Mobile Phone: A Possible Vector of Bacterial Transmission in Hospital Setting

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Citation

Karkee P, Madhup SK, Humagain P, Thaku N, Timilsina B. Mobile Phone: A Possible Vector of Bacterial Transmission in Hospital Setting. *Kathmandu Univ Med J.* 2017;59(3):217-21.

ABSTRACT

Background

Mobile phones of Health Care Workers (HCWs) are capable of harbouring microorganisms that can potentially cause nosocomial infections. Frequent movement of hospital staff inside and outside the hospital can augment bacterial transmission inside hospital and even to the community.

Objective

To screen the mobile phones of Health Care Workers for potential pathogens and perform microbiological study of the isolates.

Methods

A cross sectional study was conducted in 124 Health Care Workers of different departments of tertiary care hospital. Swabs were taken from their mobile phones, processed immediately and identified and their antibiotic suceptibility pattern was studied.

Results

This study revealed that bacterial growth was positive for pathogenic organisms in 89 out of 124 (71.8%) mobile phones out of which 33 (82.5%) were of male and 56 (66.7%) of female. However, there was no significant association between gender and isolation of pathogens. Single pathogen was isolated in 74 (59.7%) of mobile phones and multiple pathogens were isolated in 15(12.1%). Amongst them, most common pathogen isolated was Coagulase Negative Staphylococcus (CoNS) (56.7%) followed by *Micrococcus spp., Escherichia. coli, Enterobacter spp., Acinetobacter spp., Staphylococcus. aureus, Klebsiella spp.* and *Enterococcus spp.* Most of the Gram Positive Cocci (GPC) were sensitive to Vancomycin (81.9%) and Ciprofloxacin (88%) while were resistant to Penicillin(83.1%). For Gram negative bacteria sensitivity to ciprofloxacin ranged from 83.33% to 100% .

Conclusion

Mobile phones are possible vectors of bacterial transmission and therefore are constant threat to the lives of already seriously ill patients as well as healthy individuals visiting the hospital. So it is recommended to make infection control guidelines which target the use of suitable disinfectants to avoid mobile phone contamination.

KEY WORDS

Antibiotics, Health care workers, Mobile phones, Nosocomial infection

INTRODUCTION

Nosocomial infections cause a significant rate of mortality and morbidity and its burden is increasing everyday which significantly increases the patient's length of hospital stay resulting in higher hospital cost.[1] Nosocomial pathogens may spread through the hands of Health Care Workers (HCWs), instruments of hospitals and even personal accessories like mobile phones.[2,3]

Mobile phones are dispensable accessories and they serve as a reservoir of bacteria and may cause nosocomial infections when not cleaned properly.[4-7] They have invaluable feature of communication and may support clinical diagnosis.[5] Because of its benefit, it is easy to overlook its hazard to health.[4] Mobile phones are particularly susceptible to bacterial contamination as they are in close contact with body parts and exposed to patients and clinical samples.[8,9] Additionally heat generated by mobile phones creates a prime breeding ground for microorganisms.[4,10,11] Strict attention is paid to changing clothes, removing jewellery, covering hair, undertaking hand hygiene measures but mobile phones often accompany staffs into the operating environment.[12] They are more problematic compared to fomites in that they facilitate intra- and inter- wards transmission.[13] Further, sharing of cell phones between HCWs and non HCWs may directly facilitate the spread of potential pathogens to the community.[14]

Use of mobile phones in clinically sensitive areas of hospital is subject of controversy as there are no guidelines for disinfection of mobile phones that meet hospital standards and some HCWs are unaware of the fact that mobile phones act as the vector for transmission of pathogens to patients.[6,15,16] So, our concern should be how to use mobile phones sensibly, getting their benefits and minimizing their risks.[7] Hence, the present study was undertaken to screen mobile phones of HCWs for presence of bacteria, as mobile phones transmitted infections possess a constant threat to lives of already ill patients.

METHODS

This study was conducted from February 2014 to July2014 in Dhulikhel Hospital, Dhulikhel. After Institutional Ethical Committee approval, this cross sectional study was carried out with written informed consent from HCWs. Confidentiality was maintained about the identity of the participants. A total of 124 samples of mobile phones were collected. Study population was randomly chosen from various wards inspite of the level and categories. Samples were collected aseptically by rolling sterile cotton swab moistened with normal saline over the different surfaces of the mobile phones and were transported to the laboratory as soon as possible in a test tube with cotton plug. Sample was inoculated in Brain Heart Infusion Broth and incubated at 37°C for 24 hours aerobically. Further subcultures were done on MacConkey agar and Blood agar plates the next day. The inoculated agar plates were incubated at 37°C for 24 hours. Identification of bacteria was done by conventional methods: colony characteristics, haemolysis on Blood agar and lactose fermentation on MacConkey Agar, Gram staining and different biochemical tests. The Antibiotic Suceptibility test was performed following modified Kirby Baeur method using Muller Hinton Agar following CLSI guidelines.[17]

RESULTS

The study was conducted on 124 HCWs from different departments of Dhulikhel hospital. The study enrolled the mobile phones of 84(67.7%) female and 40(32.3%) male HCWs which included consultants, medical officers and nurses. This study revealed that bacterial growth was positive for pathogenic organisms in 89(71.8%) mobile phones, out of which 33(82.5%) were of male and 56(66.7%) of female. However 35(28.2%) of total mobile phones, 7(17.5%) of male and 28(33.3%) of female did not show growth of pathogenic organisms. Out of the positive samples, single pathogen was isolated in 74(59.7%) of mobile phones and multiple pathogens were isolated in 15(12.1%) of the sample. However no significant association between gender and isolation of pathogen was found. Distribution of sample according to hospital departments (both wards and opd) and pattern of growth of bacteria is shown in Table 1.

Table 1. Sample distribution according to hospital departments and pattern of growth among 124 HWCs

Department	No. of HCWs n(%)	Growth n(%)	No Growth n (%)
ENT	9(7.3)	5(55.6)	4(44.4)
Gynecology	21(16.9)	10(47.6)	11(52.3)
ICU	3(2.4)	3(100)	0(0)
Internal medicine	14(11.3)	11(78.6)	3(21.4)
NICU	9(7.3)	5(55.6)	4(44.4)
Ophthalmology	17(13.7)	12(70.6)	5(29.4)
Orthopedics	13(10.5)	9(69.2)	4(30.8)
Pediatric	10(8.1)	7(70)	3(30)
Psychiatry	8(6.5)	7(87.5)	1(12.5)
General Surgery	15(12.1)	15(100)	0(0)
Dermatology	5(4)	5(100)	0(0)
Total	124(100)	89(71.8)	35(28.2)

Amongst 124 study subjects, 100(80.6%) of them claimed of cleaning their mobile with simple cloth frequently and remaining 24(19.4%) claimed of cleaning their mobile phones with special agents (alcohol, hand sanitizer etc). However no significant association was found between the cleaning agents used and isolation of pathogens as frequency of pathogen isoaltion was quite similar in both as shown in Table 2.

Table 2. Growth pattern of bacteria according to the cleaning agent used among 124 HCWs

Cleaning agent used	Frequency n (%)	Growth n (%)	No growth n (%)
Simple cloth	100 (80.6)	71 (71)	29 (29)
Alcohol/hand sanitizer	24 (19.4)	18 (75)	6 (25)
Total	124 (100)	89 (71.8)	35 (28.2)

In response to questions asked to HCWs, 121(97.6%) out of 124 subjects, use cell phones in hospital. Amongst them 57(46%) use it while attending patients.

There is predominance of Gram positive bacteria over Gram negative as shown in Table 3. Coagulase negative Staphylococci (CoNS) was the most common, followed by *Micrococcus spp., E. coli, Enterobacter spp., Acinetobacter spp., S. aureus, Klebsiella spp.* and *Enterococcus spp.*

Table 3. Types and frequecy of bacteria isolated

Bacteria	Frequency n (%)
Gram positive	**83(79.81)**
CoNS	59 (56.7)
Micrococcus spp.	16(15.38)
S. aureus	5 (4.81)
Enterococcus spp.	3 (2.88)
Gram negative	**21(20.19)**
E. coli	6 (5.7)
Enterobacter spp.	6 (5.7)
Acinetobacter spp.	5 (4.8)
Klebsiella spp.	4 (3.84)

Based on gram staining and organisms isolated, their antibiotic sensitivity pattern was determined. The details of antibiotic sensitivity pattern of Gram Positive Cocci (GPC) is shown in Table 4. Most of the GPCs were sensitive to Vancomycin and Ciprofloxacin while were resistant to Penicillin.

Amongst Gram positive cocci, CoNS was most sensitive to ciprofloxacin (91.53%) followed by Vancomycin (81.36%) while resistant to Penicillin (81.36%). Similarly *Micrococcus spp.* were most sensitive to Ciprofloxacin(87.5%) followed by Vancomycin (75%) while resistant to Penicillin(93.75%). Sensitivity to Ciprofloxacin, Cloxacillin and Vancomycin was 100% for Enterococcus spp while it was resistant to Gentamicin (100%), Penicillin(66.67%) and Erythromycin(66.67%). *S. aureus* were not resistant to Vancomycin and 40% of *S. aureus* were MRSA while resistance to Penicillin and Erythromycin was 80% .

Most of the Gram negative bacteria were sensitivite to ciprofloxacin. Amongst 6 *Enterobacter spp.* isolated, 5 (83.33%) were sensitive to Cotrimoxazole, Ceftriazone, Ceftazidime and Ciprofloxacin while all were resistant to Nitrofurantoin followed by Cefoxitine 4(66.67%) and Gentamicin 4(66.67%). All 5(100%) of *Acinetobacter spp.*

Table 4. Antibiotic sensitivity pattern of Gram positive cocci

Antibiotics	CoNS (N=59) n(%)	*Micrococcus spp* (N=16) n(%)	*S. aureus* (N=5)n(%)	*Enterococcus spp.* (N=3) n(%)
Vancomycin	48 (81.36)	12 (75)	5 (100)	3 (100)
Penicillin	11 (18.64)	1(6.25)	1 (20)	1 (33.33)
Ciprofloxacin	54 (91.53)	14(87.50)	2 (40)	3 (100)
Cloxacillin	40 (67.80)	7 (43.75)	3 (60)	3 (100)
Gentamicin	34 (57.63)	4 (25)	2 (40)	0 (0)
Ampicillin	-	-	-	2 (66.67)
Erythromycin	23 (38.98)	6 (37.50)	1 (20)	1 (33.33)

Table 4. Antiobiotic sensitivity pattern of isolated Gram negative bacilli

Antibiotics	*E. coli* (N=6) n(%)	*Klebsiella spp.* (N=4) n(%)	*Enterobacterspp.* (N=6) n(%)	*Acinetobacter spp.* (N=5)n(%)
Cefoxitine	2(33.33)	0(0)	2(33.33)	-
Cotrimoxazole	6(100)	4(100)	5(83.33)	-
Ampicillin	1(16.67)	0(0)	3(50)	-
Ceftriaxone	-	2(50)	5(83.33)	-
Gentamicin	3(50)	2(50)	2(33.33)	4(80)
Ciprofloxacin	6(100)	4(100)	5(83.33)	5(100)
Nitrofurantoin	2(33.33)	2(50)	0(0)	-
Amikacin	-	-	-	5(100)
Piperacillin	-	-	-	0(0)
Carbenicillin	-	-	-	1(20)
Ceftazidime	6(100)	2(50)	5(83.33)	1(20)
Colistin	-	-	-	5(100)

N: Total number of bacteria, n: No. of sensitive bacteria to antibiotics
'-': antibiotic sensitivity not tested

isolated were most sensitive to Colistin, Ciprofloxacin and Amikacin followed by Gentamicin 4(80%) while resistant to Piperacillin 5(100%), Carbenicillin 4(80%) and Ceftazidime 4(80%). *E. coli* was found to be most sensitive to Ciprofloxacin, Cotrimoxazole and Ceftazidime 6(100%) while 5(83.33%) were resistant to Ampicillin. *Klebsiella spp.* isolated were most sensitive to Cotrimoxazole and Ciprofloxacin 4(100%) while resistant to Ampicillin and Cefoxitine 4(100%). The details of the Antibiotic sensitivity pattern of Gram negative bacilli (GNB) is shown in Table 5 .

DISCUSSION

Many reports have documented the contamination of mobile phones among HCWs.[9,13-16,20-23] In our study, majority of mobile phones (67.7%) were contaminated by bacterial agents. Our result is consistent with a previous study conducted in Nigeria which showed contamination in 62% of 400 mobile phones.[20] Similarly, several studies conducted in India showed comparable contamination rates of mobile phones with our study.[20,22,16] However

various other studies showed higher contamination rates (82.5% to 97.4%).[9,13,14,23] The higher rates of contamination of cell phones in HCWs might be due to the influence of various factors like general hygiene, hand washing practices, disinfection practice followed in hospital, frequency of use and cleaning of cell phones etc.[14]

Our study revealed that male HCW's mobile phones were comparitively more contaminated than female HCWs phone. The present study concurs with the findings of other studies which showed 76% and 69% of mobile phones of male doctors and 44% and 31% of mobile phones of female doctors to be contaminated respectively.[19,22] As suggested by other study, it might be due to the reason that females generally keep their phones in purses and use it less frequently than male HCWs whereas male HCW keep it in pocket and use it whenever and wherever it is needed and were thus more contaminated.[19]

Regarding the isolated microorganisms, CoNS was the most prevalent bacterial agent isolated (56.7%) in our study. This results corroborates with several other findings in which the most frequently isolated organism was CoNS and the isolation rate ranged from 40% to 71.4%.[16,20-22,24,25] This might be because these types of bacteria breed in optimum temperature of warm mobile phones due to frequent use and can resist drying as proposed in previous study. Even though CoNS is considered as a resident flora, it can acquire the characteristics of patient's pathogenic flora and can produce disease if introduced into foreign locations or compromised host.[18] CoNS are the most commonly isolated organism in blood stream infections and surgical site infections. They have a major impact on patient's health as most of these are hospital acquired.[16]

In our study other prevalent organisms isolated was Micrococcus spp. which was similar to rate isolated by Tambekar et al.[19] The profile of microorganisms isolated from mobile phones in our study is similar to previous reports from India and almost all of these bacteria are known to be agents of nosocomial infections.[16,26] However, varying frequency of organism was found in other studies where most commonly isolated organisms were *E. coli* and *S. aureus*.[9,13,19] As suggested by previous study, isolation of nosocomially significant pathogens demonstrates source of transmission of nosocomial agents.[18] The ability of Acinetobacter spp to contaminate cell phones is quite possible as this is a multi-drug resistant water and soil organism and is responsible for infection in predisposed patients in the hospital.[18] Furthermore, isolation of *E. coli, Klebsiella* and *Enterococci* indicate fecal contamination of mobile phones.[26]

In our study nearly half of the *S. aureus* were methicillin resistant which was higher than the finding of Chawla et al. and Tambe et al.[14,9] High rate of MRSA was isolated by Tambekar et al. (83%) and Rawia et al. (52%).[6,19] In several other studies done in Non HCWs, pathogenic organisms were isolated in them as well which is indeed surprising.[24]

Regarding antibiotic susceptibility test, Group of antibiotics used was different for Gram positive and Gram negative bacteria. Gram positive bacteria were most sensitive to Ciprofloxacin followed by Vancomycin while most were resistant to penicillin and erythromycin. Similarly in another study conducted by Akinyemi et al. 80.7% of total bacteria were sensitive to ciprofloxacin.[20] However sensitivity ranged from 96-100% to ciprofloxacin in other study and that study found all gram positive organisms to be sensitive to Vancomycin. Similarly sensitivity to erythromycin was found to be much higher than in our study.[25] The sensitivity pattern of GNB towards Gentamicin ranged from 33-80% whereas sensitivity to ciprofloxacin ranged from 83-100%. Most of them were resistant to Cefoxitin, Ampicillin and Nitrofurantoin. Our study was in concordance with the other study where most of GNB were reistant to ampicillin.[10] There were a lot of variations in the sensitivity pattern obtained from bacterial isolates from similar studies.[9,10,13,25] This is a significant observation and could reflect the sensitivity pattern of bacteria in different parts of the world. This data on antibiotic resistance could also be used to characterize these opportunistic pathogens and highlights the need for even more stringent measures to be followed in the hospitals to prevent spread of such bacterial strains.

Among our study subjects, most of them frequently clean their mobile with simple cloth and few clean their mobile phones with special agents. This result is consistent with the findings of Srikanth et al where they found that only 12% of HCW used disinfectant to wipe their mobile.[24] Hence it can be emphasized that knowledge should be disseminated among HCWs regarding possible contamination of mobile phones and importance of periodic cleaning of phones. Further importance of hand hygiene should be given highest priority as several studies revealed that mobile phones carried the same profile of microorganisms as in the dominant hand of the holder.[6,25,27]

In our study, there was no significant association between the cleaning agent used and isolation of bacteria. In contrary to our finding, another study has demonstrated the significant reduction of microorganisms on the surface of mobile phone with use of disinfection methods like UV radiation and ozone. Similarly, reduction in isolation of bacteria after wiping mobile phone with 70% isopropyl alcohol was also found in other studies.[11,28,29] The possible explanation for such deviation of our result from previous studies might be because of inappropriate method of using disinfectants or recall bias of HCWs regarding the composition of special agents though it is unlikely. However, present study did not check the efficacy of various chemical disinfectants for cleaning mobile phones which needs to be done in future.

Limitation of this study is that the bacterial counts of microorganisms was not done so we could not assess the level of contaminating microorganism per square cm and

only mesophilic aerobic and facultative anaerobic bacteria were identified. Nevertheless, further studies involving more number of samples are needed to substantiate the role of mobile phones in the transmission of infection to critically ill patients in the hospital.

CONCLUSION

Since several nosocomial pathogens were isolated with resistant trait to several commonly used antibiotics, infection control guidelines must target use of suitable disinfectants to avoid mobile phone contamination. We also advocate hand-wash prior to and after mobile phone usage. Policy makers of individual healthcare facilities should formulate specific protocols for restricted use of mobile phones in sensitive patient care areas and we advocate not using mobile phones while attending patients unless it is very important so as their cellular telephones may carry potentially pathogenic microbes that may affect not only patients, but also their loved ones at home.

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