalmology	6	3.9
Orthopedics	7	4.6
Pediatrics	7	4.6
Pathology	9	5.9
Pharmacology	7	4.6
Physiology	5	3.3
Pulmonary	6	3.9
Radiology	5	3.3
Surgery	9	5.9
Total	152	100.0

Table 3 showed almost all the Staphylococcus aureus and CONS were 100% sensitive towards linezolid, teicoplanin, vancomycin, and resistance to penicillin and erythromycin. All the Streptococcus pyogenes showed 100% sensitivity to penicillin, erythromycin, linezolid, clindamycin, and vancomycin and enterococcus species were 100% sensitive to streptomycin, penicillin, chloramphenicol linezolid, and teicoplanin.

Table 3: Antimicrobial susceptibility pattern of gram-positive aerobic bacteria isolated from the mobile phone of HCW

	Organisms			
	Staphylococcus aureus (71)	**CONS (49)**	**Enterococcus species (3)**	**Streptococcus pyogenes (2)**
Antimicrobial	S/R	S/R	S/R	S/R
Cefoxitin	52/19	33/16	NT	NT
Penicillin	22/49	17/32	3/0	2/0
Erythromycin	36/35	21/28	2/1	2/0
Clindamycin	50/21	31/18	NT	2/0
Cotrimoxazole	58/13	41/8	NT	1/1
Ciprofloxacin	38/33	24/25	NT	NT
Chloramphenicol	67/4	47/2	3/0	2/0
Linezolid	64/7	45/4	3/0	2/0
Teicoplanin	66/5	46/3	3/0	NT
Vancomycin	67/4	45/4	3/0	2/0
Amikacin	52/19	34/15	NT	NT
Ciprofloxacin	56/15	35/13	NT	NT
Streptomycin	NT	NT	3/0	NT

The gram-negative aerobic bacteria other than Pseudomonas were sensitive to gentamycin, cephalosporins, and resistant to ampicillin. ESBL-producing gram-negative aerobes were sensitive to meropenem, piperacillin/tazobactam, cefoperazone/sulbactam, and cefepime and least sensitive to ampicillin and cephalosporins. Non-ESBL producing Pseudomonas aeroginosa showed the highest sensitivity towards tobramycin, ceftazidime, gentamycin, and amikacin whereas ESBL-producing Pseudomonas aeroginosa showed the highest sensitivity to meropenem and Pepracillin/tazobactam. (Table 4, 5, 6)

Table 4: Antimicrobial susceptibility of gram-negative aerobic bacilli isolated from mobile phone of HCW

	Organisms	
	Escherichia coli (17)	Acinetobacter species (1)
Antibiotics	S/R	S/R
Ampicillin	6/11	0/1
Cefixime	17/0	1/0
Cefotaxime	17/0	1/0
Ceftazidime	17/0	1/0
Gentamycin	16/1	1/0
Ciprofloxacin	15/2	1/0

Table 5: Antimicrobial susceptibility ESBL-producing gram-negative aerobic bacilli isolated from the mobile phone of HCW

	Organisms			
	Escherichia coli (31)	Klebsiella pneumoniae (1)	Acinetobacter species (14)	Enterobacter aerogenes (2)
Antimicrobial	S/R	S/R	S/R	S/R
Ampicillin/sulbactam	24/7	1/0	10/4	2/0
Cefoperazone/salbactum	29/2	1/0	14/0	2/0
Piperacillin/tazobactam	28/3	1/0	14/0	2/0
Amikacin	26/5	1/0	10/4	2/0
Levofloxacin	16/15	1/0	8/6	2/0
Cotrimoxazole	14/17	1/0	11/3	2/0
Meropenem	30/1	1/0	11/3	1/1
Cefepime	22/9	1/0	10/4	Nt

Table: 6 Antimicrobial susceptibility Non-ESBL and ESBL-producing Pseudomonas aeroginosa isolated from mobile phone of HCW

	Organism			
	Pseudomonas aeroginosa			
	Non-ESBL(10)		ESBL(1)	
Antibiotics	Sensitive	Resistance	Sensitive	Resistance
Ceftazidime	6	4	0	1
Ciprofloxacin	7	3	0	1
Gentamycin	9	1	1	0
Levofloxacin	7	3	1	0
Amikacin	8	2	0	1
Cefepime	8	2	0	1
Tobramycin	10	0	0	1
Aztreonam	NT	NT	1	0
Meropenem	NT	NT	1	0
Pepracillin/ tazobactum	NT	NT	1	0

DISCUSSION

In our study, we found pathogenic bacteria contaminated the majority of mobile phones of HCWs (70.6%). This finding was almost similar to the survey conducted by Karkee P et al and Akinyemi KO et al which showed contamination in 67.7% of 124 mobile phones and 62.7 of 400 mobile phones respectively.[7, 13] In many studies across different countries, the contamination of mobile phones of HCWs ranges from 24-94.5 %. This difference in contamination might be due to the habit of cleaning their mobile phone and hand hygiene of the study populations. [7, 14,15,16,17.18.19] The most predominant bacteria isolated from mobile phones of HCWs were Staphylococcus aureus (35.3%) followed by CONS (23.8%) and Escherichia coli (23.8%). These results were very similar to the study done by Sapkota J et al and Batt DR et al. 20,21 In the study done by Karkee P et al, Qadi M et al, and Mushabati NA et al. the most common bacteria isolated was CONS and this finding did not match with our finding.7, [22,23]

In this study, 70.6% of mobile phones of HCWs showed bacterial growth and this finding was slightly lower as compared to a study done by, Arora U et al, Ugler et al, Rao SJP et al and Bhumbla U et al which showed 91.6%, 94.5.6%, 92.0% and 92.0% of mobile phones of HCWs were contaminated with pathogenic bacteria respectively.[6,18,24,25] The rate of contamination of the mobile phones of HCWs in our study was lower due to most of the study population cleaning their mobile phones weekly. In the present

study, 104 (68.4%) mobile phone samples showed monomicrobial growth, 47 (30.9%) mobile phone samples showed two types of bacterial growth, and 1 (0.6%) mobile phone samples showed more than two types of bacterial growth, and which was not similar to study done by Bhumba U et al which showed 12.6 % were monomicrobial growth, 30.5% showed growth of two bacteria and 7.36% had growth of more than two bacteria and Sharma K et al showed 90.0% had single growth of bacteria, 8.33% showed two types of bacterial growth and 1.67% had more than two types of bacterial growth.[25, 26] The most common organisms isolated in our study were Staphylococcus aureus (35.3%), Escherichia coli (23.8%), and CONS (23.8%). This finding was not similar to a study done by Sailo et al,[27] which demonstrated Acinetobacter baumanii was the most common bacterial isolate, followed by Staphylococcus hominins. In the present study, most of the HCWs 62 (40.8%) were using alcohol to clean mobile phones and our finding was lower as compared to the study done by N Yao et al, [28] where 95.0 % of HCWs were using alcohol to clean mobile phones. Most of the HCWs were using alcohol for cleaning their mobile phones because alcohol is easily available in hospital settings, will not damage the mobile phone, and reduces chances of contamination with pathogenic bacteria. This result is inconsistent with Srikanth et al, [29] who found that only 12% of HCWs used disinfectants to clean their mobile phones.

The present study showed that majority of study participants' age group was 41- 60 years and all most equal number of male and female participants were involved in the study. Which was not similar to the study done by Bodena D et al.[30]

In this study, almost all the Staphylococcus aureus, CONS, and Enterococcus species isolated from moble phone of HCWs showed 100% sensitivity towards linezolid, teicoplanin, vancomycin, and resistance to penicillin and erythromycin. This was similar to a study by Santosh K et al,[31] Sapkota J et al,[20] and Sailo CV et al.[27]

In the present study, Non-ESBL-producing Gram-negative bacilli showed a higher range of sensitivity toward gentamycin, and 3rd generation cephalosporin and ESBL-producing gram-negative bacilli were sensitive to meropenem, piperacillin/tazobactam and cefoperazone/ salbactum. This finding was well in agreement with a study conducted by Sailo CV et al[27] and Morubagal RR et al.[32]

CONCLUSION

The study emphasizes the need for routine decontamination of mobile phones used in healthcare settings and reinforces the importance of hand hygiene among HCWs and regulations regarding the use of mobile phones in hospitals. So regular infection prevention training, visual demonstration on hygiene practice, dissemination of institutional protocols, routine audits with feedback and guidance on the proper use of disinfectants for mobile device sanitation are required. Monitoring bacterial contamination and susceptibility patterns helps in the early detection of resistant strains and the implementation of effective infection control measures.

LIMITATION OF THE STUDY

Although utmost sincerity and dedication were invested to carry out the study it could not beyond some limitation like:

The result could not be generalized to other are because the study was conducted in semi-urban population and therefore, it may not apply to whole population of Morang.

The sample size was small due to the limited period of study and limitation of resources.

Molecular studied was not done

ACKNOWLEDGMENT

The authors would like to thank all of the participants who made this study possible

CONFLICT OF INTEREST: None

FINANCIAL DISCLOSURE: None

REFERENCES

1. Kapdi M, Hoskote SS, Joshi SR. Health hazards of mobile phones: an Indian perspective. J Assoc Physicians India. 2008 Nov; 56:893-7.
PMID: 19263689

2. Hikmah NA, Anuar TS. Mobile phones: a possible vehicle of bacterial transmission in a higher learning institution in Malaysia. Malays J Med Sci. 2020 Mar; 27(2):151-58.
DOI: 10.21315/mjms2020.27.2.15
PMID: 32788850 PMCID: PMC7409564

3. Ulger F, Dilek A, Esen S, Sunbul M, Leblebicioglu H. Are healthcare workers' mobile phones a potential source of nosocomial infections? Review of the literature. J Infect Dev Ctries. 2015 Oct; 9(10):1046-1053.
DOI: 10.3855/jidc.6104
PMID: 26517478

4. Olsen M, Campos M, Lohning A, Jones P, Legget J, Bannach BA. Mobile phones represent a pathway for microbial transmission: A scoping review. Travel Med Infect Dis. 2020 May; 35:101-704.
DOI: 10.1016/j.tmaid.2020.101704
PMID: 32360322 PMCID: PMC7187827

5. Gashaw M, Abtew D, Mekonnen Z. Prevalence and antimicrobial susceptibility pattern of bacteria isolated from mobile phones of health care professionals working in Gondar town health centers. Int Sch Res Notice. 2014 Mar; 2014(1):1-6.
DOI: 10.1155/2014/205074

6. Pal S, Juyal D, Adekhandi S, Sharma M, Prakash R, Sharma N. Mobile phones: Reservoirs for the transmission of nosocomial pathogens. Adv Biomed Res. 2015 Jul; 4(1):144.
DOI: 10.4103/2277-9175.161553
PMID: 26322292 PMCID: PMC4549928

7. Karkee P, Madhup SK, Humagain P, Thakur N, Timilsina B. Mobile phone: a possible vector of bacterial transmission in hospital setting. Kathmandu Univ Med J. 2017 Jul; 15(59):217-221.
PMID: 30353896

8. Lavanya J, Swaroop Rani NB, Jais M, Upadhya AK. Microbial contaminationofmobilephonesinatertiaryhealthcaresetting. Int J Curr Microbiol App Sci. 2016 Sep; 5(9):508-13.
DOI: 10.20546/ijcmas.2016.509.056

9. Ramesh J, Carter AO, Campbell MH, Gibbons N, Powlett C, Moseley H. Use of mobile phones by medical staff at Queen Elizabeth Hospital, Barbados: evidence for both benefit and harm. J Hosp Infect. 2008 Oct; 70(2):160-65.
DOI: 10.1016/j.jhin.2008.06.007
PMID: 18701190

10. Bhattacharya K. Mobile phone and the surgeon- is there a controversy? Indian J Sur. 2005 Apr; 67(1):53-4.
DOI: 10.1007/s12262-024-04068-z

11. Clinical and Laboratory Standards Institute. CLSI document M100-S25, Performance standards for antimicrobial susceptibility testing: twenty-fifth informational supplemented. Wayne: CLSI; 2015 Jan Vol. 34 No. 1. ISBN-156238742197815623874 26.

12. Jenkins SG, Schuetz AN, Current concepts in laboratory testing to guide antimicrobial therapy. Mayo Clin Proc. 2012 Mar; 87(3):290-308.
DOI: 10.1016/j.mayocp.2012.01.007
PMID: 22386185 PMCID: PMC3496983

13. Akinyemi KO, Atapu AD, Adetona OO, Coker AO. The potential role of mobile phones in the spread of bacterial infections. J Infec Dev Ctries. 2009 Sep; 3(8):628-32.
DOI: 10.3855/jidc.556
PMID: 19801807

14. Balapriya P, Padmakumari J, Vijayalakshmi A. Screening for nosocomial pathogens in stethoscopes, sphygmomanometers, and mobile phones of health care providers in a tertiary care hospital. Int J Curr Microbiol App Sci. 2016 Oct; 5(10):91-98.
DOI: 10.20546/ijcmas.2016.510.011

15. Jayalakshmi J, Appalaraju B, Usha S. Cellphones as reservoirs of nosocomial pathogens. J Asso Physicians India. 2008 May; 56:388-89. PMID: 18700649.,

16. Pandey A, Asthana AK, Tiwari R, Kumar L, Das A, Madan M. Physician accessories: doctor, what you carry is every patient's worry. Indian J Pathol Microbiol. 2010 Oct; 53(4):711-13. DOI: 10.4103/0377-4929.72047.
DOI: 10.4103/0377-4929.72047
PMID: 21045398

17. Pimpalkar S, Bhawnani D, Singh O. Mobile phone use among health care workers and its possible role in spreading the hospital-acquired infections in medical college hospital, Rajnandgaon. Int J Curr Microbiol App Sci. 2018 Dec; 7(12):2905-12.
DOI: 10.20546/ijcmas.2018.712.331

18. Ulger F, Esen S, Dilek A. Are we aware of how contaminated our mobile phones with nosocomial pathogens? Ann Clin Microbiol Antimicrob. 2009 Mar; 8 (7): 1476-87.
DOI: 10.1186/1476-0711-8-7
PMID: 19267892 PMCID: PMC2655280

19. Trivedi HR, Desai KJ, Trivedi LP, Malek SS, Javdekar TB. Role of mobile phone in spreading hospital-acquired infection: a study in a different group of health care workers. Natl J Interg Res Med. 2011 Sep; 2(3):56-61.
DOI: https://doi.org/10.70284/njirm.v2i3.1922

20. Sapkota J, Sharma M Jha B, Mishra B. Profile and antibiotic susceptibility pattern of bacterial isolates from mobile phones of healthcare workers in a tertiary care center of Nepal. J Inst Med Nepal. 2020 Aug; 42(2):29-32.
DOI: 10.59779/jiomnepal.1107

21. Bhatta DR, Hamal D, Shrestha R, Hosuru S, Baral N, Singh RK . Bacterial contamination of frequently touched objects in a tertiary care hospital of Pokhara, Nepal: how safe are our hands? Antimicrob Resist Infec Control. 2018 Aug; 6(7):97.
DOI: 10.1186/s13756-018-0385-2
PMID: 30128144 PMCID: PMC6091187

22. Qadi M, Khayyat R, Alhajhamad MA, Naji YI, Maraqa B, Abuzaitoun K . Microbes on the mobile phones of healthcare workers in Palestine: identification, characterization, and comparison. Can J Infect Dis Med Microbiol. 2021 Feb; 26(2021):8845879.
DOI: 10.1155/2021/8845879
PMID: 33727996 PMCID: PMC7935563

23. Mushabati NA, Samutela MT, Yamba K, Ngulube J, Nakazwe R, Nkhoma P. Bacterial contamination of mobile phones of healthcare workers at the university teaching hospital, Lusaka, Zambia. Infec Prev Pract. 2021 Feb; 3(2):100126.
DOI: 10.1016/j.infpip.2021.100126
PMID: 34368743 PMCID: PMC8336300

24. Rao SJP, Rao R, Nayani S. Bacterial isolates from mobile phones of health care workers in a tertiary care hospital, Hyderabad. Sch J Appl Med Sci. 2016 Jul; 4(7):2627-29.
DOI: 10.21276/sjams.2016.4.7.69

25. Bhumbla U, Ahmad S, Mathur D, Bandey L, Mathur G. Study on microbial contamination of mobile phones and their role in nosocomial infections in a tertiary hospital of South India. Asian J Pharm Clin Res. 2016 Dec; 9(9):201-2.
DOI: 10.22159/ajpcr.2016.v9s3.14603

26. Sharma K, Kaur Najotra D, Slathia P, Raina S. Microbiological flora of cell phones: a reservoir of potential pathogens? Int J Med Res Rev. 2017 Feb; 5(2):204-8.
DOI: 10.17511/ijmrr.2017.i02.16

27. Sailo CV, Pandey P, Mukherjee S. Pathogenic microbes contaminating mobile phones in a hospital environment in Northeast India: incidence and antibiotic resistance. Trop Med Health. 2019 Dec; 59(20191):47. DOI: 10.1186/s41182-019-0190-5
PMID: 31889887 PMCID: PMC6905087

28. Yao N, Yang XF, Zhu B. Bacterial colonization on healthcare workers' mobile phones and hands in municipal hospitals of Chongqing, China: Cross-contamination and Associated Factors. J Epidemiol Glob Health. 2022 Sep; 12(4):390-99. DOI: 10.1007/s44197-022-00057-1
PMID: 36070175 PMCID: PMC9449931

29. Srikanth P, Rajaram E, Sudharsanam S, Lakshmanan A, Mariappan U, Jagannathan K. Mobile phones: An emerging threat for infection control. J Infect Pre. 2010 May; 11(3):87-90.
DOI: 10.1177/1757177410364866

30. Bodena D, Teklemariam Z, Balakrishnan S. Bacterial contamination of mobile phones of health professionals in Eastern Ethiopia: antimicrobial susceptibility and associated factors. Trop Med Health. 2019 Feb; 47(15):1349-4147.
DOI: 10.1186/s41182-019-0144-y
PMID: 30858754 PMCID: PMC6391816

31. Kotgire S, Siddiqui S, Jamal H, Afreen U. Bacterial contamination of mobile phones of healthcare workers at a tertiary care hospital. Indian J Microbiol Res. 2018 Oct; 5 (4):460-465.
DOI: 10.18231/2394-5478.2018.0094

32. Morubagal RR, Shivappa SG, Mahale RP, Neelambike SM. Study of bacterial flora associated with mobile phones of healthcare workers and non-healthcare workers. Iran J Microbiol. 2017 Jun; 9(3):143-151.
PMID: 29225753