ORIGINAL ARTICLE

Identification of microorganisms on mobile phones of intensive care unit health care workers and medical students in the tertiary hospital

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ABSTRACT

Aim To identify and investigate a difference between microorganisms present on intensive care unit (ICU) health care workers' (HCW, doctors, nurses or medical technicians) and medical students' mobile phones as well as to investigate a difference between the frequency and the way of cleaning mobile phones.

Methods Fifty swabs were collected from HCWs who work in the ICU (University Hospital Centre Osijek) and 60 swabs from medical students (School of Medicine, University of Osijek). Microorganisms were identified according to standard microbiological methods and biochemical tests to the genus/species level.

Results Out of 110 processed mobile phones, mobile phones microorganisms were not detected on 25 (22.7%), 15 (25%) students' and 10 (20%) HCW's mobile phones. No statistically significant difference was found between the number of isolated bacteria between the HCW' and students' mobile phones ($p>0.05$). Statistically significant difference was found between both HCW and students and frequency of cleaning their mobile phones ($p<0.001$). A significant difference was also obtained with the way of cleaning mobile phones between HCWs and students ($p <0.001$).

Conclusion The most common isolated microorganisms in both groups were coagulase-negative staphylococci (CoNS) and *Staphylococcus aureus*. Most HCWs cleaned their mobile phones at least once a week, 35 (52.0%), and most medical students several times per year, 20 (33.3%). HCW clean their mobile phones with alcohol disinfectant in 26 (40.0%) and medical students with dry cloth in 20 (33.3%) cases.

Key words: cell phones, swab, coagulase-negative staphylococci

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INTRODUCTION

Nowadays mobile phones have become an inevitable part of our lives. Their number per capita is often much larger than the population of a country (1). Using mobile phones in hospitals can lead to improved quality of health care, especially in terms of faster communication in emergency situations within hospital departments (2). However, with all the benefits that mobile phones offer, their potential role in microorganism transmission has to be emphasized as well (3). While working with patients and touching their mobile phones, health care workers (HCW) can easily transmit microorganisms from patients to their mobile phones and vice versa. Combination of constant handling with the heat generated by the mobile phones can create a prime breeding ground for many microorganisms (4).

Researchers reported different kinds of isolated microorganisms from the surface of mobile phones. In some cases those microorganisms belong to the normal skin flora, but researchers have also isolated and given special attention to microorganisms which can cause nosocomial infections (5-6). Those infections are increasing day-by-day and are causing increased morbidity and mortality of hospitalized patients. Not only do they affect the general patients' health but they are also a huge financial burden (7).

Presence of nosocomial microorganisms is one of the main problems in the intensive care unit (ICU) today as well. The ICU cares for patients whose vital functions are at risk, patients are connected to various tubes and the entry of pathogens is very pronounced and easily enabled. Due to their characteristics, such patients are extremely sensitive to be infected by microorganisms that can be transmitted, not only from any of the objects connected to the patient but also from mobile phones of HCWs (8). For that reason, it is necessary to examine whether the HCWs in ICU clean their mobile phones, how often and what microorganisms can be found on the surface. It is expected from HCWs who work in the intensive care unit to pay special attention to hand hygiene before and after using mobile phones (9-10). Nevertheless, medical students, who are participating in the work of the clinic, could also transmit microorganisms-potential causes of nosocomial infections through their mobile phones maybe even more often (11).

The aim of this study was to determinate the presence (species) of microorganisms on health care workers' and medical students' mobile phones, to investigate their awareness of the presence of microorganisms and the way of cleaning of their mobile phones, as well as to find a potential correlation between the frequency and the way of cleaning mobile phones, and the number of microorganisms isolated.

MATERIALS AND METHODS

Study design

The study was conducted in the tertiary care teaching hospital - University Hospital Center Osijek, Croatia, in April 2012, and at the School of Medicine, University of Osijek, Croatia in October 2012. A total number of 110 mobile phones were swabbed and included in this study: 50 swabs were collected from health care workers (working in the Intensive Care Unit) and 60 swabs were collected from medical students. Gender, age, profession, year of study, awareness of microorganisms on mobile phones, routine cleaning and cleaning agent of the mobile phones were recorded. After filling out questionnaires, swabs of mobile phone were taken from participants' mobile phones.

Methods

A plain sterile swab (Copan S.p.A, Brescia, Italy) moistened with sterile saline, was rotated over the surface of both sides of mobile phones. The swabs were applied to blood agar plates (BD BBL Blood agar base + 5% horse blood) (Sparks, MD, USA) and incubated aerobically during 18-24 hours at 35 (± 2) °C (12). Microorganisms were identified according to standard microbiological methods and biochemical tests to the genus/species level (13). Cefoxitin disk (BD Sensi-Disc, *Heidelberg, Germany)* was used to detect *Staphylococcus aureus* resistant to methicillin (MRSA; inhibition zone ≥22 mm) (14-15).

Participants were not previously informed by the date of collecting the samples. All participants filled out an anonymous questionnaire about their habits of cleaning and cleaning agent for their mobile phones, awareness of the presence of microorganisms on their mobile phones.

Participation in the survey was voluntary and anonymous. Oral consent was taken from all the

participants who agreed to participate in this study. The study was conducted in accordance with the rules and ethical principles of the Ethics Committee of the School of Medicine in Osijek and as a part of the graduate work it was approved by the Committee for final and graduate exams of the School of Medicine in Osijek.

Statistical analysis

The difference observed between the groups was tested by Pearson Chi-Square test and Fisher's exact test. Statistical significance level was confirmed at $p<0.05$.

RESULTS

The study included 50 HCWs working in intensive care unit: 13 physicians, specialists in anesthesiology, intensive care and reanimatology; 12 senior nurses/senior medical technicians and 25 nurses / medical technicians, all aged 20 to 60 (mean 33.96 ± 9.65) years. Also, this study included a total of 60 students: 21 attended the 4th grade, 18 the 5th grade and 21 attended the 6th grade (last year of the study), all aged 20 to 27 (mean 22.75 ± 1.31).

No statistically significant difference was found between the number of isolated bacteria between HCWs' and medical students' mobile phones ($p> 0.05$).

Out of 110 processed mobile phones, mobile phones microorganisms were not detected on 25 (22.7%), 15 (25%) of all students' mobile phones and 10 (20%) HCWs' mobile phones. The most common isolated microorganisms in both groups were coagulase-negative staphylococci (CoNS) and *Staphylococcus aureus*.

One microorganism was present on 38 (34.5%), two microorganisms on 31 (28.2 %) and three microorganisms were detected on 16 (14.5%) mobile phones (Table 1). The MRSA was not detected.

There was no statistically significant difference between the number of isolated microorganisms on mobile phones whether they were owned by physicians, senior nurses/medical technicians and nurses/medical technicians ($p>0.05$). However, a statistically significant difference between the number of isolated microorganisms among medical students' mobile phones ($p<0.001$) was found (Figure 1). The highest number of isolated microorganisms was on medical students' mobile phones on 5th year of study.

Table 1. Microorganisms identified from health care workers' and medical students' mobile phones*

Microorganism isolated	No (%) of health care workers (n= 50)	No (%) of medical students (n=60)
Gram-positive bacteria		
Coagulase negative staphylococci	34 (68)	43 (71.67)
Staphylococcus aures	13 (26)	9 (15)
Sarcina spp.	4 (8)	2 (3.33)
Bacillus spp.	2 (4)	0
Corynebacterium spp.	1 (2)	2 (4)
None	10 (20)	15 (25)
Gram-negative bacteria		
Non-fermenting	0	1 (1.67)
Neisseria spp	0	1 (1.67)

*on some mobile phones there were more than one isolated microorganism species

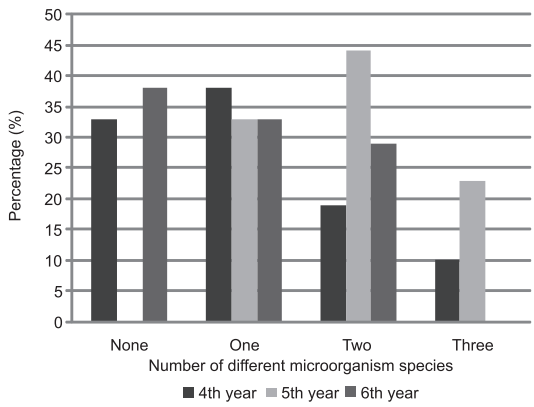

Figure 1. Number of different microorganism species on medical students' mobile phones on 4th, 5th and 6th year of study

A statistically significant difference was found between both HCWs and medical students and the frequency of cleaning their mobile phones ($p<0.001$). Only four (8.0%) and 15 (25.0%) HCWs and medical students, respectively, never cleaned their mobile phones (Table 2).

A significant difference was also obtained with the way of cleaning mobile phones between HCWs and medical students ($p<0.001$): 20 (33.3%) medical students cleaned their mobile phones with a dry cloth (e.g. handkerchief, tissue) and 20 (40.0 %) HCWs cleaned their mobile phones with alcohol disinfectant (e.g. ethyl alcohol, *isopropyl alcohol*) (Table 3).

Table 2. Frequency of cleaning medical students' and health care workers' (HCW) mobile phones

Group	No (%) participants with cleaning frequency				
	Never	Several times per year	Several times per month	At least once a week	Total
Medical students	15 (25.0)	20 (33.3)	16 (26.7)	9 (15.0)	60 (100.0)
HCW	4 (8.0)	5 (10.0)	15 (30.0)	26 (52.0)	50 (100.0)
Total	19 (17.3)	25 (22.7)	31 (28.2)	35 (31.8)	110 (100.0)

Table 3. Cleaning agent of the mobile phones

	No (%) of participants cleaning with					
Group	**Dry cloth**	**Alcohol disinfectant**	**Dry cloth and alcohol disinfectant**	**Not at all**	**Other ways**	**Total**
Medical students	20 (33.3)	6 (10.0)	13 (21.7)	15 (25.0)	6 (10.0)	60 (100.0)
HCW	8 (16.0)	20 (40.0)	15 (30.0)	4 (8.0)	3 (6.0)	50 (100.0)
Total	28 (25.5)	26 (23.6)	28 (25.5)	19 (17.3)	9 (8.2)	110 (100.0)

HCW, Health care workers

A total number of 50 (83.3%) medical students and 42 (84.0%) HCWs had awareness of the presence of microorganisms on their mobile phones. Only 10 (16.7%) medical students and eight (16.0%) HCWs did not think about that. In total 92 (83.6%) participants had awareness of the presence of microorganisms on their mobile phones and 18 (16.4%) did not think about that.

DISCUSSION

Although there are reports that document the contamination of mobile phones among HCWs' and medical students' mobile phones (8), so far no study has ascertained the contamination of mobile phones with microorganisms among medical students (16). We found that medical students' mobile phones (with 2 Gram-negative bacteria isolated) were slightly more contaminated with microorganisms than HCWs' mobile phones; there was also a difference between the numbers of isolated microorganisms on mobile phones among medical students regarding their year of the study, the 5th year medical students had the largest number of isolated microorganism on their mobile phones). Because of that, the students constantly need to emphasize the importance and ways on preventing the spreading of microorganisms through their mobile phones. Through their further education more effort should be made to improve that knowledge.

In this study, 77.3% of 110 mobile phones from the entire study group were found contaminated by microorganisms. Elkholy and Ewees in Cairo reported mobile phone contamination of 96.5% (17), with 42% of phones grew one bacterial species, 29% two and 25.5% three or more different species. In our study we obtained similar data, 34.5%, 28.2%, and 14.5%, respectively. A group of authors from Barbados found that that the rate of bacterial contamination of medical staff's mobile phones was 45% of 101 mobile phones (16). But on the other hand, Karabay et al. from Turkey reported bacterial contamination on 90.1 % of 122 mobile phones of healthcare personnel (18).

Microorganisms which were isolated in our study indicate that mobile phones are relatively free from pathogenic microorganisms. Akinyemi et al. did not isolate nosocomial pathogens like *Pseudomonas aeruginosa, Klebsiella pneumoniae, Escherichia coli, Enterococcus feacalis* (19). Ibrahim Badr and Ali from Egypt isolated *Serratia marsecens* and *Proteus mirabilis* from HCWs' mobile phones (20). A group of authors (Gibbons, Powlett) from Barbados isolated *Pseudomonas aeruginosa, Acinetobacter, Enterobacter* and *Klebsiella spp* from medical staff's (including medical students') mobile phones. (16). Hirsch et al. reported contamination of CoNS from the vast majority of iPads (21). CoNS are a broad group of species that commensally inhabit the human skin and mucous membranes (22-23) and consequently they are the most isolated microorganism from mobile phones. Although they are less virulent than *S. aureus* and almost non-pathogenic in healthy individuals, their persistence on hospital surfaces and devices (including mobile phones) can be the source of bloodstream infections (24). None of *S. aureus* in the present study was methicillin resistant.

Awareness of the presence of microorganisms on mobile phones' surfaces of HCWs and medical students was strongly expressed among our respondents, 83.3% and 84%, respectively. It may be associated with the implementation of "My five moments for hand hygiene", which was constantly carried out in our hospital (25). Gashaw et al. reported awareness of 70.7 % (26), similar to 78% reported in United Kingdom (27). In the present study only small number of both HCW and medical students never clean their mobile phones (8.0% and 25%, respectively). The group of authors from Barbados reported that 53% (of 116) medical staff and medical students never cleaned their mobile phones, and a study from Croatia showed that 100% of 40 health care stuff never cleaned their mobile phones, 40.0 % of the HCWs wipe their mobile phones with alcohol disinfectant and only 10% of medical students (16,28). Medical students in most cases wipe their mobile phones with dry cloth

(33.3%). It is recorded that using 70% isopropyl alcohol can be effective as a disinfectant (28-31). A group of authors from Thailand showed that after cleaning mobile phones with alcohol no microorganisms were detected (32), and Purohit and Singh from India reported that after decontamination surfaces of mobile phones with alcohol bacterial load was reduced by 87% (33). However, our study did not statistically prove the correlation between the number of isolated colonies of microorganisms and methods used to clean mobile phones.

Besides of low number of participants the limitation of this study is, that participants may have had tendencies to over-report their cleaning behaviors that are deemed to be acceptable. Possible surface mobile phone cleaning prior to swab collecting can be neglected since participants were neither previously informed of the date the samples were to be collected nor when the study was to be conducted.

In conclusion, analyzed HCWs' and medical students' mobile phones in searching for microorganisms showed that most of the isolated microorganisms belonged to the natural flora of the human body. A very high percentage of respondents were aware of the possibility of contamination of mobile phones, which affected their behavior in the use and cleaning of devices. As the result, the multidrug resistant etiological agents of nosocomial infections were not detected in the study. Further studies are needed with inclusion of a larger number of participants and institutions.

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TRANSPARENCY DECLARATION

Conflict of interest: None to declare.

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Identifikacija mikroorganizama na mobilnim telefonima zdravstvenih radnika u jedinici intenzivnog liječenja i studenata medicine u kliničkoj bolnici

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Cilj Identificirati i istražiti razliku između mikroorganizama prisutnih na mobilnimtelefonimazdravstvenih radnika u jedinici intenzivnog liječenja (liječnici, medicinske sestre ili medicinski tehničari) i studenata medicine, kao i razliku između učestalosti i načina čišćenja mobilnih telefona.

Metode Pedeset briseva je prikupljeno s mobilnih telefona zdravstvenih radnika koji rade u jedinici intenzivnog liječenja KBC Osijek i 60 briseva s mobilnih telefona studenata medicine Medicinskog fakulteta Sveučilišta u Osijeku. Mikroorganizmisu identificirani standardnim mikrobiološkim postupcima i biokemijskim testovima do razine roda/vrste.

Rezultati Od sveukupno 110 obrađenih briseva mikroorganizmi nisu izolirani iz 25 (22,7%), od čegakod 15 (25%) studenata, a 10 (20%) kod zdravstvenih radnika. Nije bilo statistički značajne razlike između broja izoliranih bakterija na mobilnim telefonima zdravstvenih radnika i studenata medicine ($p> 0,05$). Statistički značajna razlika pronađena je između učestalosti čišćenja mobilnih telefona zdravstvenih radnika i studenata ($p <0,001$). Značajna razlika je također dobivena kod načina čišćenja mobilnih telefonaizmeđu zdravstvenih radnika i studenata ($p <0,001$).

Zaključak Najčešće izolirani mikroorganizmi u obje skupine ispitanika bili su koagulaza negativni stafilokoki (CoNS) i *Staphylococcus aureus*. Većina zdravstvenih radnikačistili su svoje mobilne telefone barem jednom tjedno, 35 (52,0%), a studenti medicine najčešće su ihčistilinekoliko puta godišnje, 20 (33,3%). Zdravstveni radnici, 26 (40,0%),čistili su svoje mobilne telefone alkoholom, a studenti medicine, 20 (33,3%), suhom krpom.

Ključne riječi: mobilni telefon, bris, koagulaza negativni stafilokok