

Health Care Workers' Mobile Phones: A Potential Cause of Microbial Cross-Contamination Between Hospitals and Community

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This study evaluated the microbial contamination of health care workers' (HCWs) mobile phones. The study was conducted at a secondary referral hospital in July 2010. Samples were taken from all surfaces of the mobile phones using a sterile swab, and incubated on Brain Heart Infusion agar at 37.5°C for 24 hr. Any isolated microorganisms were grown aerobically on 5% sheep blood agar and eosin methylene-blue agar medium at 37.5°C for 24–48 hr. The Sceptor microdilution system was used to identify the microorganisms, together with conventional methods. The oxacillin disc diffusion test and double-disc synergy test were used to identify methicillin-resistant Staphylococcus aureus (MRSA) and expanded-spectrum beta-lactamase (ESBL)-producing Gram-negative bacilli, respectively. The mobile phones were also categorized according to whether the HCWs used them in the intensive care unit (ICU). Overall, 183 mobile phones were screened: 94 (51.4%) from nurses, 32 (17.5%) from laboratory workers, and 57 (31.1%) from health care staff. In total, 179 (97.8%) culture-positive specimens were isolated from the 183 mobile phones, including 17 (9.5%) MRSA and 20 (11.2%) ESBL-producing Escherichia coli, which can cause nosocomial infections. No statistical difference was observed in the recovery of MRSA ($p = 0.3$) and ESBL-producing E. coli ($p = 0.6$) between the HCW groups. Forty-four (24.6%) of the 179 specimens were isolated from mobile phones of ICU workers, including two MRSA and nine ESBL-producing E. coli. A significant ($p = 0.02$) difference was detected in the isolation of ESBL-producing E. coli between ICU workers and non-ICU workers. HCWs' mobile phones are potential vectors for transferring nosocomial pathogens between HCWs, patients, and the community.

Keywords community, contamination, emerging pathogens, health care workers, mobile phone, nosocomial infections

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INTRODUCTION

Although technical innovations have greatly improved people's lives, they may lead to various adverse effects on health.^(1–5) Mobile phones are useful devices used by people worldwide, in both developed and developing countries. These devices have become almost indispensable elements in the fabric of social life. Health care workers (HCWs) use these devices extensively in daily life and at work. Mobile phones have increased the speed of communication and contact within health care institutions.^(1,2,6–9)

Although extensive concerns have been raised about the possibility that exposure to the radio frequency fields from mobile phones or their base stations deleteriously affect people's health,^(3,4) microbial contamination of these devices, especially those used by HCWs, has not adequately raised concern.^(2,9) These devices, which HCWs might use while working, may be contaminated by nosocomial emerging pathogens, such as methicillin-resistant *Staphylococcus aureus* (MRSA) and expanded-spectrum beta-lactamase (ESBL)-producing Gram-negative bacteria.^(1,2,6–11) Common nosocomial pathogens can survive on inanimate surfaces for weeks.^(12–14) Therefore, mobile phones may cause microbial cross-contamination between workers, patients, and the community. Nosocomial pathogens can lead to severe infections, with high morbidity, mortality, and cost.⁽¹⁵⁾ In recent years, community-acquired MRSA and ESBL-producing Enterobacteriaceae have become great threats to public health.^(16–22)

Several studies have examined the microbial contamination of mobile phones in developing countries. This study evaluated the microbial contamination of mobile phones used by HCWs in a secondary referral hospital in Eastern Turkey.

MATERIALS AND METHODS

Setting and Study Design

This study was performed in all departments of Elazig Education and Research Hospital, a 650-bed secondary referral hospital, in July 2010. Overall, 350 HCWs are employed at the hospital. The study examined 183 mobile phones used by HCWs: nurses, laboratory workers, and health care staff. Physicians were not included in the study because they did not wish to participate. The mobile phones were also categorized according to whether the HCWs worked in the intensive care unit (ICU). Microbiological cultures were taken from mobile phones on Wednesday at about 15:00 hr by two physicians who were blind to the HCWs. Each HCW was asked two questions when the microbiological cultures were taken: (1) Do you ever clean your mobile phone with antiseptic wipes? (2) Do other individuals outside the hospital (e.g., family members such as children and the elderly) use your mobile phone? HCWs who did not want to participate in the study were excluded. The use of mobile phones by HCWs has not been limited or banned in our hospital.

Microbiological Investigations

All samples were processed at the clinical microbiology laboratory of Elazig Private Medical Park Hospital. Microbiological cultures were taken from all surfaces of the mobile phones using sterile cotton swabs, horizontally and vertically; moistened with sterile demineralized water; and incubated on brain heart infusion agar (Merck, Darmstadt, Germany) at 37.5°C for 24 hr. One sterile swab was used per mobile phone. Then, the microorganisms were grown aerobically on 5% sheep blood agar (RTA Laboratories, Kocaeli, Turkey) and eosin methylene-blue (EMB) agar (Merck) at 37.5°C for 24–48 hr. Only one apparently dominant type of microorganism was pulled from each polymicrobial culture.

In addition, three sterile cotton swabs, three sterile dematerialized water tubes, and three aliquots of brain heart infusion agar, which were selected from the study materials randomly, were checked for quality control. The Sceptor microdilution system (BBL Microbiology Systems, Cockeysville, Md.) was used to identify the microorganisms. Conventional methods such as the morphological appearance of the colonies, Gram stain, coagulase test, and oxidase and catalase reactions were used. The oxacillin disc diffusion test and double-disc synergy test (Oxoid, Milan, Italy) were used to identify methicillin-resistant *Staphylococcus* spp. and ESBL-producing Gram-negative bacilli, respectively, as recommended by the Clinical Laboratory Standards Institute.⁽²³⁾ The rates of MRSA and ESBL-positive *E. coli* strains were also investigated at the hospital in July 2010.

Statistical Analysis

Statistical analysis was performed using SPSS for Windows version 16.0 (SPSS Inc., Chicago, Ill.). The chi-square test was used to compare categorical variables, and *p*-values lower than 0.05 were considered significant. The incidence of MRSA,

methicillin-resistant coagulase-negative *Staphylococcus* (MR-CNS) spp., and ESBL-producing *E. coli* was compared among HCW groups.

RESULTS

The study evaluated 183 microbiological cultures from 183 mobile phones used by 183 HCWs: 94 (51.4%) nurses, 32 (17.5%) laboratory workers, and 57 (31.1%) other health care staff. In total, 179 (97.8%) culture-positive specimens were isolated from the 183 mobile phones. No microbes were recovered from four mobile phones. Five (2.8%) of 179 culture-positive specimens from which MSCNS spp. had been isolated were polymicrobial. The microorganisms isolated from culture-positive specimens are shown in Table I. No significant difference was observed in terms of the isolation of MRSA, MRCNS spp., and ESBL-producing *E. coli* among three HCW groups (Table I).

Of the 179 culture-positive specimens, 44 (24.6%) were isolated from mobile phones of ICU HCWs (Table II). A significant difference was found in the recovery of ESBL-producing *E. coli* between ICU workers and other HCWs (*p* = 0.02) (Table II). No vancomycin-resistant *Enterococcus* spp. or ESBL-positive *Klebsiella* spp. was detected. At our hospital, in July 2010, 41% of the *S. aureus* from inpatient cultures were MRSA and 23% of the *E. coli* were ESBL-positive. Overall, 177 (96.7%) of 183 HCWs stated that they never cleaned their mobile phones with antiseptic wipes. All HCWs who participated in the study said that their mobile phones were used daily by other individuals, mainly family members, especially children.

No microbes were isolated from the quality control samples.

DISCUSSION

Some studies have reported that mobile phones can interfere with medical equipment.^(3,24,25) We believe that the microbial contamination of HCWs' mobile phones in the hospital setting is as dangerous as interference with medical equipment. Devices contaminated by nosocomial pathogens may serve as vectors among HCWs, patients, and the community, as nosocomial pathogens can survive for weeks on inanimate surfaces.^(12–14) Consequently, nosocomial pathogens may be transferred to other places via mobile phones, such as the workers' homes. We found a high microbial contamination rate (97.8%) of mobile phones, including 9.5% MRSA, 23.5% MRCNS spp., and 11.2% ESBL-positive *E. coli*. Previous studies done in Turkey found similar high microbial contamination rates on HCWs' mobile phones, including 94.5% by Ulger et al.⁽⁶⁾ and 91.0% by Krabay et al.⁽⁷⁾ The reason for these high contamination rates among HCWs is believed to be the unconscious handling of mobile phones while providing health care services. Also, there is a lack of awareness about nosocomial infections and the lack of awareness about the contamination of mobile phones by infectious microorganisms among HCWs.

TABLE I. Microorganisms Isolated from Culture-Positive Specimens of HCW Mobile Phones

Microorganisms	Nurses	Lab Workers	Health Care Staff	Total (%)	P-value
MRSA	6	5	6	17 (9.5)	0.3
MSSA	6	7	15	28 (15.6)	
MRCNS spp.	26	6	10	42 (23.5)	0.3
MSCNS spp.	29	6	13	48 (26.8)	
ESBL (+) <i>E. coli</i>	11	2	7	20 (11.2)	0.6
ESBL (-) <i>E. coli</i>	7	4	6	17 (9.5)	
<i>Klebsiella</i> spp.	3	1	0	4 (2.2)	
<i>Enterococcus</i> spp.	2	1	0	3 (1.7)	
Total	90	32	57	179 (100)	

Notes: MRSA; Methicillin-resistant *Staphylococcus aureus*. MSSA: Methicillin-sensitive *Staphylococcus aureus*. ESBL (+): Expanded-spectrum Beta-lactamase positive. ESBL (-): Expanded-spectrum Beta-lactamase negative. MRCNS: Methicillin-resistant coagulase-negative *Staphylococcus* spp. MSCNS: Methicillin-sensitive coagulase-negative *Staphylococcus* spp.

The high contamination rates may constitute an important threat to public health worldwide, especially in developing countries. Ulger et al.⁽⁶⁾ also reported that the microorganisms isolated from HCWs' mobile phones were similar to those colonizing their hands. Although HCWs endeavor to comply with hand hygiene in hospitals, as we found in this study, many of them never clean their own mobile phones. Consequently, we believe that these devices may become vectors for nosocomial pathogens. Unfortunately, HCWs are not conscious of this potential threat, especially in developing countries. Goldblatt et al.⁽²⁾ noted that cellular telephones can potentially act as "Trojan horses," introducing community-acquired MRSA to areas previously free of MRSA.

In this study, no significant difference was observed in the microbial contamination of mobile phones by nosocomial pathogens among different HCW groups (Table I), which suggests that a number of HCWs are unaware of the potential risks resulting from contamination of their phones. Our study showed that ICU workers' mobile phones had a significantly

higher risk of contamination with ESBL-positive *E. coli* than non-ICU workers' mobile phones (Table II), perhaps because of the routine "patient body care" given to ICU patients. On a positive note, no vancomycin-resistant *Enterococcus* spp. were recovered from HCWs' mobile phones in our study. At our hospital, the rates of MRSA and ESBL-producing *E. coli* obtained from inpatient cultures in July 2010 matched the rates of MRSA and ESBL-producing *E. coli* obtained from HCWs' mobile phones.

This study reveals that all HCWs' mobile phones are frequently used outside the hospital by other individuals, especially family members. Currently, children commonly use mobile phones because of their multimedia functions, e.g., to play games. Children and other individuals who use HCWs' mobile phones may be colonized or infected by nosocomial pathogens, such as MRSA and ESBL-producing Gram-negative bacteria, which poses a great threat to public health in terms of the spread of these pathogens. In the community, children, elderly individuals, and immunocompromised patients should avoid contact with HCWs' mobile phones.

Previous studies reported that mobile phones can lead to cross-contamination between HCWs and inpatients but did not mention cross-contamination between HCWs and the community.^(1,6,8-11) Few studies have noted that mobile phones can be reservoirs for pathogenic bacteria that can be transferred between hospitals and the community.^(2,7) Studies have not adequately identified the role of the contamination of HCWs' mobile phones. In this study, we emphasize that mobile phones are not only a potential cause of cross-contamination between HCWs and inpatients but also a potential cause of cross-contamination between HCWs and the community, perhaps causing an increase in MRSA and ESBL-producing *Enterobacteriaceae* in the community.

Recent studies have demonstrated that HCWs and their community contacts are potentially at risk for MRSA infection, and that a close relationship exists between community-acquired and health care-acquired MRSA infections.^(17,20,26) Similarly, Moor et al.⁽²⁷⁾ reported that health care facilities are

TABLE II. Distribution of Microorganism Isolated from Culture-Positive Specimens from ICU and Non-ICU Workers' Mobile Phones

Microorganisms	ICU Workers	Non-ICU Workers	P- value
MRSA	2	15	0.2
MSSA	4	24	
MRCNS spp.	13	29	0.3
MSCNS spp.	10	38	
ESBL (+) <i>E. coli</i>	9	11	0.02
ESBL (-) <i>E. coli</i>	6	11	
<i>Klebsiella</i> spp.	0	4	
<i>Enterococcus</i> spp.	0	3	
Total	44	135	

significant reservoirs for ESBL-producing Enterobacteriaceae infections in the community. This parallels our view. In a recent review, Albrich and Harbart⁽²⁰⁾ noted clear molecular and epidemiologic evidence of MRSA transmission from HCWs to patients. Considering the long survival time of nosocomial pathogens on inanimate surfaces, a risk exists of MRSA transmission between HCWs and the community. Mackenzie et al.⁽¹⁷⁾ confirmed our view, reporting that the monthly MRSA rate in the community was strongly related to the monthly MRSA rate observed 1 month earlier at the hospital.

Brady et al.⁽¹⁾ reported that many HCWs (80–92%) never clean their mobile phones. The reported rates of MRSA and Gram-negative microorganisms (nosocomial pathogens isolated from HCWs' mobile phones) were 1.9–14% and 3.0–15%, respectively. These results are similar to our findings and suggest that the contamination of HCWs' mobile phones is a common problem worldwide. In addition, HCWs are not aware that their mobile phones may be vectors for microbial cross-contamination. HCWs should be educated about this problem, and infection control committees should prepare guidelines such as preventive measures for the decontamination of mobile phones.

Unfortunately, no guidelines exist telling HCWs how to mitigate the risk of microbial contamination of their mobile phones in developing and developed countries.^(1,8) Health institutions should encourage efforts to prepare such guidelines. Restriction of the use of mobile phones in the clinical setting, regularly cleaning of these devices with wipes containing antiseptics such as 0.5% chlorhexidine–70% isopropyl alcohol, and strict hand hygiene before and after the use of mobile phones may offer a solution. Furthermore, recommendations to prevent the cross-contamination of mobile phones should be developed and added to hospital infection control guidelines.

Limitations

HCWs and their families were not investigated for nasal MRSA carriage because of limited laboratory resources. The mobile phones of individuals who were not in contact with HCWs or hospitals were not investigated as a control group in terms of contamination with nosocomial emerging pathogens because of those limited laboratory resources. Further studies should consider these limitations.

CONCLUSIONS

This study reveals the contamination of HCWs' mobile phones by nosocomial emerging pathogens in our hospital. Mobile phones are potential vectors that may lead to cross-contamination between HCWs, patients, and the community. Use of these devices by HCWs should be limited or banned in the clinical setting, ICUs, laboratories, and places having high risk for contamination with nosocomial pathogens in hospitals. Suitable disinfection of mobile phones may be an important component to include in the infection control efforts for the health care environment and for HCWs.

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