

ORIGINAL ARTICLE

Nose Picking and Nasal Carriage of *Staphylococcus aureus*

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OBJECTIVE. Nasal carriage of *Staphylococcus aureus* is an important risk factor for *S. aureus* infection and a reservoir for methicillin-resistant *S. aureus*. We investigated whether nose picking was among the determinants of *S. aureus* nasal carriage.

SETTING AND PARTICIPANTS. The study cohort comprised 238 patients who visited the ear, nose, and throat (ENT) disease outpatient clinic of a tertiary care hospital and did not have a nose-specific complaint (defined as ENT patients) and 86 healthy hospital employees (including medical students and laboratory personnel).

MEASUREMENTS. All participants completed a questionnaire on behavior regarding the nose and were screened for *S. aureus* nasal carriage; only ENT patients underwent nasal examination by an ear, nose, and throat physician for clinical signs of nose picking.

RESULTS. Among ENT patients, nose pickers were significantly more likely than non-nose pickers to carry *S. aureus* (37 [53.6%] of 69 vs 60 [35.5%] of 169 patients; relative risk, 1.51 [95% confidence interval, 1.03-2.19]). Among healthy volunteers, there was a statistically significant positive correlation between the self-perceived frequency of nose picking and both the frequency of positive culture results ($R = 0.31$; $P = .004$) and the load of *S. aureus* present in the nose ($R = 0.32$; $P = .003$).

CONCLUSION. Nose picking is associated with *S. aureus* nasal carriage. The role of nose picking in nasal carriage may well be causal in certain cases. Overcoming the habit of nose picking may aid *S. aureus* decolonization strategies.

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Staphylococcus aureus, irrespective of its resistance to methicillin, is a frequent cause of both community-acquired and hospital-acquired infections, with substantial morbidity and mortality as a result.^{1,2} About one-third of all persons carry *S. aureus* in the nose.³ Nasal carriage of *S. aureus* is a well-known risk factor for *S. aureus* infection, and eradication of this microorganism from the nose can be an effective preventive measure, mostly in surgical and dialysis patients.³⁻⁶ The same prophylactic strategy is used as an infection control measure for eradicating carriage of methicillin-resistant *S. aureus* (MRSA).

Although numerous studies have been performed, a valid explanation for nasal carriage of *S. aureus* has yet to be given. Since hand carriage and nasal carriage of *S. aureus* are associated and *S. aureus* resides in the anterior part of the nose, we considered the habit of nose picking as a potential determinant of *S. aureus* nasal carriage.⁷ In a pilot study, we demonstrated a positive correlation between nose picking and *S. aureus* nasal carriage.⁸ Therefore, we studied this determinant in a larger cohort with predefined criteria for nose picking.

METHODS

Participants

Participants were patients who visited the ear, nose, and throat (ENT) outpatient clinic of the Erasmus University Medical Center Rotterdam (Rotterdam, The Netherlands) and healthy volunteers, including personnel and medical students, from the hospital. Ethical review board approval was obtained. All participants gave written informed consent.

ENT Patients

Patients (age, 18 years or older) who visited the ENT outpatient clinic between June 2001 and July 2002 primarily because of non-nose-specific complaints were screened for nasal carriage of *S. aureus* and assessed for nose picking behavior. The following exclusion criteria were used: signs of rhinitis, use of antibiotics at the time of inclusion, and inability to understand the Dutch language. The following data were obtained: demographic characteristics, medical history, and medication history. Patients were given a standardized

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TABLE. Topics Addressed in a Questionnaire Administered to Patients Who Presented With Non-Nose-Specific Complaints to an Ear, Nose, and Throat (ENT) Clinic

Complaint at the time of presentation

Epistaxis
Nasal dryness
Nasal itchiness
Nasal crusts
Nasal wounds
Runny nose
Rhinitis

Behavior

Smoking
Exhaling smoke through the nose
Blowing the nose
Turning up the nose^a
Picking the nose
Rubbing the nose externally

^a Defined as strongly inhaling through the nose.

questionnaire on which they could give answers on a 5-point scale regarding behavior and symptoms related to the nose (Table). Patients were not informed that the primary determinant of this investigation was their nose picking behavior.

A nasal examination was performed by an ENT specialist, who was blinded to *S. aureus* carriage status of the patient and the patient's answers to the questionnaire. The following symptoms and signs were scored: vestibulitis, recurrent epistaxis, septal hyperkeratosis, scratch effects in the vestibulum nasi, wounds and erosions in the vestibulum nasi, septum perforation, and any nasal injury that was considered by the ENT doctor to be potentially due to nose picking. These signs were considered to be indicative of nose picking if they could not otherwise be explained. Furthermore, the ENT specialist had to state whether they considered the examined patient to be a nose picker, solely on the basis of their clinical ex-

pertise. One swab specimen from the anterior nares was cultured, just prior to the ENT examination.

Patients were identified as nose pickers if they reported that they at least sometimes picked and they had at least one sign of nose picking found during nasal examination.

Healthy Volunteers

Between January 2002 and May 2003, nasal swab specimens were obtained from healthy volunteers (age, 18 years or older). At least 5 nasal swab specimens were obtained at 1-week intervals to differentiate between the different *S. aureus* carriage types. Frequent carriers had *S. aureus* detected in more than two-thirds of their cultures; moderate carriers, in one-third to two-thirds of cultures; occasional carriers, in less than one-third of cultures; and noncarriers, in no cultures. These persons completed the same questionnaire described above but were not examined by an ENT specialist. Volunteers were excluded if they were currently receiving antibiotic therapy.

Microbiological Analysis

Nasal specimens were obtained using sterile cotton-wool swabs, which were placed in a transport medium (Transwab; Medical Wire & Equipment) after swabbing. Specimens from both the left and right anterior nares were obtained by rubbing the same swab 4 times in each nostril. Each swab was immediately placed in Stuart's medium and was cultured within 24 hours.

Nasal swab specimens from ENT patients were cultured quantitatively on selective media (phenol-red mannitol salt [PHM] agar and PHM broth), as described elsewhere.⁹ Colonies that were morphologically consistent with *S. aureus* were subcultured overnight on Columbia blood agar plates (Becton-Dickinson B.V.), and catalase-agglutination and latex-agglutination tests (Staphaurex Plus; Murex) were performed.

Nasal swab specimens from healthy volunteers were cul-

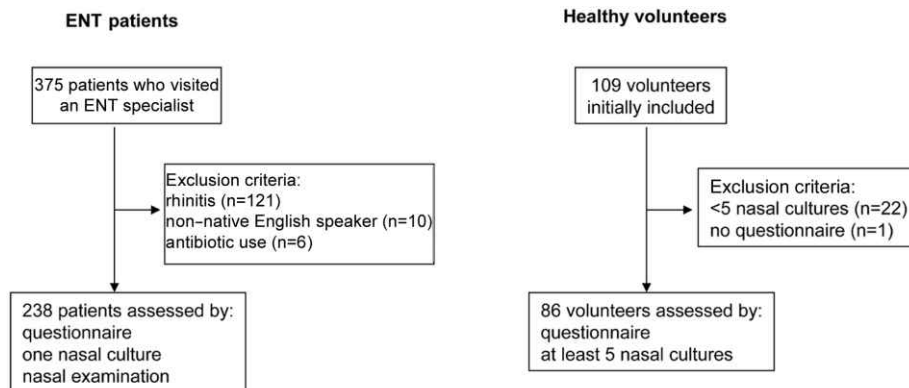


FIGURE 1. Summary of the selection of patients who visited an ear, nose, and throat (ENT) outpatient clinic at Erasmus University Medical Center Rotterdam (Rotterdam, The Netherlands) and healthy volunteers from the same hospital in a study of the relationship between nose picking and nasal carriage of *Staphylococcus aureus*.

tured on Columbia blood agar plates and suspended in PHM broth. The media were incubated for 48 hours at 35°C and checked each day for bacterial growth. Suspected *S. aureus* colonies were identified on the basis of results of catalase-agglutination and latex-agglutination tests. The degree of growth was ascertained in a semiquantitative manner.

Statistical Analysis

We used SPSS statistical software, version 10.0 (SPSS), for data analysis. The questionnaire allowed respondents to report the frequency of nose picking on a 5-point scale (never, rarely, sometimes, regular, and frequent), and the different degrees of carriage were coded from 0 to 4. The number of colony-forming units (cfu) of *S. aureus* was measured quantitatively and then \log_{10} transformed (\log_{10} [number of colony-forming units + 1]) to obtain a normal distribution. Correlations were measured with the Spearman rank correlation method. Fisher's exact test was used to analyze 2 × 2 tables. Mean values were compared by means of unpaired Student's *t* tests and 1-way analysis of variance, as appropriate. *P* values less than .05 were considered to be statistically significant.

RESULTS

ENT Patients

A total of 375 patients were asked to participate in this study, of whom 137 were excluded (Figure 1). Fifty-eight percent of participants were male, and the mean age was 47 years. The primary complaints of 71% of the participants were ear and hearing problems. In this study population, 97 (41%) of 238 patients were *S. aureus* nasal carriers, and we found that 69 (29%) of 238 met the criteria for nose picking. The prevalence of *S. aureus* carriage was higher among people identified on the basis of both self-report and physical examination findings as nose pickers (37 [54%] of 69 patients), compared with people identified on the basis of both criteria as non-nose pickers (60 [36%] of 169 patients), resulting in a relative risk of 1.51 (95% confidence interval, 1.03-2.19) (Figure 2). This result was confirmed when the analysis was limited to patients categorized only on the basis of physical examination findings of ENT specialists: 59% of the patients classified as nose pickers were carrying *S. aureus* in the nose, compared with 35% of patients classified as nonpickers (*P* = .019).

In this patient population, there was no correlation between the questionnaire responses and the *S. aureus* load (*R* = 0.10; *P* = .18). However, significantly more colony-forming units were detected for patients who self-reported that they picked their nose at least sometimes (geometric mean *S. aureus* load, 1.9 cfu), compared with patients who responded that they never picked their nose (geometric mean *S. aureus* load, 0.9 cfu; *P* = .02).

Self-reported nose picking was significantly correlated with self-reported nasal itchiness (*R* = 0.25; *P* < .001), nasal crusts (*R* = 0.423; *P* < .001), nasal dryness (*R* = 0.21; *P* = .001),

nasal wounds (*R* = 0.20; *P* = .001), turning up the nose (defined as strongly inhaling through the nose) (*R* = 0.19; *P* = .004), and rubbing the nose (*R* = 0.31; *P* < .001). Self-reported nose picking frequency was only significantly correlated with nasal crusts found during nasal examination (*R* = 0.16; *P* = .013). There were no significant associations between the separate signs of nose picking and *S. aureus* carriage. If the number of colony-forming units of *S. aureus* is taken into account, there was a significant correlation between *S. aureus* load and nasal wounds (*R* = 0.14; *P* = .032), nasal crusts (*R* = 0.13; *P* = .048), and vestibulitis (*R* = 0.14; *P* = .035).

Healthy Volunteers

Eighty-six healthy volunteers who completed the questionnaire and had at least 5 nasal specimens obtained for culture were included in the study (Figure 1). Twenty-eight (32.6%) were male, and the mean age was 23 years. A mean of 7 swab specimens were obtained per volunteer (range, 5-10 swab specimens). Thirty-three volunteers (38.4%) were noncarriers, 22 (25.6%) were occasional carriers, 9 (10.5%) were moderate carriers, and 22 (25.6%) were frequent carriers. There was a statistically significant positive correlation between self-reported frequency of nose picking and both the

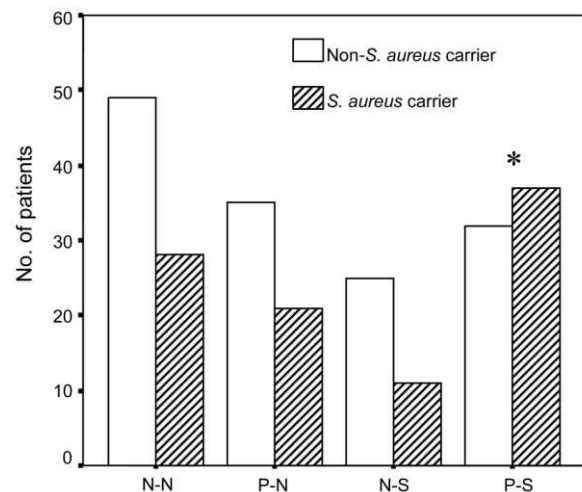


FIGURE 2. Nose-picking behavior, according to self-report and physical examination, among carriers and noncarriers of *Staphylococcus aureus*. N-N, rarely or never picked according to self-report and no signs of nose picking detected on physical examination; N-S, rarely or never picks according to self-report but signs of nose picking detected on physical examination; P-N, picks at least sometimes according to self-report but no signs of nose picking detected on physical examination; P-S, picks at least sometimes according to self-report and signs of nose picking detected on physical examination. *There were significantly more *S. aureus* carriers in the P-S group, compared with all other groups (*P* = .013), the N-S group (*P* = .024), and the N-N group (*P* = .036). There was no significant difference between the number of carriers in the P-S group and the number in the P-N group (*P* = .072).

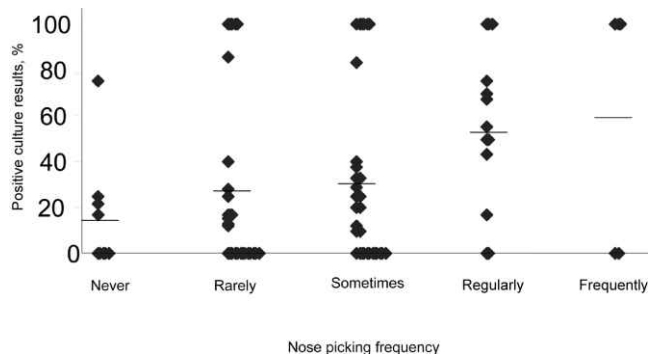


FIGURE 3. Percentage of patients with cultures positive for *Staphylococcus aureus*, according to self-reported frequency of nose picking.

frequency of positive culture results ($R = 0.31$; $P = .004$) (Figure 3) and the semiquantitative count of *S. aureus* colony-forming units ($R = 0.33$; $P = .002$) (Figure 4). The reported frequency of nose picking was significantly correlated with self-report of nasal crusts ($R = 0.45$; $P < .001$), rubbing the nose ($R = 0.23$; $P = .033$), and turning up the nose ($R = 0.29$; $P = .007$).

DISCUSSION

The findings of this study support the hypothesis that nose picking is associated with nasal carriage of *S. aureus*. The habit of nose picking is probably initiated by the presence of nasal crusts. *S. aureus* carriage was observed among a significantly higher percentage of ENT patients classified as nose pickers by defined criteria (see Methods). Also, the rate of *S. aureus* carriage was significantly higher among patients classified as nose pickers by the ENT specialist. Furthermore, there were significant correlations between the self-reported frequency of nose picking and both the frequency of positive culture results and the *S. aureus* load in the nose. This dose-response relationship suggests a causal relation between nose picking and nasal carriage of *S. aureus*.

We realize that the questionnaire we used is a subjective tool for determining nose picking behavior. It was unfeasible for us to secretly observe the nose picking behavior of participants, so we used the study design described in Methods. This disadvantage was partly compensated by blinding the respondents to their carriage status and not telling them the objective of the study. The questionnaire was also anonymous, which probably improved the sincerity of the answers given. We also included findings of nasal examination by an ENT specialist, who objectively scored signs of nose picking.

Jefferson et al.¹⁰ studied the habit and severity of nose picking and found that 90% of the study population picked their nose at least sometimes and that 2 study subjects even perforated their septum. To be classified as a nose picker in our study, one needed to have at least 1 objective clinical sign assumed to be due to nose picking. Therefore, patients classified as nose pickers all had some type of traumatic lesion that was probably the result of nose picking. Interestingly,

nose picking signs in subjects who denied nose picking behavior in the questionnaire were not predictive of *S. aureus* nasal carriage. Patients with rhinitis were excluded, because the associated inflammation impeded the determination of signs of nose picking.

We classified patients as nose pickers if damage to the nasal mucosa and dermis was detected. These surfaces act as first-line defenses to microbial colonization and invasion. Lesions on these surfaces expose extracellular matrix molecules, including fibronectin and collagen, to which *S. aureus* can adhere.^{2,11,12} However, recent in vitro studies found that *S. aureus* teichoic acid, clumping factor B, and other cell wall-associated adhesins may be involved in adhering to nasal epithelial cells, suggesting that exposure of extracellular matrix molecules may not be essential for colonization.¹³⁻¹⁶ However, *S. aureus* is well known to heavily colonize skin lesions, including eczematous lesions, which indicates that, in vivo, *S. aureus* exhibits high affinity to extracellular matrix molecules.¹²

Alternatively, carriage of *S. aureus* in the nose may elicit an immune response that results in irritation and itchiness, which may elicit more frequent or rigorous nose picking. A recent study suggests that *S. aureus* colonization induces a local inflammatory response.¹⁷ Eradicating *S. aureus* from the nose may result in reduced inflammation and itchiness. It remains to be resolved whether nose picking is a cause or a consequence of *S. aureus* nasal carriage.

Hand carriage is known to be associated with nasal carriage of *S. aureus*. The number of staphylococci on the fingers increases with increasing nasal counts.¹⁸ Furthermore, persons with nasal carriage of *S. aureus* are more likely to have hand carriage of *S. aureus*, and nasal eradication of *S. aureus* often leads to disappearance of the microorganism from the hands, as well.¹⁹ A study by Hare et al.²⁰ elegantly demonstrated that 9 students who were observed during a 1-hour lecture touched their mouth or nose on 6-23 separate occasions. Another study showed that nasal *S. aureus* carriers have different *S. aureus* loads on their left and right fingers.¹⁸ Clearly, hands

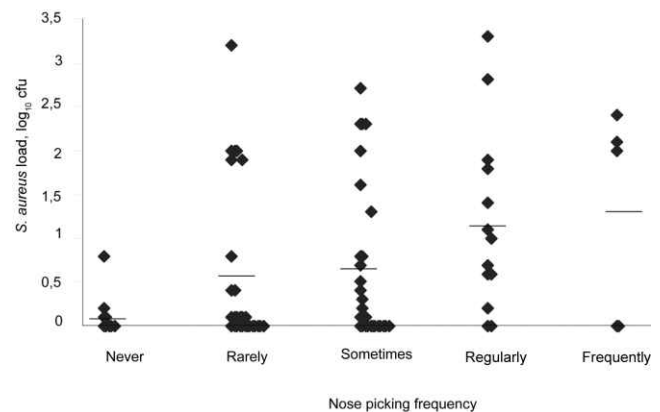


FIGURE 4. *Staphylococcus aureus* load (in log₁₀ colony-forming units [cfu]), according to self-reported frequency of nose picking.

are the major vectors for transmitting *S. aureus* from the environment into the nose, and vice versa. It is likely that staphylococci are introduced into the nose by the hand and that persistence of carriage may, in part, be determined by the frequency, duration, and intensity of nose picking. The data in Figure 2 suggest that nose picking or nasal trauma alone do not lead to a higher carriage rate. It is probably a combination of both the introduction of *S. aureus* by the finger and the presence of nasal trauma (due to nose picking or other factors) that facilitates *S. aureus* nasal carriage. We conclude that nose picking is associated with nasal carriage of *S. aureus* and may well be causal. Future studies should reveal whether nose picking is a cause or a consequence of *S. aureus* nasal carriage and whether stopping the habit of nose picking prevents nasal colonization with *S. aureus*. Understanding the pathogenesis of *S. aureus* nasal carriage will help optimize prophylactic strategies to prevent *S. aureus* disease and the spread of MRSA.

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