Throat Swabs Are Necessary to Reliably Detect Carriers of *Staphylococcus aureus*

Dominik Mertz,[1] Reno Frei,[2] Barbara Jaussi,[1] Andreas Tietz,[1] Christine Stebler,[3] Ursula Flückiger,[1] and Andreas F. Widmer[1]

[1]Division of Infectious Diseases and Hospital Epidemiology and [2]Microbiology Laboratory, University Hospital Basel, and [3]Transfusion Centre, Basel, Switzerland

The anterior nares are the most important screening site of colonization with *Staphylococcus aureus*. We screened 2966 individuals for *S. aureus* carriage with swabs of both nares and throat. A total of 37.1% of persons were nasal carriers, and 12.8% were solely throat carriers. Screening of throat swabs significantly increases the sensitivity of detection among carriers by 25.7%.

The anterior nares are considered to be the primary colonization site of *Staphylococcus aureus* [1–3]. Approximately 30% of the healthy population carries *S. aureus* in their anterior nares [4, 5]. Carriage of *S. aureus* in the nose appears to play a key role in the epidemiology and pathogenesis of infection and is associated with an increased risk of infectious complications after surgery in patients with end-stage renal failure and in those with intravascular devices [1, 6]. Approximately 80% of invasive nosocomial infections are of endogenous origin in nasal carriers [7, 8].

The emergence of methicillin-resistant *S. aureus* (MRSA) in hospitals and in the community has triggered many screening programs to identify carriers of *S. aureus*—in particular, MRSA. Early identification of carriers is a crucial step in MRSA prevention programs; this is especially true for "search and destroy" strategies, which are recommended in The Netherlands [9]. Screening of all persons who are admitted to the hospital is currently being debated in the United States.

Most *S. aureus* screening programs that include MRSA require obtainment of a swab specimen from the anterior nares only; a swab specimen from the throat is not yet considered to be standard. The additional yield of culturing the throat is considered to be negligible, because it adds discomfort for the patient and cost to the health care system without significantly increased sensitivity. This belief is based on the observation that throat carriers of *S. aureus* are likely to carry *S. aureus* in the nares as well. However, colonization of the throat but not of the nares may be more common than is currently acknowledged.

Publications from the 1940s reported throat colonization rates of 4%–63% [3]. A recent study confirmed the observation that the throat may be selectively colonized and escape current routine screening programs [10].

Unrecognized carriers may spread MRSA and render infection-control programs futile. Therefore, we questioned the practice of screening of the anterior nares alone and evaluated the additional benefit of screening both the nares and the throat in 4 different study populations.

Patients and methods. We collected data from 4 different groups of individuals. The first group included patients and health care workers who were screened after exposure to an MRSA carrier during the years 2000–2005. Since 1997, this procedure has been part of the hospital's policy for prevention of the spread of MRSA. The second group consisted of health care workers who participated in a trade fair for medical and hospital equipment (the Internationale Fachmesse für Arzt- und Spitalbedorf convention at an exhibition center in Zurich, Switzerland) on 26–29 October 2004 and who volunteered to participate in a prevalence survey of *S. aureus* carriage among the Swiss population. The third group included healthy blood donors who were screened for *S. aureus* in the year 2005. Group 4 consists of a large sample of nasal and throat cultures that were pooled in the laboratory; separate results are not available. This group consists of patients and health care workers, as in group 1.

MRSA carriers were analyzed separately to avoid any potential bias, because it is unknown whether MRSA has the same colonization pattern as methicillin-susceptible *S. aureus* (MSSA). Screening was performed by infection-control nurses or physicians after appropriate training. The study was approved by the human subjects committee of the University of Basel (Switzerland).

Specimens were obtained with a sterile polyester fiber–tipped swab that had been moistened with sterile saline; samples were taken from the anterior nares (5 rotations in each anterior nostril) and from the posterior wall of the pharynx using a

Received 16 February 2007; accepted 20 April 2007; electronically published 5 July 2007.

Reprints or correspondence: Dr. Andreas F. Widmer, Div. of Infectious Diseases & Hospital Epidemiology, University Hospital Basel, Petersgraben 4, CH-4031, Basel, Switzerland (spitalhygiene@uhbs.ch).

Clinical Infectious Diseases 2007; 45:475–7

1058-4838/2007/4504-0012$15.00
DOI: 10.1086/520016

Table. 1. Rates of isolation of *Staphylococcus aureus* from the anterior nares and the throat.

Variable	Groups 1–3	Group 1	Group 2	Group 3	Group 4
No. of persons screened	2966	832	634	1500	2075
No. with *S. aureus* carriage	1480	369	304	807	1082
Overall rate of positivity, %	49.9	44.4	47.9	53.8	52.1
Nares cultures					
No. of persons with positive results	1100	301	237	562	…
Overall rate of positivity, %	37.1	36.2	37.4	37.5	…
Overall rate of positivity among carriers, %	74.3	81.5	77.9	69.6	…
Nares and throat cultures					
Positive results of both					
No. of persons	650	188	119	343	…
Overall rate of positivity among carriers, %	43.9	50.9	39.1	42.5	…
Positive results of nares cultures and negative results of throat cultures					
No. of persons	450	113	118	219	…
Overall rate of positivity among carriers, %	30.4	30.6	38.8	27.1	…
Negative results of nares cultures and positive results of throat cultures					
No. of persons	380	68	67	245	…
Overall rate of positivity, %	12.8	8.2	10.6	16.3	…
Overall rate of positivity among carriers, %	25.7	18.4	22.0	30.4	…

NOTE. Group 1, persons who underwent *S. aureus* screening during hospital stay; group 2, health care workers; group 3, blood donors; group 4, patients and health care workers for whom swabs from the nares and throat were pooled and for whom separate results were unavailable.

second swab. Swabs were sent to the laboratory in a transport tube (M40 Transystem; Copan) and were processed within 24 h. For culture, a selective enrichment broth (brain heart infusion broth with 6% NaCl) was inoculated. After incubation at 35°C overnight, the broth was subcultured onto both chromogenic agar for *S. aureus* (Chromagar Staph.aureus; Hy Laboratories) and Columbia agar with 5% sheep blood (Becton Dickinson). Plates were read after 24 and 48 h, and colonies that were suspected of being *S. aureus* were further analyzed. *S. aureus* was identified on the basis of various traits, such as typical growth on the chromogenic medium and/or blood agar and detection of clumping factor, protein A, and capsular antigens (Pastorex Staph-Plus; Bio-Rad). *S. aureus* isolates were tested for oxacillin resistance by using an oxacillin disk, an oxacillin screening agar plate, or, more recently, a cefoxitin disk, in accordance with guidelines issued by the Clinical and Laboratory Standards Institute (formerly NCCLS). If results were equivocal or if MRSA was suspected, additional tests were performed, as follows: the presence of aurease was determined using Rapidec staph (bioMérieux), the MRSA-Screen (Denka Seiken) was used to detect penicillin-binding protein 2a, and PCR was used to detect the *mecA* and *femA* genes; also, a comprehensive antibiogram was performed in accordance with the Clinical and Laboratory Standards Institute guidelines.

Results. A total of 5041 persons were included in our study. Three groups (groups 1–3), which included a total of 2966 individuals, were screened for *S. aureus* carriage, with separate results for nose and throat carriage. A fourth group (group 4) consisted of 2075 individuals for whom data from nares and throat swabs were pooled in the laboratory. The average age was 50 ± 21 years, and 50.4% of the subjects were female. In groups 1–3, a total of 1480 individuals (49.9%) tested positive for *S. aureus* (table 1). A total of 37.1% of the study population (in groups 1–3) had nasal carriage of *S. aureus*, with or without positive throat culture results. A total of 380 persons (12.8% of the study population and 25.7% of the *S. aureus* carriers) were colonized in the throat alone. Thus, screening of the throat significantly increased the sensitivity by 25.7%. The anterior nares were the site most frequently colonized with *S. aureus*, with the exception of the group of blood donors; among blood donors, the throat swab cultures yielded *S. aureus* more frequently than cultures of swab specimens from the nares. The rate of *S. aureus* carriage in group 4 (i.e., the pooled results group) was 52.1%, which is similar to that observed with the combined results for nares and throat swab cultures in groups 1–3.

A subset analysis was performed for 37 subjects with MRSA carriage (0.74% of all individuals screened). In 23 MRSA carriers, separate results were available for cultures of throat and nasal swab specimens. The additional yield of throat cultures was comparable with the results described for MSSA: 5 of 23 (22% of all MRSA carriers versus 25.7% of all MSSA carriers).

Discussion. To our knowledge, this is the largest study to have evaluated the importance of the throat in *S. aureus* carriage. The additional throat swab cultures increased the yield from 37% (cultures of nares swabs only) to almost 50% (cultures of nares and throat swabs combined), an increase of sensitivity by 25.7%. Results for group 4 (the pooled specimen group)—separate cultures of swab specimens from nares and the throat were not performed—corroborated the results for groups 1–3, with a prevalence of *S. aureus* carriage of 49.9% and 52.1%, respectively. Therefore, pooling culture results for swabs from nares and the throat may be an appropriate method to optimize the yield of *S. aureus*–positive while saving the expenses of additional cultures.

Today, *S. aureus* screening is mainly performed to identify MRSA carriers. Unidentified throat carriers may spread MRSA, explaining, in part, why many decolonization schemes are prone to failure. Throat carriage even triggered a large outbreak of MRSA infection, which was traced back to a health care worker who was solely colonized in the throat. Routine nasal screening failed to identify this carrier [11]. Admission screening of selected patients or of all patients that aims to control MRSA infection is performed in many hospitals, but screening focuses on the nares along in most institutions [9]. However, throat swab specimens have been obtained routinely in The Netherlands for decades as part of the successful search-and-destroy policy, which is outlined in their national guidelines (http://www.wip.nl).

Our data confirm the results of previous studies that the anterior nares are the single most colonized site with *S. aureus.* The rate of carriage was higher in the throat than in the nares only among blood donors (group 3). The finding may be related to the fact that only 1 trained, highly motivated investigator obtained all of these swab specimens. Untrained investigators may find it difficult to screen the posterior wall of the throat while avoiding patient discomfort. Alternatively, throat carriage may indeed be more common among healthy individuals than among individuals who are exposed to the health care system, but such a hypothesis requires confirmation by other investigators in different, non–health care populations.

Overall, the prevalence of carriage was ~50%, which is higher than the rate reported in most other studies (25%–35%) [5]. Several factors may explain this discrepancy. First, in other studies, throat carriage was not taken into account. In fact, the rate of nasal carriage (with data from throat cultures excluded) was comparable at a rate of 37.1%. Second, enrichment broth may have additionally increased the sensitivity of the culture [12]. Third, only specially trained health care workers obtained the swab specimens, so samples were obtained from posterior wall of the throat and not the mouth.

The addition of throat cultures to cultures of swabs from the anterior nares significantly increased the sensitivity of screening by 25.7%. Overall, 37.1% of subjects had nasal carriage of *S. aureus,* but 12.8% of the individuals had throat carriage alone, and these subjects would have escaped traditional screening methods. Therefore, any screening for *S. aureus*—in particular, screening for MRSA—should include both cultures of swabs samples from the anterior nares and the throat. Pooling the samples can maintain the additional expenses associated with throat screening while maintaining sensitivity.

Acknowledgments

Financial support. The Swiss National Science Foundation (3200BO-104179).

Potential conflicts of interest. One year after completion of the study, A.T. accepted a position at F. Hoffmann–La Roche. All other authors: no conflicts.

References

1. Kluytmans J, van Belkum A, Verbrugh H. Nasal carriage of *Staphylococcus aureus*: epidemiology, underlying mechanisms, and associated risks. Clin Microbiol Rev **1997**; 10:505–20.
2. Lowy FD. *Staphylococcus aureus* infections. N Engl J Med **1998**; 339: 520–32.
3. Williams RE. Healthy carriage of *Staphylococcus aureus*: its prevalence and importance. Bacteriol Rev **1963**; 27:56–71.
4. Bassetti S, Wolfisberg L, Jaussi B, et al. Carriage of *Staphylococcus aureus* among injection drug users: lower prevalence in an injection heroin maintenance program than in an oral methadone program. Infect Control Hosp Epidemiol **2004**; 25:133–7.
5. Wertheim HF, Melles DC, Vos MC, et al. The role of nasal carriage in *Staphylococcus aureus* infections. Lancet Infect Dis **2005**; 5:751–62.
6. Wenzel RP, Perl TM. The significance of nasal carriage of *Staphylococcus aureus* and the incidence of postoperative wound infection. J Hosp Infect **1995**; 31:13–24.
7. von Eiff C, Becker K, Machka K, Stammer H, Peters G. Nasal carriage as a source of *Staphylococcus aureus* bacteremia. Study Group. N Engl J Med **2001**; 344:11–6.
8. Wertheim HF, Vos MC, Ott A, et al. Risk and outcome of nosocomial *Staphylococcus aureus* bacteraemia in nasal carriers versus non-carriers. Lancet **2004**; 364:703–5.
9. Wertheim HF, Vos MC, Boelens HA, et al. Low prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) at hospital admission in The Netherlands: the value of search and destroy and restrictive antibiotic use. J Hosp Infect **2004**; 56:321–5.
10. Nilsson P, Ripa T. *Staphylococcus aureus* throat colonization is more frequent than colonization in the anterior nares. J Clin Microbiol **2006**; 44:3334–9.
11. Kluytmans J, van Leeuwen W, Goessens W, et al. Food-initiated outbreak of methicillin-resistant *Staphylococcus aureus* analyzed by phenoand genotyping. J Clin Microbiol **1995**; 33:1121–8.
12. Safdar N, Narans L, Gordon B, Maki DG. Comparison of culture screening methods for detection of nasal carriage of methicillin-resistant *Staphylococcus aureus*: a prospective study comparing 32 methods. J Clin Microbiol **2003**; 41:3163–6.