

GENETIC SIMILARITY OF *STAPHYLOCOCCUS AUREUS* STRAINS ISOLATED FROM NOSE AND MOBILE PHONES OF HEALTHCARE PROVIDERS WORKING IN THE OPERATING ROOM AND INTENSIVE CARE UNIT

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ABSTRACT

Purpose: *Staphylococcus aureus* colonized in the nose of healthcare workers is an important risk factor for the development of hospital-acquired staphylococcal infections. Cross-contamination of this bacterium between the hands of healthcare workers and the surfaces they contact is known. In this study, we aimed to evaluate the clonal relationship between eight *S. aureus* strains isolated from the nose of healthcare providers and five *S. 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 (PFGE) 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 *S. aureus* strains colonized in the nose of healthcare workers 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 workers 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.

Keywords: *Staphylococcus aureus*, healthcare worker, mobile phone, nasal carriage, pulsed-field gel

INTRODUCTION

Hospital-acquired infections are a very significant problem that causes increased mortality and morbidity (1). It is stated that hospital-acquired infections develop in approximately 5-10% of hospitalized patients all over the world (2, 3). These

infections caused by microorganisms that exhibit multidrug resistance lead to cost increases due to the prolonged period of hospitalization and additional treatment initiatives (4). The spread of these microorganisms that cause hospital-acquired infections takes place through the hands of healthcare workers, the equipment and tools used by them, and through the inanimate surfaces in the hospital (5).

Mobile phones have become an integral part of the life of healthcare workers because they facilitate communication, cooperation, and information sharing (6). The widespread use of these phones in the hospital, especially in intensive care units and operating rooms where high hygienic standards are required, has raised concerns about hospital-acquired infections. In the studies carried out, it was found out that mobile phones used by healthcare workers showed high bacterial contamination and the rate of contamination with potential clinical pathogens was reported as 14.3 - 75% (7-10).

Staphylococcus aureus (*S. aureus*), one of the most commonly isolated agents in both community and hospital-acquired infections worldwide, causes common infections such as skin and soft tissue infections, surgical site infections, endocarditis, osteomyelitis, and pneumonia (11).

In recent years, the prevalence of infections caused by *S. aureus* has increased due to increased antibiotic resistance and use of medical devices. *S. aureus* is the second most common cause of hospital-acquired sepsis. 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 workers (12). This bacterium can be transmitted to the mobile phones used by healthcare workers through their hands (7, 8).

The relationship between *S. aureus* colonized in the noses of healthcare workers 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 workers?" is waiting to be answered.

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

operating room, and *S. aureus* isolates isolated from the mobile phones of IMICU workers.

METHODS

In this study, eight methicillin-sensitive *S. aureus* (MSSA) strains isolated from the noses of the healthcare providers working in the internal medicine intensive care unit (IMICU), anesthesia intensive care unit (AICU) and operating room of our hospital and five methicillin-sensitive *S. aureus* (MSSA) strains isolated from their mobile phones were included in the 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. (13). 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 PFGE (14).

RESULTS

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

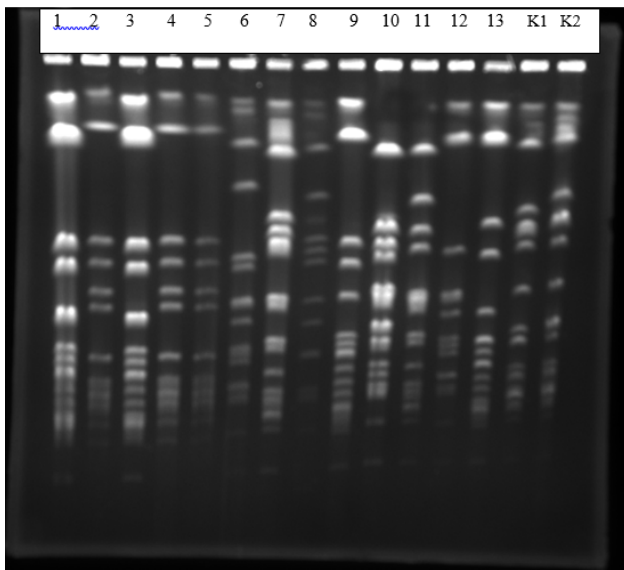


Figure 1. PFGE band patterns of strains (Batches 1-13: strains isolated from the noses and mobile phones of healthcare workers, K1: EMRSA 2, K2: EMRSA 6)

DISCUSSION

Bacterial contamination of healthcare workers' mobile phones is an extensively studied subject (6, 10). 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 workers. We found that out *S. aureus* strains isolated from the mobile phones of two healthcare workers 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 hands (15). Furthermore, it was found out in our study that the strain isolated from the nose and mobile phone of a healthcare worker and the strain detected on the mobile phone of another healthcare worker were identical, which shows that *S. aureus* strains colonized in the noses of healthcare workers 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 workers using contaminated mobile phones (15). 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%. (16) The researchers reported that 25.8% of the healthcare workers with *S. aureus* detected in their nose and hands had *S. aureus* in their mobile phones, and the genotyping study they conducted showed that the identical strains were found in the noses of seven of the eight healthcare workers with *S. aureus* detected in their mobile phones.

In their study, Brady et al. demonstrated the relationship between nasal *S. aureus* carriage of healthcare workers and the *S. aureus* contamination of the mobile phones used by patients and emphasized the risk of cross-contamination (17). Shi et al. reported the cross-contamination of *S. aureus* on the surfaces which healthcare workers contacted with their hands in a large city hospital (18).

Nasal *S. aureus* carriage of healthcare workers is defined as a significant risk in the emergence of hospital-acquired infections, especially in surgery, pediatrics, hemodialysis and intensive care units. The hands of healthcare workers take an important place in the spread of this bacterium in the hospital environment (12).

In many studies conducted, it was reported that nasal *S. aureus* carriage was detected at a high rate in healthcare workers. Chang et al. detected that *S. aureus* nasal carriage in 43% of healthcare workers (16). 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 (19, 20, 21).

It is important to avoid contamination due to high *S. aureus* nasal carriage rates in healthcare workers. Mobile phones are very vulnerable to this contamination as an integral part of healthcare workers. The findings of our study indicate that mobile phones used by healthcare workers may be

Table 1. 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

A

Internal medicine intensive care unit

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 workers will be useful in determining the ways of infection transmission.

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 infections (22). 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 workers with *S. aureus* nasal carriage, to treat the carriage and to pay

attention to the use of shared devices to prevent hospital-acquired infections.

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