

Nasal carriage of *Staphylococcus aureus* and presence of genetically identical strains on the mobile phones carried by healthcare providers in the intensive care unit.

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Abstract

Aims of the study: *Staphylococcus aureus* colonized in the nose of healthcare providers is an important risk factor for the development of hospital-acquired staphylococcal infections. Cross-contamination of this bacterium between the hands of healthcare providers and the surfaces is known. In this study, we aimed to evaluate the clonal relationship between eight *Staphylococcus aureus* strains isolated from the nose of healthcare providers and five *Staphylococcus aureus* strains isolated from mobile phones carried by healthcare providers. Methods: The clonal relationship between the strains and molecular epidemiological status were investigated by the pulsed-field gel electrophoresis method. Results: The first and third strains are isolated from the mobile phone and the nose of a healthcare provider working in the intensive care unit were the same. The second and fourth strains were isolated from the mobile phone and nose of another healthcare provider working in the intensive care unit were the same. The fifth strain, which was found to be the same as the second and fourth strains, was isolated from the mobile phone of another healthcare provider working in the intensive care unit. No similarity was observed between the other strains. Conclusion: Our findings indicate that *Staphylococcus aureus* strains colonized in the nose of healthcare providers are also transmitted to other surfaces and that the hospital environment and co-used devices pose a risk for spread. For this reason, training of healthcare providers on the infection control procedure, hand hygiene, environmental disinfection and regular cleaning of mobile phones are important components in order to prevent hospital-acquired infections.

INTRODUCTION

Staphylococcus aureus, one of the most commonly isolated agents in both community and hospital-acquired infections worldwide¹. One of the important risk factors for the development of hospital-acquired staphylococcal infections is *S. aureus*, which is colonized in the noses of healthcare providers². This bacterium can be transmitted to the mobile phones used by healthcare providers through their hands^{3, 4}.

The relationship between *S. aureus* colonized in the noses of healthcare providers and *S. aureus* detected in their mobile phones is still unclear. The question of “Are mobile phones randomly contaminated with *S. aureus* or contaminated with *S. aureus* colonized in the noses of healthcare providers?” is waiting to be answered.

The aim of this study was to evaluate the clonal relationship between *S. aureus* strains isolated from the noses of healthcare providers working in the internal medicine intensive care unit (IMICU) and the operating room, and *S. aureus* strains isolated from the mobile phones of IMICU workers.

METHODS

During the period from December 2014-January 2015, 96 mobile phones of healthcare providers in IMICU, anesthesia intensive care unit (AICU) and operating room of our hospital were sampled for bacterial contamination. On the other hand, during the same period we investigated nasal *S. aureus* colonization of same healthcare providers. The samples were screened for bacterial pathogens by standart bacteriological procedures. The methicillin sensitivity of the identified *S. aureus* isolates were tested. Eight methicillin-sensitive *S. aureus* (MSSA) strains isolated from the noses of the healthcare providers and five MSSA strains isolated from their mobile phones were included in this study. The section from which the strains were isolated, occupational group and sample distribution are presented in

Table I.

The clonal relationship between the strains and molecular epidemiological status were investigated by the pulsed-field gel electrophoresis (PFGE) method. The bacterial DNA was obtained from each strain by the acromopeptidase method. The DNA macrorestriction analysis was performed according to the protocol prepared by the Scottish MRSA Reference Laboratory with the *Sma* I restriction method suggested by Bannerman et al.⁵ The Chef DR III (Biorad) device was used for PFGE, and EMRSA 2 and EMRSA 6 strains were included in the study with the aim of making a comparison. After electrophoresis, the gel was stained with ethidium bromide (0.5 µg/ml), and DNA bands were observed. The clonal relationship between the strains was evaluated according to the criteria described by Tenover et al. from the DNA band patterns formed in the gel after PFGE⁶.

RESULTS

In the evaluation of the strains with the PFGE analysis, the 1st and 3 rd strains, and the 2 nd, 4 th and 5 th strains were identical. The 1st strain was isolated from the mobile phone of a healthcare provider working in the IMICU, and the 3 rd strain was isolated from the nose of the same worker. Similarly, the 2 nd strain was isolated from the mobile phone of a healthcare provider working in the IMICU, and the 4 th strain was isolated from the nose of the same worker. The 5 th strain, which was observed to be identical with the 2 nd and 4 th strains, was isolated from the mobile phone of another healthcare provider working in the IMICU. No similarity was observed between other strains (Figure 1).

DISCUSSION

Bacterial contamination of healthcare providers' mobile phones is an extensively studied subject⁷. However, the relationship between nasal colonization and mobile phone contamination is not well understood. In this study, we conducted PFGE to investigate the closeness between *S. aureus* strains isolated from the noses and mobile phones of healthcare providers. We found that out *S. aureus* strains isolated from the mobile phones of two healthcare providers and *S. aureus* strains isolated from their noses were genetically identical. This shows that bacteria colonized in the nose contaminate mobile phones. Kanayama et al. showed that *S. aureus* strains isolated from the mobile phones of nurses and *S. aureus* strains detected in their hands were genetically identical and mentioned the cross-contamination between mobile phones and hands⁸. Furthermore, it was found out in our study that the strain isolated from the nose and mobile phone of a healthcare provider and the strain detected on the mobile phone of another healthcare provider were identical, which shows that *S. aureus* strains colonized in the noses of healthcare providers can be transmitted to other surfaces through hands, and that the hospital environment and the shared devices pose a risk for spread. Similarly, *S. aureus* strains, which were also genetically identical in the study of Kanayama et al. were observed in many mobile phones and the hands of people using them, indicating that these strains spread to large areas within the hospital through the hands of healthcare providers using contaminated mobile phones⁸.

In the study of Chang et al. which examines the bacterial contamination of mobile phones of healthcare providers working in the operating room and compares this with the hand and nose colonization of the same healthcare providers, it was found out that the rate of mobile phone contamination was 98%, and also the bacteria in the mobile phones, hands, and noses of the healthcare providers were identical at the rate of 94.3%⁹.

In their study, Brady et al. demonstrated the relationship between nasal *S. aureus* carriage of healthcare providers and the *S. aureus* contamination of the mobile phones used by patients and emphasized the risk of cross-contamination ¹⁰. Shi et al. reported the cross-contamination of *S. aureus* on the surfaces which healthcare providers contacted with their hands in a large city hospital ¹¹.

In many studies conducted, it was reported that nasal *S. aureus* carriage was detected at a high rate in healthcare providers. Chang et al. detected that *S. aureus* nasal carriage in 19,9 % of healthcare providers ⁹. According to other studies in the literature, this rate was reported to be 30 % in a study conducted in Argentina, 12 % in a study conducted in Ethiopia, and 26 % in a study conducted in India ¹²⁻¹⁴.

The findings of our study indicate that mobile phones used by healthcare providers may be reservoirs for potential pathogens in nasal colonization. The most common potential pathogen *S. aureus* is encountered in surgical site infections, pneumonia, septicemia and instrument-related infections. The identification of the relationship between *S. aureus* strains isolated from these infections and *S. aureus* strains isolated from the noses and mobile phones of healthcare providers will be useful in determining the ways of infection transmission.

CONCLUSION

In the light of these findings, it is important that mobile phone use should be regulated and cleanliness should not be neglected in areas with a high risk of infection in the hospital. Hand hygiene is one of the basic factors in the prevention of hospital infections¹⁵. Hand hygiene must be definitely ensured after the use of a mobile phone and before contact with the patient. In addition to appropriate hand hygiene, it is important to determine the healthcare providers with *S. aureus* nasal carriage, to treat the carriage and to pay attention to the use of shared devices to prevent hospital-acquired infections.

AUTHOR CONTRIBUTIONS :

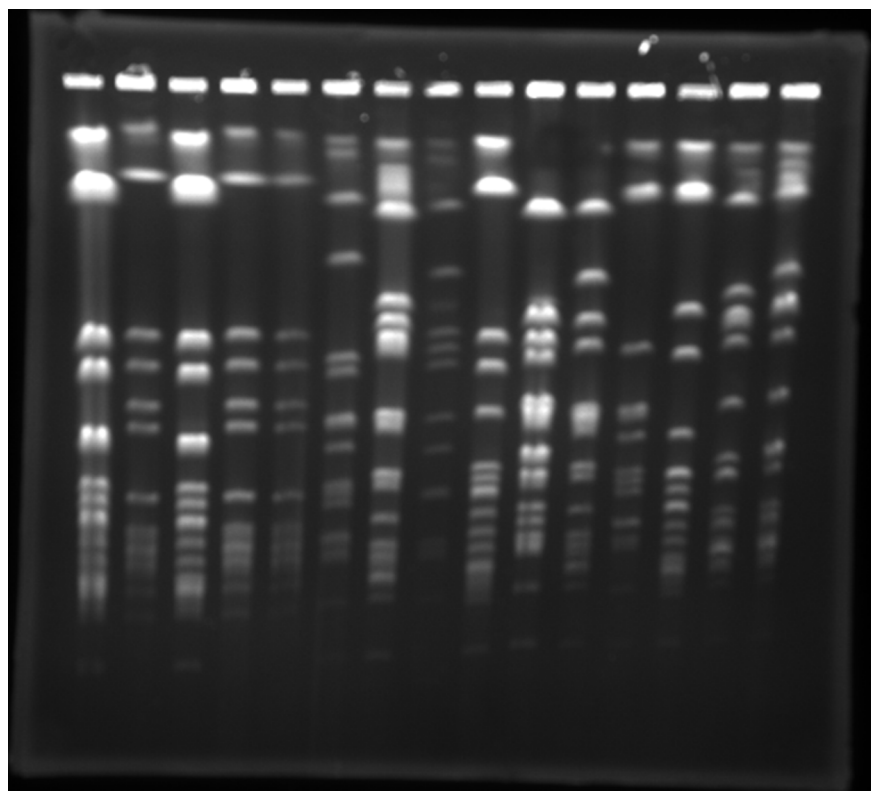
All authors were involved in the conception or design of the study, data analysis and interpretation, drafting, critical revision and approval of article.

Table I: Isolated section, occupational group and sample distribution of the strains

Strain No	Sample used in isolation	Section	Occupational group	PFGE Pattern
1	Mobile phone	IMICU ^A	Doctor 1	A
2	Mobile phone	IMICU	Doctor 2	B
3	Nose	IMICU	Doctor 1	A
4	Nose	IMICU	Doctor 2	B
5	Mobile phone	IMICU	Doctor 3	B
6	Mobile phone	IMICU	Allied Health Personnel 1	C
7	Mobile phone	IMICU	Nurse 1	D
8	Nose	IMICU	Doctor 4	E
9	Nose	IMICU	Allied Health Personnel 2	F
10	Nose	Operating Room	Allied Health Personnel 3	G
11	Nose	IMICU	Doctor 5	H
12	Nose	Operating Room	Allied Health Personnel 4	I
13	Nose	IMICU	Allied Health Personnel 5	J

^AInternal medicine intensive care unit

Figure 1: PFGE band patterns of strains (Batches 1-13: strains isolated from the noses and mobile phones of healthcare workers, K1: EMRSA 2, K2: EMRSA 6)



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