



ARAŞTIRMA / RESEARCH

Effect of use of nail polish on bacterial colonization after surgical handwashing in operating room nurses: a preliminary study

Ameliyathane hemşirelerinde oje kullanımının cerrahi el yıkama sonrası bakteriyel kolonizasyona etkisi: bir ön çalışma

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Abstract

Purpose: This study aims to analyze the effect of nail polish applied by operating room nurses on bacterial colonization after surgical hand washing.

Materials and Methods: This is a self-controlled, experimental study in which the before and after values of the same group were analyzed. This study was conducted on 33 operating room nurses. The glove juice method was used to measure bacterial colonization on the nurses' hand flora. The data were collected using the Introductory Information Form for Nurses and the Data Recording Form. The data were analyzed using descriptive statistical methods along with the Wilcoxon test.

Results: Of the nurses, 54.56% had a bachelor's degree, 78.8% had been working as a nurse for at least 11 years, and 63.7% had been working as an operating room nurse for at least 11 years. Of them, 66.7% had nails shorter than 2 mm. and 60.6% sometimes used moisturizer. No statistically significant difference was found between the amount of bacteria in the samples obtained from the nurses' hands with and without nail polish after surgical hand washing.

Conclusion: The findings showed that freshly applied nail polish has no effect on bacterial colonization.

Key words: Hand washing, surgical, nursing, operating room, contamination

Öz

Amaç: Araştırma ameliyathane hemşirelerinde oje kullanımının cerrahi el yıkama sonrası bakteriyel kolonizasyona etkisini incelemek amacıyla yapıldı.

Gereç ve Yöntem: Bu araştırma, kendi kendisinin kontrolü olan ve aynı grupta önceki ve sonraki değerlerin karşılaştırıldığı, deneysel çalışma olarak gerçekleştirildi. Araştırma 33 ameliyathane hemşiresi ile yapıldı. Araştırmada hemşirelerin el florası üzerindeki bakteri kolonizasyonunu ölçmek için eldiven sıvı yöntemi (glove juice methodu) kullanıldı. Verilerin değerlendirilmesinde; tanımlayıcı istatistiksel yöntemlerin yanı sıra Wilcoxon testi kullanıldı.

Bulgular: Hemşirelerin %54.56' sının lisans mezunu olduğu, %78.8' inin 11 yıl ve üzerinde hemşirelik yaptığı, %63.7' sinin de 11 yıl ve üzerinde ameliyathanede hemşire olarak çalıştığı bulundu. Cerrahi el yıkamayı etkileyen bireysel faktörler incelendiğinde ise; hemşirelerin %66.7' sinin tırnak uzunluğunun 2 mm' den kısa olduğu, %60.6' sının bazen nemlendirici kullandığı, saptandı. Araştırmada, hemşirelerin cerrahi el yıkama sonrası oje sürülen ve oje sürülmeyen ellerinden alınan örneklerdeki bakteri sayıları arasında istatistiksel olarak anlamlı bir farklılık bulunmadı.

Sonuç: Araştırma bulguları, taze sürülmüş ojenin bakteriyel kolonizasyonda etkisi olmadığını gösterdi.

Anahtar kelimeler: El yıkama, cerrahi, hemşirelik, ameliyathane, kontaminasyon

INTRODUCTION

The most frequently observed complication among in-patients throughout the world is the infections related to healthcare services. While the prevalence

of the infections related to healthcare services varies between 1% and 16.5% in Turkey, the Centers for Disease Prevention and Control (CDC) data indicate that infections related to healthcare services develop in approximately 5% to 10% of the in-patients in

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the United States of America. These infections cause approximately 75,000 deaths per year¹⁻⁷.

Surgical site infections hold an important place as preventable complications among infections related to healthcare services. Although there are many risk factors for surgical site infections in operating rooms, the most significant preventable risk is the infection that is transmitted by the hands of operating room personnel. Therefore, operating room personnel should completely remove the temporary flora, and partially remove the permanent flora through surgical hand washing 8-16. A study by the CDC showed that 70% of the infections related to healthcare services can be prevented through basic infection prevention methods. It also emphasized that surgical site infections are reduced by 17% when compliance with prevention methods is high^{1,2,17-19}.

The literature indicates that the majority of microorganisms on hands are under and around the nails. However, in Turkey and around the world, the number of existing studies that have analyzed the effect of surgical hand washing on surgical site infections by personnel wearing nail polish is inadequate. Although the limited number of previous studies have shown that nail polish does not affect the amount of bacteria after surgical hand washing²⁰⁻²², many hospital guidelines recommend that nail polish be removed before surgical hand washing.

The World Health Organization, the Association of Perioperative Registered Nurses, and the Association of Surgical Technologists reported that freshly applied nail polish does not cause an increase in the amount of bacteria. However, nail polish that has been worn for at least four days, or chipped nail polish may increase the amount of bacteria. These associations stated that operating room nurses can therefore wear freshly applied nail polish^{19,23-29}. Therefore, the procedures vary according to the institutions proposing them. WHO published guideline that while the procedures strictly forbid the use of artificial nails by operating room personnel (Level of evidence: IA), they do not include definitive statements regarding the use of nail polish. It is recommended that this issue be analyzed as an open question²⁹.

This study aims to analyze the effect of nail polish worn by operating room nurses on bacterial colonization after surgical hand washing.

MATERIALS AND METHODS

This is a self-controlled (in which each nurses serves as his or her own control) study in which the before and after values of the same group were analyzed. Written permission was obtained from the Clinical Studies Ethics Committee (decision no. 23/06/2015-05). In addition, written permission was obtained from the Turkish Institute of Public Hospitals, Zonguldak General Secretariat of Public Hospitals Union in order to conduct the study. The aim and implementation of the study was explained to the nurses who participated in the study, and their written consents were obtained.

The study population consisted of 33 nurses working in the operating room of a state hospital. Only circulating nurses were included to maintain patient safety and the success of the operation during the application of the study. Sample size was not calculated. The nurses who were included in the study volunteered to participate, were female, did not have a latex allergy, skin irritation or eczema, and had not used antibiotics in the last two weeks. Also, they had not performed surgical hand washing within 24 hours before the first sample was taken, and they did not perform surgical hand washing for any other purpose than the aim of this study.

The data were collected using the Personal Form for Nurses and the Survey Form. The personal form for nurses included eight questions regarding age, education level, duration of working as a nurse and in operating rooms, length of nails, use of moisturizer, potential allergies, and body temperature. The survey form recorded the amount and types of bacteria identified on the samples obtained from both hands of the nurses without nail polish after surgical hand washing, and the samples obtained from both hands of the nurses after nail polish was applied and then the nurses performed surgical hand washing and maintained the sterilization for one hour.

Procedure

The data were collected between January 9, 2015 and July 15, 2016. After the informed consent form was obtained from the nurses, the introductory information form was completed through face-to-face interviews. The total length of the nails was measured as well as the body temperature of the forehead. Then the researcher demonstrated the

surgical hand washing technique to the nurses. Afterwards, the nurses were asked to wash their hands using the surgical hand washing technique. The researcher supplied the nurses with

chlorhexidine gluconate of 3 ml and 4% to be used during hand washing, to ensure that all nurses used the same amount of antiseptic. Surgical hand washing completed in 3 minutes (Table 1).

Table 1. Procedure of surgical hand washing

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| <ul style="list-style-type: none"> • Rings, watches and bracelets are removed before starting the surgical scrub. • Hands and forearms are washed with plain soap. • All surfaces of the hands and forearms are rubbed with chlorhexidine gluconate %4 (3ml) for 3 minutes. • Hands and forearms are rinsed under running water. • All surfaces of the hands and forearms are rubbed with chlorhexidine gluconate %4 (3ml) for 3 minutes. |
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Microbiological samples were taken using the glove juice method ASTM E1115-02 30 after surgical hand washing to determine how effectively the nurses performed surgical hand-washing. The researcher performed hygienic hand washing and wore gloves before taking samples from all nurses, and different nail polishes was applied on each nurse to prevent cross contamination. The nurses wore gloves in accordance with sterile glove wearing instructions, and 50 ml. of Tryptic Soy Broth was placed inside the gloves as the growth medium. The gloves were tied up at the wrists. Both hands were rubbed from the exterior surface of the gloves for one minute, then 5 to 10 ml samples of the liquid inside the gloves were taken from a fingertip of the gloves using a sterile plastic pipet with an injector of 50 ml. These samples were placed in a sterile container.

The samples were then transported to the microbiology laboratory of the hospital within one hour, and the growth medium was developed. The samples were analyzed by a microbiologist. In the microbiological analysis, each collected sample was quantitatively seeded with the aid of calibrated loop; the plates contained blood agar and EMB agar. After sowing, the plates were placed on incubators for 48 hours at 37°C. After the incubation period, the colonies present in the plates were counted and the total number of colonies was multiplied by the factor of dilution (1:100) to define the total of colony-forming units per milliliter of sample (cfu/ml). The results of this procedure were accepted as basic values.

After the first samples were taken, the nurses were asked to perform hygienic hand washing to ensure that the liquid in the gloves was cleansed from their hands. Then nail polish was applied to their right hands, but no nail polish was applied to their left

hands. The nail polish was not cultured. After the nail polish dried, the nurses performed surgical hand washing and were asked to dress in sterile clothes. They were also asked to do their routine work in the operating room for one hour, wearing a sterile shirt and gloves. Nurses who applied nail polish within the scope of the research do not enter operation to maintain patient safety, this situation would adversely affect the operating system of the hospital's operating room unit, so we didn't apply nail polish 12 hours before. At the end of this one-hour duration, the gloves and shirts were taken off without contaminating the hands. Samples were taken again from both hands using the glove juice method. Laboratory personnel were not informed at which stage of the implementation process the samples were taken. This allowed to remain neutral regarding the method used.

Statistical analysis

Logarithms (base 10) of reductions in colony counts from the samples were used to normalize data and for comparing the antimicrobial efficacy of surgical hand washing on the nurses' hands with and without nail polish. The data were analyzed using the Statistical Package for the Social Sciences 16.0 (SPSS) for Windows 7. The descriptive statistics of the categorical variables were indicated using frequency and percentage, and the continuous variable was determined using average, standard deviation, minimum and maximum values. The Shapiro-Wilk test was used to determine whether the data were normally distributed. The mean CFU count of both right and left hands were analyzed using the Wilcoxon Signed Ranks and Spearman rho correlation tests. The comparisons with a p value under 0.05 were accepted to be statistically significant.

RESULTS

The average age of the nurses was 42.70 ± 9.50 (min: 26, max: 56). Of the nurses, 54.56% had a bachelor's degree, 78.8% had been working as a

nurse for at least 11 years, and 63.7% had been working as an operating room nurse for at least 11 years. Of them, 66.7% had a nail length shorter than 2 mm. and 60.6% sometimes used moisturizer (Table 2).

Table 2. The Demographic Characteristics of the Nurses

Characteristics	Features	Mean ± SD	Min - Max
Age (years)		42.70 ± 9.50	26-56
		<u>n</u>	<u>%</u>
Education level	High School	1	3.0
	Associate Degree	14	42.4
	Bachelor's Degree	18	54.6
Duration of working as a nurse	<1 years	0	0
	>1 and <10 years	7	21.2
	>11 years	26	78.8
Duration of working as an operating room nurse	<1 years	4	12.1
	>1 and <10 years	8	24.2
	>11 years	21	63.7
Length of nails	<2 mm.	22	66.7
	>2 mm and <2.99 mm	11	33.3
	>3 mm.	0	0
Using moisturizer	Regularly using	10	30.3
	Not using	3	9.1
	Sometimes using	20	60.6

SD: Standart Deviation

Table 3. Amount of bacteria after surgical hand washing on the nurses' right hands with and without nail polish

Time	Negative n (%)	Positive n (%)	Amount of Bacteria Mean± SD	Min - Max	Z* p
Immediately after surgical hand washing	29 (87.9)	4 (12.1)	0.61±95.15	0-1000	-0.340 p=0.734
1 hour after applying nail polish and performing surgical hand washing	29 (87.9)	4 (12.1)	7.88±88.05	0-500	

SD: Standart Deviation * Wilcoxon test

Table 4. Amount of bacteria after surgical hand washing on the nurses' left hands with and without nail polish

Time	Negative n (%)	Positive n (%)	Amount of Bacteria Mean± SD	Min - Max	Z* p
Immediately after surgical hand washing	29 (87.9)	4 (12.1)	48.48 ± 182.21	0- 1000	-0.425 0.671
1 hour after surgical hand washing without applying nail polish	29 (87.9)	4 (12.1)	63.64 ± 213.33	0- 1000	

SD: Standart Deviation * Wilcoxon test

Table 3 shows the amount of bacteria on the samples taken from the nurses' right hand immediately after surgical hand washing, and one hour after applying nail polish and performing surgical hand washing. Bacterial growth was not

observed in 87.9% of the nurses after surgical hand washing, while it was observed in 12.1% of the nurses. In addition, bacterial growth was not observed in 87.9% of the nurses with nail polish on their right hand one hour after surgical hand

washing, while it was observed in 12.1% of them, as found in the results of the samples taken immediately after surgical hand washing. The average amount of bacteria was 60.61 ± 195.15 cfu. on the samples taken from the nurses' right hands immediately after surgical hand washing. The average amount of bacteria was 87.88 ± 288.05 cfu. on the samples taken from the right hand of the nurses with nail polish one hour after surgical hand washing. No statistically significant difference was found between the samples taken from the nurses' right hands with and without nail polish ($p = 0.734$) (Table 3).

It was found that *S. warner* grew on one nurse's right hand, *Kocuria kristinae* grew on two nurses' right hand, and *Staphylococcus hominis* grew on one nurse's right hand immediately after surgical hand washing. Also, it was observed that *S. warner* grew on one nurse's right hand, *Kocuria kristinae* grew on two nurses' right hand and *S. haemolyticus* grew on one nurse's right hand after surgical hand washing 1 hour after applying nail polish. Table 4 shows the amount of bacteria on the samples taken from the nurses' left hands immediately after and one hour after surgical hand washing.

Bacterial growth was not observed in 87.9% of the nurses after surgical hand washing, while it was observed in 12.1% of the nurses. Similarly to the results of the samples taken immediately after surgical hand washing, bacterial growth was not observed in 87.9% on the nurses' left hand one hour after surgical hand washing, while it was observed in 12.1% of them. The average amount of bacteria was 48.48 ± 182.21 cfu on the samples taken from the nurses' left hands immediately after surgical hand washing. The average amount of bacteria was 63.64 ± 213.33 cfu. on the samples taken from the nurses' left hand one hour after surgical hand washing. No statistically significant difference was found between the amount of bacteria on the samples taken from the nurses' left hands immediately after surgical hand washing, and those samples taken one hour after surgical hand washing ($p = 0.671$) (Table 4).

It was found that *S. warner* grew on two nurses' left hand and *Kocuria kristinae* grew on two nurses' left hand immediately after surgical hand washing. It was also found that *S. warner* and *S. epidermidis* grew on one nurse's left hand, *S. warner* grew on one nurse's left hand, *Streptococcus mitis* and *Streptococcus oralis* grew on one nurse's left hand, and *Kocuria kristinae* grew on one nurse's left hand

one hour after surgical hand washing.

DISCUSSION

This current study aimed to determine whether nail polish applied by operating room nurses had an effect on bacterial colonization after surgical hand washing. It was found that the amount of bacteria on the samples taken from the nurses' right hands with nail polish, and the amount of bacteria on the samples taken from the left hands without nail polish one hour after surgical hand washing, were higher than the amount of bacteria on the samples taken immediately after surgical hand washing. The discovery of bacterial growth on the nurses' left hands - without nail polish - implied that nail polish was not the only reason for increased bacterial growth on their right hands. Studies have shown that microorganisms may increase on hands over time, even when sterile gloves are worn. It may not always be possible to completely remove the permanent flora after surgical hand washing, and the microorganisms in permanent flora may increase again after a while⁹.

Bacterial growth was identified on the samples taken immediately after and one hour after surgical hand washing, during which the nurses fulfilled their routine duties in the operating room wearing a sterile shirt and gloves, after applying nail polish on their right hands. However, this finding showed no statistically significant difference between the samples ($p > 0.05$). In addition, bacterial growth was identified on the samples taken from the nurses' left hands under the same conditions (working in the operating room wearing a sterile shirt and gloves), even though nail polish had not been applied. Similarly, this finding also showed no statistically significant difference ($p > 0.05$). Baumgardner et al.²⁰ found no significant difference between the amount of bacteria on the hands of 26 healthcare personnel on whom they had applied nail polish four days before the study, and the healthcare personnel on whom they had not applied nail polish. Edel et al.²¹ found no significant difference between the amount of bacteria on the hands of healthcare personnel with and without nail polish before surgical hand washing. However, they found that the amount of bacteria on the hands of the personnel with nail polish was higher than that of the personnel without nail polish after five minutes of surgical hand washing. Wynd et al.²² compared the healthcare personnel without nail polish, with freshly applied

nail polish, with chipped nail polish and with nail polish applied four days prior, and found that the amount of bacteria on the hands of the healthcare personnel with chipped nail polish and with nail polish that had been worn for four days was higher than that of the personnel with freshly applied nail polish, and that of the personnel without nail polish. Fagernes and Lingaas compared three groups, one without nail polish, one with unchipped nail polish and one with chipped nail polish, and observed that the amount of bacteria did not vary by group³¹. White reviewed the literature and determined that nail polish did not affect bacterial colonization after surgical hand washing³². Arrowsmith and Taylor performed a literature review in the Cochrane database and indicated that a sufficient number of resources did not exist to make a final decision³³.

It was found that *S. warneri*, *Kocuria kristinae* and *S. hominis* grew on the nurses' right hands and *S. warneri* and *Kocuria kristinae* grew on the nurses' left hands immediately after surgical hand washing. *S. warneri* is a member of gram-positive staphylococci and is a microorganism living commensal on the skin of animals. Although this is rare, it may be a cause of disease when the immune system is suppressed. *Kocuria kristinae* are Micrococcus type bacteria and are colonized on the skin, in mucous and in the oropharynx. Generally they are not pathogenic, but they can cause infections as opportunistic pathogens particularly in immunosuppressed patients. *S. hominis* is an element of human skin flora, and a coagulase negative microorganism obtained from opportunistic pathogens. Since this study included nurses without any infections, it is concluded that these bacteria have no effect³¹.

As on the samples taken immediately after surgical hand washing, it was determined that *S. warneri* and *Kocuria kristinae* grew on the samples taken from the nurses' right hands one hour after surgical hand washing after the nail polish was applied; however, *S. haemolyticus* also grew on these samples. Along with the *S. warneri* and *Kocuria kristinae* bacteria found on the nurses' left hands without nail polish immediately after surgical hand washing, *S. epidermidis*, *Streptococcus mitis* and *Streptococcus oralis* were also identified on their left hands one hour after surgical hand washing. *S. epidermidis*, is an opportunistic pathogen microorganism found on skin and in upper respiratory tract mucosa isolated from soft tissue wounds and abscesses, and in

pneumonia, arthritis, meningitis, empyema, sepsis, endocarditis, conjunctivitis, and cystitis infections. Karahocagil et al.³⁴ found in their study that *S. epidermidis* causes 9.5% of surgical site infections. *Streptococcus mitis*, a major member of the viridians group streptococci, is found in the oropharynx, the gastrointestinal tract, the female genital tract and among normal skin flora, and may cause serious infections in immunosuppressed patients, although it has a low virulence and pathogenicity. *S. oralis* is among the opportunistic pathogen microorganisms in oral mucosa flora, and may be a cause of disease when the immune system is suppressed, although this is rare. All of these bacteria can be effective in immunosuppressed people; but they are not considered to have a negative effect on the nurses included in this study³¹.

We identified 2 major limitations of this study. First, Only circulating nurses for patient safety and the success of the operation was included in this study. Second, the sample size was small. In this context, it may not be possible to generalize the study results.

This study showed that freshly applied nail polish had no effect on bacterial colonization after surgical hand washing. It is recommended that studies be conducted on a larger sample size, the effect on wound infections of nail polish be analyzed, and the deficiencies in surgical hand washing be eliminated by providing in-service training for all nurses as they begin working in operating rooms.

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