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Bacterial colonization of healthcare workers' mobile phones in ICU and sanitization's efficacy.

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ABSTRACT

Extra-european studies reported high rates of multi-drug resistant bacteria colonization of healthcare workers' mobile phones in intensive care unit. The purpose was to assess the prevalence of bacterial colonization of healthcare workers' mobile phones in a French intensive care unit and the efficacy of a sanitization product.

We designed a prospective monocentric study in a 15-bed intensive care unit in a 300-bed private hospital. Bacterial colonization was assessed in 56 healthcare workers' mobile phones immediately before and after 5 min of sanitization with bactericidal wipes. Control were 42 administrative staff' mobile phones.

All mobile phones were colonized in both groups; at least with coagulase negative *Staphylococcus*. The number of different bacterial species per phone was higher in healthcare workers' (2.45 ± 1.34 vs. 1.81 ± 0.74, $p=0.02$). Colonization with pathogens did not differ significantly across healthcare workers' phones and controls' (39.3% vs. 28.6%, $p=0.37$). *Staphylococcus aureus* was the most common pathogen in both groups (19.6% and 11.9%, $p=0.41$). Only 1 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 pathogens colonization. After sanitization, only 8.9% of mobile phones were sterilized yet colonization with pathogen bacteria decreased (21.4% vs. 39.3%, $p=0.002$) as well as the number of CFUs/mL (367 ± 404 vs. 733 ± 356, $p<0.001$)

In conclusion, colonization of intensive care unit healthcare workers' and administrative staff's mobile phones is similar. Colonization is rare with multi-drug resistant bacteria but frequent with pathogens. Sanitization with bactericidal wipes is incompletely effective. Specific sanitization protocol and recommendations regarding healthcare workers' mobile phones management in intensive care unit should be developed and good hand hygiene after touching mobile phones should be kept in mind to prevent cross-infections.

INTRODUCTION

Bacterial colonization of environmental surfaces or medical devices is very common.[1] Normal skin or environmental flora is found on almost all positive cultures.[1] Colonization with pathogens or multi-drug resistant (MDR) organisms has been reported in many medical devices such as blood pressure cuffs, pulse-oximeter, thermometers, stethoscopes, ultrasound probes… [1] reportedly serving as vector for cross-infections.[2] Strict sanitization of medical devices is therefore mandatory, especially in intensive care units (ICUs).[3]

In recent years, global mobile phones dependence and increasing use of medical apps led healthcare workers (HCWs) to largely use them at work. However, few studies assessed bacterial colonization of HCWs' mobile phones in ICU. A Turkish study reported 94.5% of bacterial colonization with high rates of pathogens.[4] Another Turkish study reported a higher rates of bacterial colonization with MDR bacteria in ICU HCWs' than in non-ICU HCWs' mobile phones.[5] The same clone of *Acinetobacter baumannii* has been found on HCWs' hands, on their mobile phones and in ICU patients, confirming their potential role in cross-infections.[6] In Australia, 7% of HCWs' mobile phone were colonized MDR organisms.[7] As 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 sanitization efficacy of mobile phones. In their review, Schabrun *et al.* suggest that 70% alcohol was the most effective agent in reducing bacterial colonization on healthcare devices.[3] However, several studies highlighted potential damage in ultrasound probes following long-term alcohol use.[3] Establishing a routine protocol for sanitization of HCWs' mobile phones with an efficient and safe agent appears crucial.

In this study, we describe the bacterial colonization of HCWs' mobile phone in a French ICU compared to that of administrative staff's and report on a sanitization protocol.

METHODS

A prospective monocentric study was conducted in the 15-bed ICU (85% medical) of a private hospital. Results were compared to those observed in administrative staff's, a group of workers who were never in direct contact with patients. To avoid the risk that participants sanitized their mobile phone in anticipation of the study and subsequent bias, they were only informed of the study just before the sampling.

One investigator, wearing sterile gloves, rubbed dry swabs in both sides of the phone, with a standardized method, in order to cover the entire surface of the device, without removing the protective case. In HCW's mobile phones, another swab was used 5 min after sanitization with bactericidal didecyldimethylammonium chloride wipes recommended for small non-submersible and non-invasive medical devices (Wip'Anios Excel©, Anios©, Lille-Hellemmes, France).

Swabs were incubated at 37°C for 48h on different types of agar. Bacterial identification was conducted by mass spectrometry (MALDI-TOF). Automatic agar reader-incubator assessed antibiotic susceptibility (SirSCAN 2000 automatic®). The number of CFUs was recorded.

Bacteria were classified according to their usual reservoir (skin flora, oropharyngeal flora, digestive flora and environmental flora) and according to their pathogenicity (Table). As coagulase negative *Staphylococcus* (CNS) was reported to be present in almost every mobile phone, we focused on pathogens colonization, excluding CNS.

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 and risk of baseline colonization was investigated with univariate logistic regression. P-value <0.05 was considered as statistically significant. The efficacy of the sanitization procedure was assessed using univariate Generalized Estimating Equations to account for within-individual repeated measurements.

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, 4 others) and 42 more from administrative workers were included. Only one senior physician declared not having a mobile phone and thus was excluded. No one refused to participate.

All 56 HCWs reported keeping their mobile phone during their shift and only 1 (1.8%) declared not entering patients rooms with it. Ten HCWs (17.9%) and 3 administrative workers (7.1%) declared to perform routine sanitization of their mobile phone with various products (weekly for 4 HCWs, monthly for the others) (p=0.12). Protective case was similarly used by HCWs and by administrative staff (69% vs. 59.5%, p=0.39).

All mobile phones were colonized in both groups of participants, at least with CNS (Table). The number of different bacterial species per phone was higher in HCWs (2.45 ± 1.34 vs. 1.81 ± 0.74, p=0.02). Colonization with pathogens did not occur more often in HCWs' mobile phones (39.3% vs. 28.6%, p=0.37). Excluding CNS, *S. aureus* represented the most common pathogen in both groups (Table). Only 1 HCW's mobile phone (1.8%) was colonized by Methicillin-Resistant *S. aureus*. No other MDR bacteria were detected.

No covariate was associated with pathogen bacteria colonization (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 pathogen bacteria to others (n=64).

After sanitization, only 5 (8.9%) mobile phones were sterilized (Table). Colonization with pathogen bacteria was less frequent (21.4% vs. 39.3%, p=0.002), as well as the number of CFUs/mL (367 ± 404 vs. 733 ± 356, p<0.001, Table).

There was no differential effect of sanitization in respect to presence/absence of a protective case.

DISCUSSION

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

Despite the low rate of MDR bacteria colonization (1.8%) in our study, our results are as so many arguments to support systematic hand rub after touching HCWs' mobile phone. First, all HCWs reported keeping their mobile phone at work. Second, very few HCWs performed (inefficient) routine sanitization of their mobile phone. Third, pathogen bacteria colonization was very common (39.3%). Fourth, the efficacy of the assessed sanitization product was clearly insufficient since 21.4% remained colonized by pathogen bacteria after sanitization. Finally, the exponential development of medical apps makes the simple ban of mobile phones in the workplace very difficult. Moreover, Ulger *et al.* reported that isolated bacteria from HCWs' hands and mobile phones were similar and Jeske *et al.* evidenced anaesthetists' hands contamination after a short call with mobile phones, making them possible reservoirs of bacteria for cross-infections.[8,9] We observed these results despite the large routine hand

hygiene with hydroalcoholic solution in our ICU. Recently, Smibert et al. pointed out that HCWs' mobile phone in their Australian ICU had higher contamination rate with MDR organisms that computer keyboards, probably because mobile phones were not concerned by daily routine cleaning.[7] However, using genome sequencing, they found no evidence that mobile phones could contribute to ICU-acquired MDR-organisms, probably because of high hand hygiene compliance rates.[7] Moreover, results observed Turkey in mobile phones of patients and visitors pointed out that they should also be concerned by systematic sanitization.[10]

Our study has several limitations. This is a monocentric study, however yielding similar numbers MDR bacteria and cross-infections events to those reported by the French ICUs surveillance network. Second, we focused on bacterial colonization and ignored fungus or virus. However, identifying them on HCWs' mobile phones could only have strengthened our message. Finally, we did not set out to compare the efficacy of our routine sanitization product to other available. However, even if 70% alcohol was reported to be the most effective agent, its potential damage observed in ultrasound probes makes its use difficult to consider on expensive products that belong to HCWs.[3]

CONCLUSIONS

Compared to administrative staff' mobile phones, we report a high rate of pathogens colonization in our ICU HCWs' mobile phones, along with a higher number of bacterial species per phone. Specific sanitization protocol and recommendations regarding HCWs' mobile phones management in ICU should be developed and good hand hygiene after touching HCWs' mobile phones should be kept in mind to prevent cross-infections.

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REFERENCES

1 Livshiz-Riven I, Borer A, Nativ R, *et al.* Relationship between shared patient care items and healthcare-associated infections: a systematic review. *Int J Nurs Stud. 52*:380–392 (2015).

2 de Gialluly C, Morange V, de Gialluly E, *et al.* Blood pressure cuff as a potential vector of pathogenic microorganisms: a prospective study in a teaching hospital. *Infect Control Hosp Epidemiol*. *27*:940–943 (2006).

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

4 Sumritivanicha A, Chintanavilas K, Apisarnthanarak A: Prevalence and type of microorganisms isolated from house staff's mobile phones before and after alcohol cleaning. *Infect Control Hosp Epidemiol*. *32*:633–634 (2011).

5 Ustun C, Cihangiroglu M: Health care workers' mobile phones: a potential cause of microbial cross-contamination between hospitals and community. *J Occup Environ Hyg*. *9*:538–542 (2012).

6 Borer A, Gilad J, Smolyakov R, *et al.* Cell phones and Acinetobacter transmission. *Emerging Infect Dis*. *11*:1160–1161 (2005).

7 Smibert OC, Aung AK, Woolnough E, *et al.* Mobile phones and computer keyboards: unlikely reservoirs of multidrug-resistant organisms in the tertiary intensive care unit. *J Hosp Infect.* Epub ahead of print: 2 March 2018. doi:10.1016/j.jhin.2018.02.013

8 Ulger F, Esen S, Dilek A, *et al.* Are we aware how contaminated our mobile phones

with nosocomial pathogens? *Ann Clin Microbiol Antimicrob*. *8*:7 (2009).

9 Jeske H-C, Tiefenthaler W, Hohlrieder M, *et al.* Bacterial contamination of anaesthetists' hands by personal mobile phone and fixed phone use in the operating theatre. *Anaesthesia*. *62*:904–906 (2007).

10 Tekerekoğlu MS, Duman Y, Serindağ A, *et al.* Do mobile phones of patients, companions and visitors carry multidrug-resistant hospital pathogens? *Am J Infect Control*. *39*:379–381 (2011).

Table 1: Mobile Phones Bacterial Colonization: Comparison Between Administrative Staff and ICU Healthcare Workers And Effect Of Sanitization.

Variable	Administrative staff' mobile phones (n=42)	ICU healthcare workers' mobile phones before sanitization (n=56)	ICU healthcare workers' mobile phones after sanitization (n=56)	Comparison between administrative staff and ICU healthcare workers before sanitization, *P* value	Effect of sanitization in ICU healthcare workers' mobile phone
Bacterial colonization, n (%)	42 (100)	56 (100)	51 (91,1)	1	NS
- Colony Forming Units /mL	775 ± 307	733 ± 356	367 ± 404	0,53	0,49 (0,39-0,60)
- Bacterial spices /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	
Pathogens (CNS excluded), n (%)	12 (28,6)	22 (39,3)	12 (21,4)	0,37	0,42 (0,19-0,96)
- *Staphylococcus aureus*	5 (11,9)	11 (19,6)	3 (5,3)	0,41	
- Digestive flora:	3 (7,1)	4 (7,1)	3 (5,4)	1	
• ***Klebsiella oxytoca***	0	1	1		
• ***Klebsiella pneumoniae***	1	0	0		
• ***Enterobacter cloacae***	1	1	1		
• ***Leclercia***	1	0	0		
• ***Enterococcus faecalis***	0	1	1		
• ***Enterococcus faecium***	0	1	0		
- Oropharyngeal flora:	2 (4,8)	5 (8,9)	2 (3,6)	0,69	
• ***Moraxella sp.***	1	1	1		
• ***Raoultella ornithinolytica***	0	1	0		
• ***Haemophilus parainfluenzae***	0	1	0		
• ***Rothia***	0	1	1		
• ***Streptococcus salivarius***	0	1	0		
• ***Aerococcus viridans***	1	0	0		
- Bacillus cereus	3 (7,1)	6 (10,7)	5 (8,9)	0,54	
Multi-drug resistant bacteria, n (%)	0	1 (1,8)	1 (1,8)	1	1,00 (0,06-16,8)
- Methicillin-Resistant *Staphylococcus aureus* n (%)	0	1 (1,8)	1 (1,8)	1	1,00 (0,06-16,8)