

Staphylococcus aureus nasal carriage rates, and risk factors in hemodialysis patients

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ABSTRACT

Aims: The aim of this study is to determine the rates of *Staphylococcus aureus* (*S. aureus*) nasal carriage, considered one of the most important sources of infection in patients undergoing haemodialysis treatment due to chronic kidney disease, and the susceptibility of *S. aureus* to mupirocin and fusidic acid.

Methods: The study included a total of 165 patients, comprising 55 women (33.3%) and 109 men (66.03%), who had been receiving treatment at the same dialysis centre for at least one year and underwent haemodialysis three times a week. Nasal swab samples were inoculated onto mannitol-salt agar (Beslab, Türkiye). The media were incubated at 37 °C for 72 hours. Methicillin resistance was determined on Mueller-Hinton agar medium using cefoxitin discs (Bioanalyse, Türkiye), and mupirocin and fusidic acid sensitivities were determined using the disc diffusion method with discs of these antibiotics (Bioanalyse, Türkiye).

Results: A total of 165 patients were tested, and *S. aureus* was detected in 14 (8.48%); 9 (5.45%) were methicillin-sensitive; of the sensitive strains, 2 were resistant to mupirocin and 2 were resistant to fusidic acid. In 5 (3.03%) of the 165 patients, methicillin-resistant *S. aureus* was detected; 1 was resistant to mupirocin and 1 was resistant to fusidic acid.

Conclusion: It has been found that the rate of *S. aureus* nasal carriage is low in haemodialysis patients. The resistance rates of methicillin-sensitive strains to mupirocin and fusidic acid were higher than the resistance rates of susceptible strains. Eliminating nasal carriage is an important approach to protecting dialysis patients from infection.

Keywords: Hemodialysis patients, nasal carriage, *Staphylococcus aureus*, mupirocin, fusidic acid

INTRODUCTION

Infections in hemodialysis patients and end-stage renal failure patients are an important cause of mortality and morbidity. In patients with end-stage chronic kidney disease, *Staphylococcus aureus* (*S. aureus*) causes serious infections, numerous complications and prolonged hospital stays, which generally result in high costs.¹⁻⁴ *S. aureus* is the most common bacterium in vascular access-related infections in dialysis patients and has a high mortality rate.^{2,5} Methicillin-resistant *Staphylococcus aureus* (MRSA) and coagulase-negative staphylococci are frequently isolated as causative agents of catheter-related bacteremia in hemodialysis patients and peritoneal dialysis catheter infection and peritonitis in peritoneal dialysis patients. The high rate of resistance to mupirocin, one of the topical antimicrobials used in the eradication of *S. aureus* nasal carriage in these patients, is also an important problem.^{3,6} The most frequently colonized body site of *S. aureus* is the nose. It has been reported that nasal carriage of *S. aureus* plays an important role in the pathogenesis of infections due to this agent.²⁻⁵

The relationship between *S. aureus* nasal carriage in hemodialysis patients and infections developing due to this

agent has been shown in many studies. It has been reported that the rates of bacteremia and catheter-related infections are higher in *S. aureus* nasal carriers than in non-carriers. MRSA have an important place in staphylococcal infections. Many studies have reported the relationship between nasal MRSA carriage and MRSA infections. The main risk factors for MRSA nasal carriage are hospitalization, broad-spectrum antibiotic use, surgical intervention, residence in a nursing home, presence of hospital personnel in the family, etc.^{1,3,6-8}

The aim of this study was to determine the rates of nasal carriage of *S. aureus* in hemodialysis patients, the risk factors associated with carriage, and the susceptibilities to mupirocin and fusidic acid in patients with nasal carriage of *S. aureus*.

METHODS

The mean age of the patients was 52±12.08. Informed consent forms were obtained from hemodialysis patients for the study, and ethical committee approval was obtained from the Ankara Bilkent City Hospital Medical Researches Scientific and Ethical Evaluation Board (Date: 04.12.2024, Decision No: TABED 1-24-384). The results are presented in tabular form.

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All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

A total of 165 hemodialysis patients, including 55 (33.3%) females and 109 (66.03%) males, who were dialyzed at the Private Ankara Balgat Dialysis Center were included in the study. Written informed consent was obtained from all individual participants prior to their inclusion in the study. Nasal swab samples obtained from the patients were sown on Mannitol-salt agar (Beslab, Türkiye) medium. The media were incubated in an oven at 37°C for 24-48 hours. Colonies that grew on Mannitol salt agar medium with yellow color reflex were evaluated as *S. aureus*, and the strains with positive catalase and coagulase tests were evaluated as *S. aureus*. MRSA1 strains was determined on Mueller Hinton agar medium with cefoxitin disk (Bioanalyse, Türkiye) and mupirocin and fusidic acid susceptibilities were determined by disk diffusion method with the discs of these antibiotics (Bioanalyse, Türkiye).

RESULTS

Of the 165 hemodialysis *S. aureus* nasal carriage was detected in 14 (8.48%) patients, 9 (5.45%) of whom had methicillin-sensitive *S. aureus* (MSSA) nasal carriage and 5 (3.03%) had methicillin-resistant *S. aureus* (MRSA) nasal carriage.

Of a total of 5 MRSA strains, 1 was resistant to mupirocin and 1 was resistant to fusidic acid. Of a total of 9 MSSA strains, 2 were resistant to mupirocin and 2 were resistant to fusidic acid. It was determined that mupirocin and fusidic acid resistance was higher in MSSA strains (Table 1).

Table 1. Mupirocin and fusidic acid resistance MSSA, and MRSA strains

Agent	Mupirocin resistant (n)	Fusidic acid resistant (n)
MSSA (n:9)	2	2
MRSA (n:5)	1	1
Total (n:14)	3	3

MSSA: Methicillin-sensitive *Staphylococcus aureus*

All patients who grew MRSA and MSSA in nasal cultures had a history of antibiotic use in the last 6 months and hospital or outpatient clinic admission in the last year as risk factors. Congestive heart failure was present in 3 patients with MRSA and 7 patients with MSSA nasal cultures. Diabetes mellitus was present in one patient with MRSA growth and in two patients with MSSA growth. Two patients who grew MSSA in nasal culture had a history of surgical intervention and one patient had a family history of healthcare personnel. None of the patients who grew MRSA and MSSA in nasal cultures had a history of nursing home stay, hospitalization in the last 1 year, immunosuppressive treatment or malignancy. The risk

factors in patients with MRSA and MSSA growth in nasal cultures are shown in Table 2.

DISCUSSION

S. aureus nasal carriage plays a key role in the pathogenesis and epidemiology of *S. aureus* infections.^{3,4,8-10} *S. aureus* nasal carriage rates in hemodialysis patients and patients receiving continuous outpatient peritoneal dialysis treatment have been reported to be higher than those in the general population.^{3,6-10} *S. aureus* infections are common in hemodialysis patients due to hospitalization, immunosuppression, invasive interventions (hemodialysis catheter, subclavian catheter, etc.), frequent antibiotic use and high staphylococcal colonization on the skin and nose.^{2,8,9}

Nasal carriage of *S. aureus* is one of the most important risk factors in the pathogenesis of catheter infections, bacteremia and sepsis in hemodialysis patients.^{2,3,8-11}

Compared to the general population, hemodialysis patients have been reported to be more colonized with *S. aureus*. Scheuch et al.⁹ found *S. aureus* carriage in an average of 40% of hemodialysis patients in their cross-sectional study, while the carriage rate in the general population was reported as 27%.

Ferrara et al.¹² *S. aureus* colonisation was detected in 25 (53.19%) of all analysed patients, with intermittent colonisation observed in 21 of these. Additionally, 38% tested positive for *S. aureus* only in samples taken during the 6th or 7th week. Of the 58 isolates, 17.2% (n=10) showed resistance to methicillin (oxacillin), while 25.86% (n=15) exhibited high vancomycin MIC values (2 µg/ml).

S. aureus is one of the most common causative agents of catheter-related bacteremia and sepsis in hemodialysis patients.¹³ Eradication of *S. aureus* nasal carriage with topical antibiotics in patients receiving hemodialysis and peritoneal dialysis treatment has been reported to cause a significant decrease in infection rates due to this agent.^{1,3-9}

Çelik et al.¹³ investigated the rate of *S. aureus* nasal carriage and risk factors in 127 patients on hemodialysis. In this study, *S. aureus* nasal carriage was found in 41 (32.3%) patients, while MRSA nasal carriage was found in five (3.9%) patients. When risk factors were evaluated, a statistically significant relationship was found between *S. aureus* carriage and concomitant gastrointestinal disease and history of antibiotic use in the last year. In the present study, all of the patients with *S. aureus* nasal carriage had a history of antibiotic use within 6 months and a history of admission to hospital or outpatient clinic within the last year as risk factors. In addition, it was noteworthy that 10 (71.4%) patients with *S. aureus* nasal carriage had congestive heart failure.

Table 2. Risk factors in patients with MRSA and MSSA growth in nasal cultures

RAAccompanying features R Nasal culture results	DM (n*)	Antibiotic use in the last 6 months	History of admission to hospital or outpatient clinic in the last year	CHF	History of surgical intervention	Presence of health personnel in the family	Staying in a care home	Hospitalization in the last 1 year	History of immunosuppressive therapy or malignancy
MRSA (n:5)	1/5	5/5	5/5	3/5	0/5	0/5	0/5	0/5	0/5
MSSA (n:9)	2/9	9/9	9/9	7/9	2/9	1/9	0/9	0/9	0/9
Total	3/14	14/14	14/14	10/14	2/14	1/14	0/14	0/14	0/14

MRSA: Methicillin-resistant *Staphylococcus aureus*, MSSA: Methicillin-sensitive, DM: Diabetes mellitus, CHF: Congestive heart failure, *Staphylococcus aureus*, n*: Patient number

Risk factors for MRSA nasal carriage in hemodialysis patients have been reported as advanced age (≥ 75 years), prolonged hospitalization, history of repeated antibiotic use, and proximity to another MRSA colonized area. In the present study, the rates of *S. aureus* and MRSA nasal carriage in hemodialysis patients were lower than the rates reported in the literature. The reasons for this situation may include the implementation of infection control measures in patients and the application of nasal fusidic acid cream to patients who are nasal carriers. The main risk factors for MRSA and MSSA nasal carriage in hemodialysis patients were antibiotic use in the last 6 months, history of hospital or outpatient clinic admission in the last year and congestive heart failure.^{1,5-8}

MRSA nasal carriage has been reported to be associated with poor clinical outcomes in outpatients on hemodialysis. Early identification of colonized patients, isolation and elimination of carriage with decolonization regimen is an appropriate approach to minimize MRSA transmission rates.^{4,6,9,11} In studies conducted in hemodialysis patients in our country, *S. aureus* nasal carriage rates were reported by Cesur et al.⁸ 22.1%, Kurutepe et al.¹⁰ 33%, Çelik et al.¹³ 32.3%. The rates of MRSA nasal carriage in hemodialysis patients were reported as 11% by Kurutepe et al.,¹⁰ 1.8% by Mutlu et al.,¹¹ and 3.9% by Çelik et al.¹³ Out of Türkiye; Lu et al.¹⁴ reported *S. aureus* carriage rate as 22% and MRSA carriage rate as 2.4%, Lederer et al.¹⁵ reported *S. aureus* carriage rate as 53% and MRSA carriage rate as 12% in hemodialysis patients.

In our study, the resistance rates of MSSA strains to mupirocin and fusidic acid, which are topical antibiotics that can be used in the eradication of *S. aureus* nasal carriage, were higher than the resistance rates of MRSA strains to mupirocin and fusidic acid.

Limitations

The limitation of our study is that we could not determine whether *S.aureus* carriage was permanent or transient carriage because the patients were not followed up for a long period of time. In our study, the rate of *S.aureus* nasal carriage was found to be low in hemodialysis patients. Possible reasons for this may be that hemodialysis patients apply to dialysis centers on a daily basis, attention is paid to infection control measures in the dialysis center, and mupirocin pomade is applied to patients with nasal carriage. In another limitation is molecular confirmation test (mec A gene via PCR) was not performed.

CONCLUSION

As a result, infection is a significant cause of morbidity and mortality in haemodialysis patients. Due to immunosuppression in patients, infection symptoms and findings may often be absent, leading to delays in diagnosis. Therefore, preventive approaches are important. Based on mupirocin and fusidic acid susceptibility results in haemodialysis patients, we believe that eliminating nasal carriage will reduce the frequency of infections, which are a major cause of morbidity and mortality in these patients.

ETHICAL DECLARATIONS

Ethics Committee Approval

The study was initiated with the approval of the Ankara Bilkent City Hospital Medical Researches Scientific and Ethics Committee (Date: 04.12.2024, Decision No: TABED 1-24-384).

Informed Consent

Written informed consent was obtained from all individual participants prior to their inclusion in the study. Participants were fully informed about the study's aims, procedures, potential risks and benefits, and their rights-including the right to withdraw at any time without consequence. All participants voluntarily signed a written informed consent form.

Referee Evaluation Process

Externally peer-reviewed.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Financial Disclosure

The authors declared that this study has received no financial support.

Author Contributions

Concept: H.Ö., M.Ö.; Design: H.Ö., M.Ö.; Control: H.Ö., M.Ö.; Resources: H.Ö., M.Ö.; Materials: H.Ö., M.Ö.; Data Collection and/or Processing: H.Ö., M.Ö.; Analysis and/or Interpretation: H.Ö., M.Ö.; Literature Review: H.Ö., M.Ö.; Writing the Article: H.Ö., M.Ö.; Critical Review: H.Ö., M.Ö.

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