

# A Nasal Carriage Rates and Understanding of Staphylococcus aureus and Methicillin-resistant Staphylococcus aureus Infections among Nursing Students

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**Abstract.** Staphylococcus aureus is considered one of the most frequently occurring community- and hospital-associated pathogens. Infectious diseases caused by Staphylococcus aureus are in various forms, ranging from mild skin infection, endocarditis, to fulminant septicemia. The purpose of this study was to determine the prevalence of methicillin-resistant Staphylococcus aureus (MRSA) nasal carriage rates among nursing students. The relevant data were collected using a questionnaire, and microbial samples were collected from the nasal cavities of 215 nursing students. From the collected specimens, strains of Staphylococcus aureus were isolated and subjected to antibiotic susceptibility tests. Of 215 students, 62 (28.8%) were nasal carriers of Staphylococcus aureus, and three students (1.4%) were nasal carriers of MRSA. None of the three students with MRSA had any history of hospitalization over the past 12 months and had not provided nursing care for MRSA patients. However, two students among these three had received antibiotics. All MRSA isolated from these three students were mupirocin-sensitive. According to the results, the rates of MRSA nasal carriage among the nursing students were lower than those of patients or other healthcare workers. Thus, routine screening for nasal MRSA culturing is not recommended in students who practice in the clinic. However, students should be educated about infection control in order to prevent practice-related MRSA nasal carriage.

**Keywords:** Infection; Nasal carriage rates; Nursing student; Methicillin-resistant Staphylococcus aureus; Staphylococcus aureus.

## 1 Introduction

Despite advances in medicine, including widespread adoption of sterilized products, hygienic medical environments, disinfection, sterilization, and anti-bacterial materials, medicine-related infections continue to occur due to various invasive treatments and use of immunosuppressive drugs [1]. Medicine-related infections not only raise death rates, but also increase hospitalization periods leading to discomfort in patients in

terms of expenses and infections; therefore, efforts are being made to prevent medicine-related infections [2].

A number of pathogenic bacteria cause medicine-related infections, but the most commonly reported is *Staphylococcus aureus* [3]. Based on its resistance to methicillin antibiotics, *Staphylococcus aureus* may be categorized as methicillin-susceptible *Staphylococcus aureus* (MSSA) and methicillin-resistant *Staphylococcus aureus* (MRSA); medicine-related infections are mostly caused by MRSA. MRSA, which is a major cause of hospital infections, is commonly found in the nasal cavity and can cause resident flora infection. Furthermore, medicine-related infections due to MRSA occur due to opportunistic infections originating from infected medical staff, hospital environment, other infected patients, or the patient's own resident flora [3, 4].

During an MRSA outbreak, MRSA nasal carriage rate increases, and it has been reported that by treating carriers, medicine-related infection due to MRSA can be reduced. Thus, nasal carriage of MRSA in medical staff or patients may play an important role in causing medicine-related infections. Consequently, in order to prevent medicine-related infections caused by MRSA in medical institutes, various infection control measures are being conducted including screening and treatment of carriers [5].

There is a growing interest in ascertaining the adult MRSA nasal carriage rates in the community, because MRSA that was acquired during a hospital visit can spread through the nasal carriers in the communities where they reside. According to a domestic study, of 179 MRSA strains acquired from samples collected from patients in wards and intensive care units, six strains (3.4%) were unrelated to the hospital, and were possibly acquired from the community [6]. In addition to hospitalized patients, MRSA-infected medical staff may facilitate the spread of MRSA to other patients; therefore, appropriate management is necessary.

During field work at the hospital, nursing students are directly involved with patient care and treatment; in case nursing students are infected with MRSA, there is a risk of spreading it to patients. Nursing students are also at higher risk of being exposed to MRSA from the patients or the environment. Therefore, it is necessary to systematically manage MRSA exposure through a surveillance system, before and after field work at the hospital.

Since there are no studies on MRSA nasal carriage rates on trainees in hospitals, the MRSA nasal carriage rate of students doing field work in hospitals are unknown. However, because nursing students have prolonged contact with patients during field work, they have greater exposure to MRSA infections, and are more likely to spread MRSA to patients. Hence, it is necessary to create a hospital infection management system for nursing students. Therefore, by identifying the rates of *Staphylococcus aureus* and MRSA nasal carriage in nursing students, this study aimed to evaluate the possibility of spreading MRSA by nursing students, and creating an effective system for prevention, education, and management of infection.

## 2 Methods

## 2.1 Subjects

Convenience sampling was conducted on nursing students enrolled at K University in Chungcheongbuk-do from April 18 to May 30, 2011. Specimens were collected from an estimated population of 30,813 nursing students nationwide. The inclusion criterion of the participants was limited to only the nursing students who had previous experience in clinical practice. The students were either in their second or third year at three-year colleges, or were juniors and seniors at four-year colleges. While setting 95% reliability levels and an error range of 0.7%, 195 subjects were needed [7]. Based on this requirement, and taking into consideration the disqualification of research subjects, data were collected from 250 students; of these, the 215 students who answered the questionnaires appropriately and participated in the microbiological examinations were chosen as the final research subjects.

## 2.2 Outcome measures

### Microorganism Culturing Examination

Two sterilized cotton swabs were soaked in sterile distilled water and rotated 360° five times inside the left and right nasal cavities to extract specimens, and then placed in Stuart's transport media. After sealing the transport media, microbiological analysis was carried out at E institute.

## 2.3 Statistical analysis

The collected data were analyzed using SPSS Windows (Version 18.0, Chicago, USA). The frequencies and percentages of infection-related parameters, including the *Staphylococcus aureus* and MRSA carrier rates were analyzed, and the differences between general parameters and infection-management parameters of *Staphylococcus aureus* and MRSA carriers and non-carriers were examined using the chi-square test and t-test. The frequencies and percentages of the status of MRSA infection awareness in nursing students were analyzed.

## 3 Results

### 3.1 *Staphylococcus aureus* and MRSA Carrier Rates

Of the 215 nursing students, *Staphylococcus aureus* was found in the nasal cavity of 28.2% (62 students), while MRSA was detected in 1.4% (3 students) .

### 3.2 Differences in General and Infection-related Parameters in *Staphylococcus aureus* Carriers and Non-carriers

There were no significant differences in all general and infection-related parameters between *Staphylococcus aureus* carriers and non-carriers (Table 1).

### 3.5 Differences in General and Infection-management Parameters of MRSA Carriers and Non-carriers

When comparing the general parameters of MRSA carriers with non-carriers, there were no significant differences in all general and infection-management parameters between MRSA carriers and non-carriers (Table 2).

**Table 1.** Comparison of characteristics in carriers and non-carriers of *Staphylococcus aureus*

Characteristics		<i>S. aureus</i> * carriers (n=62) M±SD/n(% )	<i>S. aureus</i> noncarriers (n=153) M±SD/n(% )	$\chi^2/t$	p
<b>Gender</b>	Male	5 (8.5)	10(6.6)	0.15	.699
	Female	57 (91.5)	143(93.4)		
<b>Age (year)</b>		21.45±2.98	21.97±3.48	1.03	.302
<b>Year grade</b>	2	31 (50.8)	88(57.5)	1.01	.315
	3	31 (49.2)	65(42.5)		
<b>Period of clinical practice (week)</b>		12.49±6.33	12.68±5.16	- 0.21	.834
<b>Use of antibiotics in the past 12 months</b>	Yes	20 (30.5)	57(37.3)	0.48	.489
	No	42 (69.5)	96(62.7)		
<b>Hospitalization in the past 12 months</b>	Yes	2 (3.4)	11(7.2)	1.22	.269
	No	60 (96.6)	142(92.8)		
<b>Hand hygiene after contact with a patient</b>	Hand washing	28(45.2)	72(47.4)	1.42	.492
	Hand sanitizer	34(54.8)	77(50.7)		
	No	0(0.0)	3(2.0)		
<b>Frequency of hand hygiene (number/day)</b>		7.03±3.24	6.94±3.18	- 0.19	.849
<b>Nursing experience with an MRSA patient</b>	Yes	23 (39.0)	44(28.8)	1.43	.232
	No	39 (61.0)	109(71.2)		
<b>Entered a MRSA patient's room</b>	Yes	28 (45.8)	51(33.3)	2.66	.103
	No	34 (54.2)	102(66.7)		
<b>Education on MRSA</b>	Yes	27 (44.1)	61(39.9)	0.25	.619
	No	35 (55.9)	92(60.1)		

\**S. aureus*: *Staphylococcus aureus*

**Table 2.** Comparison of characteristics in carriers and non-carriers of methicillin-resistant *Staphylococcus aureus*

Characteristics		MRSA carriers (n=3) M±SD/n(%)	MRSA noncarriers (n=212) M±SD/n(%)	$\chi^2/t$	<i>p</i>
<b>Gender</b>	Male	0 (0.0)	16(7.5)	0.25	.621*
	Female	3 (100.0)	196(92.5)		
<b>Age (year)</b>		21.33±1.53	21.83±3.37	0.25	.800
<b>Year grade</b>	2	1 (33.3)	118(55.7)	0.60	.440*
	3	2 (66.7)	94(44.3)		
<b>Period of clinical practice (weeks)</b>		14.67±5.77	12.51±6.01	0.62	.538
<b>Use of antibiotics in the past 12 months</b>	Yes	2 (66.7)	75(35.4)	1.26	.262*
	No	1 (33.3)	137(64.6)		
<b>Hospitalization in the past 12 months</b>	Yes	0 (0.0)	13(6.1)	0.20	.658*
	No	3 (100.0)	199(93.9)		
<b>Hand hygiene after contact with a patient</b>	Hand washing	1(33.3)	100(47.1)	0.29	.866*
	Hand sanitizer	2(66.7)	109(51.4)		
	No	0 (0.0)	3(1.4)		
<b>Frequency of Hand hygiene (number/day)</b>		6.67±2.89	6.97±3.20	0.16	.870
<b>Nursing experience with an MRSA patient</b>	Yes	0 (0.0)	67(31.6)	1.38	.554*
	No	3 (100.0)	145(68.4)		
<b>Entered a MRSA patient's room</b>	Yes	1 (33.3)	78(36.8)	1.26	.292*
	No	2 (66.7)	134(63.2)		
<b>Education on MRSA</b>	Yes	1 (33.3)	87(41.0)	0.07	.788*
	No	2 (66.7)	125(59.0)		

\*Fisher's Exact Test

## 4 Discussion

*Staphylococcus aureus* normally exists on the skin or mucous membrane and is generally susceptible to methicillin. However, some strains of *Staphylococcus aureus* are resistant to methicillin, giving rise to issues of anti-bacterial resistance.

The MRSA nasal carrier rate of nursing students who participated in this study was 1.4%, similar to that of patients in Europe, but lower than the overall nasal carrier rates of patients and medical staff in Korean hospitals. Further, upon comparing with domestic and foreign studies on students, MRSA nasal-carriage rates were higher in Korean patients than Thai college students [8] but were lower than those in dental school students in the United States [9] and in nursing school students in Iraq [10]. While the nasal carrier rates for Korean patients are reportedly higher than those of patients of other nationalities, the nasal carrier rates were not very high for the nursing students in this study. We propose that this may be due to a number of reasons such as limited exposure of the nursing students to MRSA patients during their clinical work, or that basic infection management and prevention rules were observed, including proper hand-hygiene after contact with patients.

When considering the effects of hospital training on MRSA nasal carrier rates, the results of a study including 42 students without clinical work experience and 52 with clinical work experience at a medical school in Louisiana, revealed that only three with clinical work experience had MRSA, while none of the students without clinical work experience had MRSA [11]. In a study on 66 nursing students that examined MRSA carriers before clinical work, no cases of MRSA were detected prior to clinical work; however, after clinical work, 6.1% of the nursing students were found to have MRSA in their hands and nasal cavities [12]. Prior hospitalization in patients has reported as a risk factor for MRSA nasal carriers, but in students, risk factors differ based on whether field work was carried out at hospitals. This difference may be attributed to basic infection management, including proper hand-hygiene and use of protective equipment, as well as participation in care for MRSA-patients. Therefore, it is necessary to educate students on prevention of MRSA infection prior to assigning field work.

Some of the students with MRSA in the study were verified to be MRSA nasal carrier although they did not have previous experience in MRSA patient nursing. There were studies that reported detection of MRSA in the workplace of nurses and doctors, corridors, and mobile phone of medical personnel, not in the wards of MRSA patients [13, 14], thus, it is understood that MRSA can be transmitted through indirect contact if being exposed to the environment contaminated by MRSA, without direct nursing of MRSA patients. Since community-acquired MRSA infection was reported in Korea[15], there is also a possibility to acquire MRSA in a community that has nothing to do with clinical practice.

In addition, although only a few MRSA nasal carriers were included in this study, it is necessary to develop prevention and management programs for the students against methicillin-resistant infections for such carriers. In order to prevent methicillin-resistant infections in students, management procedures used for multi-drug resistant bacteria infection, including thorough hand hygiene should be included in the program. While screening of MRSA carriers by microbial cultures can be considered for medical workers, routine examinations can be ineffective in terms of cost. Moreover, as selective examinations are recommended for high-risk groups of carriers [5], instead of conducting microbial tests to identify carriers among nursing students, infection management programs should be developed to prevent students from contracting multi-drug resistant bacteria such as MRSA. In case students

received training at a department where there was an MRSA outbreak, selective carrier examinations and treatment should be taken into consideration.

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