Bacterial colonization of healthcare workers’ mobile phones in the ICU and effectiveness of sanitization

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ABSTRACT

Extra-European studies report high rates of multi-drug resistant bacteria colonization of healthcare workers’ mobile phones in intensive care units. We aimed to assess the prevalence of bacterial colonization of healthcare workers’ mobile phones in an intensive care unit in France and the effectiveness of a sanitization product. We designed a prospective, monocentric study in a 15-bed intensive care unit within a 300-bed private hospital. Bacterial colonization was assessed on 56 healthcare workers’ mobile phones immediately before and 5 min after sanitization of the phones with bactericidal wipes. The mobile phones of 42 administrative staff acted as controls. All mobile phones in both groups were colonized. Healthcare workers’ phones had a higher number of different bacterial species per phone (2.45 ± 1.34 vs. 1.81 ± 0.74, p = 0.02). Colonization with pathogens did not differ significantly between healthcare workers’ and controls’ phones (39.3% vs. 28.6%, p = 0.37). Excluding coagulase negative Staphylococcus, Staphylococcus aureus was the most common pathogen found in both groups (19.6% and 11.9%, p = 0.41). Only one healthcare workers’ mobile phone was colonized by methicillin-resistant Staphylococcus aureus, and no other multi-drug resistant bacteria was detected. No covariate was associated with pathogen colonization. After sanitization, 8.9% of mobile phones were sterilized, and colonization with pathogenic bacteria decreased (21.4% vs. 39.3%, p = 0.04) as did the number of CFUs/mL (367 ± 404 vs. 733 ± 356, p < 0.001). Colonization of intensive care unit healthcare workers’ and administrative staff’s mobile phones was similar. Colonization with pathogens was frequent but colonization with multi-drug resistant bacteria was rare. Disinfecting the phones with bactericidal wipes is not completely effective. Specific sanitization protocols and recommendations regarding the management of healthcare workers’ mobile phones in intensive care units should be developed. Additionally, good hand hygiene after touching mobile phones should be kept in mind to prevent cross-infections.

KEYWORDS

Bacteria; cell phone; cross infection; hygiene; intensive care unit; sanitization

Introduction

Bacterial colonization of environmental surfaces or medical devices is common.¹ Normal skin is colonized with environmental flora.¹ Colonization of many medical devices such as blood pressure cuffs, pulse-oximeters, thermometers, stethoscopes, and ultrasound probes with pathogens or multi-drug resistant (MDR) organisms has been reported¹ and may serve as a vector for cross-infections.² Strict sanitization of medical devices is therefore mandatory, especially in intensive care units (ICUs).³

In recent years, people are increasingly dependent on mobile phones, and healthcare workers (HCWs) increasingly use medical apps that are available on these devices in their work. However, few studies assessed bacterial colonization of HCWs’ mobile phones in an ICU. A Turkish study reported 94.5% of phones had bacterial colonization, with high rates of pathogens isolated.⁴ Another Turkish study reported higher rates of colonization with MDR bacteria on mobile phones of HCWs in an ICU than for the phones of those working in other areas of the hospital.⁵ The same clone of Acinetobacter baumannii...
has been found on HCWs’ hands, their mobile phones, and in patients in the ICU, confirming their potential role in cross-infections.[6] In Australia, 7% of HCWs’ mobile phone were colonized with MDR organisms.[7] Because the prevalence of cross infections and MDR bacteria varies worldwide, these findings may not apply to western countries where similar studies are lacking.

Little is known about the effectiveness of sanitizing mobile phones. In their review, Schabrun et al. suggest that 70% alcohol is the most effective agent in reducing bacterial colonization on healthcare devices.[3] However, several studies highlighted potential damage to ultrasound probes following long-term alcohol use.[3] Establishing a routine protocol for sanitizing HCWs’ mobile phones with an efficient and safe agent appears crucial.

In this study, we describe the bacterial colonization of HCWs’ mobile phones in an ICU in France compared to that of the administrative staff’s phones, and report findings from a sanitization protocol.

Methods
A prospective, monocentric study was conducted in the 15-bed ICU (85% medical) of a private hospital. Microbiological test results of isolates taken from HCW’s mobile phones were compared to the results from the administrative staff’s phones, a group of workers who are never in direct contact with patients. To avoid the risk that participants sanitized their mobile phone in anticipation of the study and the subsequent bias, participants were only informed of the study just before the sampling.

To take a sample, one investigator, wearing sterile gloves, rubbed both sides of the phones with dry swabs (BD ESewab Regular Collection Kit: White cap w/Liquid Amies and a regular flocked swab) using a standardized method. The method used covered the entire surface of the device, without removal of the protective case. For HCW’s mobile phones, another swab was used 5 min after sanitization with bactericidal didecyldimethylammonium chloride wipes, which are recommended for small, non-submersible and non-invasive medical devices (Wip’Anios Excel, Anios, Lille-Hellemmes, France).

After centrifugation for 30 secs at maximum speed, 100 µL of each sample was inoculated onto the following media: PVX media (bioMérieux, Marcy l’Etoile, France); CPSE media (bioMérieux, Marcy l’Etoile, France); ANC media (bioMérieux, Marcy l’Etoile, France) for the selective detection of Gram-positive bacteria; Drigalski media (bioMérieux, Marcy l’Etoile, France) for the selective detection of Gram-negative bacteria; SAIDE media (bioMérieux, Marcy l’Etoile, France) for the selective detection of Staphylococcus aureus; and CLO media (bioMérieux, Marcy l’Etoile, France) for the detection of Clostridium difficile. The CLO media was incubated at 37°C for 48 hr in an anaerobic atmosphere and all other media were incubated at 37°C for 48 hr in an aerobic atmosphere. Each medium was examined after 24 hr and 48 hr of culture. All types of colonies present on different media were identified. An overall quantification of the total number of colonies was performed on PVX agar after 48 hr of incubation. Bacterial identification was conducted by mass spectrometry (MALDI-TOF, Bruker microflex biotyper). All Enterobacteriaceae, Enterococci, and S. aureus were selected for antimicrobial susceptibility testing, which was performed and interpreted according to the recommendations of the antibiogram committee of the French Society of Microbiology and the European Committee of Antimicrobial Susceptibility Testing 2017 (CA-SFM-EUCAST 2017). Inhibition diameters were measured using the SIRscan Auto (I2A, Montpellier, France).

Bacteria were classified according to their usual reservoir (skin flora, oropharyngeal flora, digestive flora, and environmental flora) and according to their pathogenicity (Table 1). In the literature, coagulase negative Staphylococcus (CNS) was reported to be present on almost every mobile phone. Therefore, we excluded CNS from the focus on pathogen colonization.

Categorical covariates were compared across HCWs and administrative staff using Fisher’s exact test for count data or Chi-squared test when deemed appropriate. Association between covariates (age, sex, HCWs’ function, administrative staff, mobile phone brand, presence of a protective case, frequency of sanitization) and risk of baseline colonization was investigated with univariate logistic regression. The effectiveness of the sanitization procedure was assessed using McNemar’s chi-squared test for binomial outcomes or Wilcoxon signed-rank paired test on log 10-transformed bacterial concentrations. Values of p < 0.05 were considered statistically significant.

The local ethical committee approved the study and informed consent was obtained from the participants.

Results
Fifty-six HCWs’ mobile phones (9 physicians, 27 nurses, 16 auxiliary nurses, and 4 others) and 42 more from administrative workers were included. Only one senior physician was excluded because of not having a
mobile phone. No one invited to the study refused to participate.

All 56 HCWs reported keeping their mobile phone with them during their shift, and only one (1.8%) declared that they did not enter patients rooms with their phone. Ten HCWs (17.9%) and three administrative workers (7.1%) reported that they performed routine sanitization of their mobile phones with various products (weekly for four HCWs, monthly for the others) ($p = 0.12$). Protective case was used by 69% of HCWs and by 59.5% of the administrative staff ($p = 0.39$).

All mobile phones from both groups of participants were colonized (Table 1). The number of different bacterial species per phone was higher in devices from HCWs ($2.45 \pm 1.34$ vs. $1.81 \pm 0.74$, $p = 0.02$). Colonization with pathogens was not more prevalent on HCWs’ mobile phones (39.3% vs. 28.6%, $p = 0.37$). Excluding CNS, *S. aureus* represented the most common pathogen in both groups (Table 1). Only one HCW’s mobile phone (1.8%) was colonized by methicillin-resistant *S. aureus*. No other MDR bacteria were detected.

No covariate was associated with colonization by pathogenic bacteria (age, sex, HCWs’ function, administrative staff, mobile phone brand, presence of a protective case, frequency of sanitization) when comparing the 34 (34.7%) phones colonized with pathogenic bacteria to others (n = 64). After sanitization, 5 (8.9%) mobile phones were sterilized (Table 1). Colonization with pathogenic bacteria was less frequent (21.4% vs. 39.3%, $p = 0.04$), as well as the number of CFUs/mL ($367 \pm 404$ vs. $733 \pm 356$, $p < 0.001$, Table 1), after sanitization.

There was no differential effect of sanitization with respect to the presence or absence of a protective case.

### Discussion

This study was the first to assess bacterial colonization of HCWs’ mobile phones in a European ICU. We found that all mobile phones were colonized with skin flora and 39.3% were colonized with pathogenic bacteria. This result is similar to that observed in common medical devices, confirming that mobile phones should now be considered an integral part of the medical environment.[1]

Despite the low rate of MDR bacterial colonization (1.8%) in our study, our results support the many

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**Table 1.** Bacterial colonization of mobile phones: Comparison between phones of administrative staff and ICU healthcare workers and the effect of sanitization.

|                              | Administrative staffs' phones (n = 42) | HCWs' phones before sanitization (n = 56) | Administrative staffs' vs. HCWs' phones (baseline) | HCWs' phones after sanitization (n = 56) | Effect of sanitization on HCWs' phones P value** |
|------------------------------|---------------------------------------|------------------------------------------|---------------------------------------------------|------------------------------------------|-----------------------------------------------|
| Bacterial colonization, n (%)| 42 (100)                              | 56 (100)                                 | 1                                                 | 51 (91.1)                                | 0.03                                          |
| - Colony forming units/mL    | 775 ± 307                             | 733 ± 356                                | 0.92                                              | 367 ± 404                                | <0.001                                        |
| - Bacterial species/phone     | 1.81 ± 0.74                           | 2.45 ± 1.34                              | 0.02                                              |                                          |                                               |
| - Skin flora                  | 42 (100)                              | 56 (100)                                 | 1                                                 |                                          |                                               |
| - Oropharyngeal flora         | 2 (4.8)                               | 4 (7.1)                                  | 0.70                                              |                                          |                                               |
| - Digestive flora             | 3 (7.1)                               | 3 (5.4)                                  | 1                                                 |                                          |                                               |
| - Environmental flora         | 23 (54.8)                             | 31 (55.4)                                | 1                                                 |                                          |                                               |
| CNS, n (%)                   | 41 (97.6)                             | 56 (100)                                 | 0.43                                              | 49 (87.5)                                | 0.008                                         |
| Other pathogens (CNS excluded), n (%) | 12 (28.6)                        | 22 (39.3)                                | 0.37                                              | 12 (21.4)                                | 0.04                                          |
| - Staphylococcus aureus       | 5 (11.9)                              | 11 (19.6)                                | 0.41                                              | 3 (5.3)                                  |                                               |
| - Digestive flora             | 3 (7.1)                               | 4 (7.1)                                  | 1                                                 | 3 (5.4)                                  |                                               |
| - Klebsiella oxytoca          | 0 (0)                                 | 1 (1.8)                                  | 1                                                 | 1 (1.8)                                  |                                               |
| - Klebsiella pneumoniae       | 1 (2.4)                               | 0 (0)                                    | 0                                                 | 0 (0)                                    |                                               |
| - Enterobacter cloaceae       | 1 (2.4)                               | 1 (1.8)                                  | 1                                                 | 1 (1.8)                                  |                                               |
| - Leclercia                   | 1 (2.4)                               | 0 (0)                                    | 0                                                 | 0 (0)                                    |                                               |
| - Enterococcus faecalis       | 0 (0)                                 | 1 (1.8)                                  | 1                                                 | 1 (1.8)                                  |                                               |
| - Enterococcus faecium        | 0 (0)                                 | 1 (1.8)                                  | 0                                                 | 0 (0)                                    |                                               |
| - Oropharyngeal flora         | 2 (4.8)                               | 5 (8.9)                                  | 0.69                                              | 2 (3.6)                                  |                                               |
| - Moraxella sp.               | 1 (2.4)                               | 1 (1.8)                                  | 1                                                 | 1 (1.8)                                  |                                               |
| - Raoultella ornithinolytica  | 0 (0)                                 | 1 (1.8)                                  | 0                                                 | 0 (0)                                    |                                               |
| - Haemophilus                 | 0 (0)                                 | 1 (1.8)                                  | 0                                                 | 0 (0)                                    |                                               |
| - parainfluenza               |                                      |                                          |                                                   |                                          |                                               |
| - Rothia                      | 0 (0)                                 | 1 (1.8)                                  | 1                                                 | 1 (1.8)                                  |                                               |
| - Streptococcus salivarius    | 0 (0)                                 | 1 (1.8)                                  | 0                                                 | 0 (0)                                    |                                               |
| - Aerococcus viridans         | 1 (2.4)                               | 0 (0)                                    | 0                                                 | 0 (0)                                    |                                               |
| - Bacillus cereus             | 3 (7.1)                               | 6 (10.7)                                 | 0.73                                              | 5 (8.9)                                  |                                               |
| Multi-drug resistant bacteria, n (%) | 0 (0)                             | 1 (1.8)                                  | 1                                                 | 1 (1.8)                                  | 1                                              |

Categorical variables are expressed are number (percentage). Continuous variables are expressed as value ± standard deviation.

*P*-value based on Chi-squared test or Fisher’s exact test for count data, and Wilcoxon signed-rank test for continuous data.

**P*-value based on McNemar’s Chi-squared for paired binomial data or Wilcoxon’s signed-rank paired test for continuous data.
arguments for systematic hand hygiene after HCWs touch their mobile phones. First, all HCWs reported keeping their mobile phones at work. Second, very few HCWs performed routine sanitization of their mobile phones, which was inefficient. Third, colonization of phones with pathogenic bacteria was common (39.3%). Finally, the exponential development of medical apps makes banning mobile phones in the workplace very difficult. Moreover, Ulger et al. reported that the species of bacteria isolated from HCWs’ hands and from their mobile phones were similar, and Jeske et al. reported that anaesthetists’ hands were contaminated after a short call on their mobile phones, making the phones possible reservoirs of bacteria for cross-infection.[8,9] We also be concerned with systematic sanitization.[10]

Visitors that anaesthetists et al. pointed out that HCWs observed these results despite routine hand hygiene with hydroalcoholic solution in our ICU. Recently, Smibert et al. reported that more than half of HCW's was efficient. Third, colonization of mobile phones pointed out that they should be confirmed in a larger study to assess the differential effect of sanitization with respect to the presence/absence of a protective case and to define the appropriate frequency of sanitization.

Conclusions

Bacterial colonization of mobile phones with pathogens occurred frequently on the phones of our ICU HCW’s and administrative staff. Specific sanitization protocols and recommendations regarding management of HCWs’ mobile phones in the ICU should be developed, and good hand hygiene by HCWs after touching mobile phones should be kept in mind to prevent cross-infections.

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