

Original Article

Methicillin-resistant *Staphylococcus aureus* (MRSA) screening upon inpatient hospital admission: Is there concordance between nasal swab results and samples taken from skin and soft tissue?

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Abstract

Background: Methicillin-resistant *Staphylococcus aureus* (MRSA) infections are associated with increased mortality and healthcare costs. In 2007, a Veterans' Affairs (VA) hospital implemented a MRSA nasal screening program, following a nationwide VA mandate, in an effort to reduce healthcare-associated MRSA infections.

Objective: To evaluate the correlation between the nasal screening results for MRSA and culture results of wound and tissue sites.

Methods: This retrospective study was conducted on inpatients at our VA hospital. Patients were included if they had undergone nasal screening for MRSA plus culture of a wound or tissue site within 30 days of hospital admission.

Results: In total, 337 patients underwent nasal screening and wound culture and 211 underwent nasal screening and wound and tissue cultures. The prevalence of MRSA nasal colonization was 14.2% for wound samples and 15.2% for tissue samples. The sensitivities of MRSA nasal screening for detecting MRSA were 64.6% for wound cultures and 65.5% for tissue cultures. Specificities were 86.2% and 88.8% for wound and tissue cultures, respectively. The positive predictive values (PPVs) were 43.7% and 51.2% for wound and tissue cultures, respectively, and the negative predictive values (NPVs) were high at 93.6% and 93.5%, respectively.

Conclusions: In cases of wound or tissue samples for which culture results are pending, a negative MRSA nasal swab may be a component of the decision to withhold or discontinue MRSA-active agents.

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Methicillin-resistant *Staphylococcus aureus* (MRSA) is one of the most frequently identified antimicrobial-resistant pathogens that cause skin and soft-tissue infections (SSTIs); it is associated with subsequent infections, high mortality rates, and increased healthcare costs.¹ Recent increased clinical precautions across the nation have resulted in a decrease of invasive MRSA infections.^{2,3} However, further advances in screening methods need to be investigated to continue to decrease the burden of MRSA infections.⁴ *Staphylococcus aureus* is naturally present in the nares, axilla, groin, and skin of many people, with the nares being the most common site of colonization.⁵ Data from previous studies note that 7% of patients⁶ and 4.3%–15% of emergency healthcare workers in United States hospitals are colonized with MRSA.^{7,8} Nasal colonization with MRSA has been shown to be a risk factor for subsequent infection with the pathogen,⁹ and the anterior nares are the source of MRSA infections in different sites in some patients.¹⁰

In 2007, VA hospitals nationwide implemented MRSA nasal screening by polymerase chain reaction (PCR) in an effort to reduce healthcare-associated MRSA infections.¹¹ Currently, nasal screening for MRSA is used as a means to prevent the spread of the pathogen in the hospital setting.¹¹ Moreover, nasal screening for MRSA may also be a helpful tool in de-escalating antibiotic therapy in the treatment of infections in the hospital setting.¹² In an age of rising antibiotic resistance, the use of well-chosen antibiotics is of the utmost importance. Previous studies have shown nasal screening for MRSA to be of significant value for the prediction of respiratory tract cultures.^{13–15} In this study, we aimed to help define the predictive value of MRSA nasal screening by PCR to guide the use of MRSA agents preceding results from subsequent wound and tissue cultures in the inpatient setting.

Methods

This single-site retrospective study was conducted at the Fargo VAHCS in Fargo, North Dakota. Veterans' were included in the study group if they were male or female aged ≥ 18 years, had been admitted to the Fargo VA between January 2008 and June 2015, and had undergone nasal screening for MRSA by PCR (GeneXpert System, Cepheid, Sunnyvale, CA) upon admission,

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Table 1. Patient Characteristics

Characteristic	No. (%) of Patients
Sex	
Male	443 (80.8)
Female	105 (19.2)
Ethnicity	
White	443 (80.8)
Native American	44 (8.0)
Black	15 (2.7)
Other	46 (8.4)
Residence	
Minnesota	258 (47.1)
North Dakota	255 (46.5)
South Dakota	12 (2.2)
Other	23 (4.2)
Medical history	
History of smoking or COPD	284 (51.8)
Previous admission within 30 d	114 (20.8)
History of MRSA infection	115 (21.0)
Immunosuppression factor	375 (68.4)

Note. COPD, chronic obstructive pulmonary disease; MRSA, methicillin-resistant *Staphylococcus aureus*.

Table 2. 2x2 Table Results of Nasal Screening for MRSA Compared With Results of Wound Culture

Nasal Screening	Wound Culture		Total
	MRSA Positive	MRSA Negative	
MRSA positive	31	40	71
MRSA negative	17	249	266
Total	48	289	337

Note. MRSA, methicillin-resistant *Staphylococcus aureus*.

Table 3. Results of Nasal Screening for MRSA Compared With Results of Tissue Culture

Nasal Screening	Tissue Culture		Total
	MRSA Positive	MRSA Negative	
MRSA positive	21	20	41
MRSA negative	11	159	170
Totals	32	179	211

Note. MRSA, methicillin-resistant *Staphylococcus aureus*.

along with culture of a secondary site within 30 days of admission. Secondary sites included wound and tissue sites. A wound culture was defined as a culture taken from superficial wounds such as abrasions, cuts, lacerations, ulcers, burns, or associated skin disease. A tissue culture was defined as a culture taken from a deep wound such as a surgical wound, bite wound, deep trauma, or any specimen that originated from deep tissue.

The following baseline data were collected: age, sex, ethnicity, geographic residence, immunosuppression factors, history of smoking or chronic obstructive pulmonary disease, length of stay, history of positive MRSA colonization or infection within the past calendar year, and a history of a previous hospital admission within 30 days. Immunosuppression factors included previous kidney transplant, glomerulonephritis, asplenia, diabetes mellitus, malignancy, HIV or AIDS, diabetes, or hepatitis B, or C. This study was reviewed and approved by the University of South Dakota Institutional Review Board and the Fargo Veterans' Affairs Health Care System (VAHCS) Research and Development Committee.

Statistical analysis

The primary outcome for the study was concordance between MRSA nasal swab results and MRSA wound and tissue cultures determined by the McNemar test for positive predictive value (PPV) and negative predictive value (NPV).¹⁶ The Bayes theorem was used to calculate positive likelihood ratio and negative likelihood ratio.¹⁷ Linear regressions were performed for all subanalyses. All analyses were conducted utilizing SPSS version 19 statistical software (IBM, Armonk, NY). Data were deemed significant at $P < .05$.

Results

Of the 942 veterans reviewed, 548 met inclusion criteria. Those included were 80.8% male and 19.2% female; 80.8% were white, Native American (8.0%), black (2.7%), and other ethnicity (8.4%). Most study participants resided in Minnesota (47.1%) and North Dakota (46.5%), with the rest being from South Dakota (2.2%) and other locations (4.2%). Furthermore, 51.8% were smokers or had previously been diagnosed with chronic obstructive pulmonary disorder (COPD). Also, 20.8% of the participants had been admitted to the hospital within the previous 30 days, and 21.0% had a previous diagnosis of MRSA colonization or infection. In addition, 68.4% had an immunosuppression factor (see Table 1 for patient characteristic breakdowns).

Of the 548 veterans who met our inclusion criteria, 337 had a culture of a wound and 211 had a culture of a tissue site. In total, 71 veterans (21.1%) in the wound-culture group and 41 (19.4%) in the tissue-culture group had a positive nasal swab for MRSA. Furthermore, 31 (9.2%) had both a nasal screening positive for MRSA and a wound culture positive for MRSA, whereas 21 (10.0%) had both a nasal screening positive for MRSA and a tissue culture positive for MRSA. Tables 2 and 3 show the results of nasal screening for MRSA compared with the results of tissue and wound cultures.

The sensitivities of MRSA nasal screening for detecting culture-proven MRSA were 64.6% and 65.5% for wound and tissue cultures, respectively, and the specificities were 86.2% and 88.8%, respectively. The PPVs were 43.7% for wound and 51.2% for tissue cultures and the NPVs were 93.6% for wound and 93.5% for tissue cultures (Table 4). The positive likelihood ratios were 4.7 for wound cultures and 5.9 for tissue cultures. The negative likelihood ratios were 0.4 for both wound and tissue cultures (Table 5).

Subanalyses were conducted using linear regression for medical history variables based on their ability to predict a positive MRSA culture swab. Results from this test indicate that patients with a history of MRSA colonization or infection are significant predictors of positive MRSA tests from both the nasal and tissue cultures ($P < .05$). Other statistical methods also confirmed these findings.

Table 4. Prevalence, Sensitivity, Specificity, PPV, and NPV of Nasal Colonization With MRSA for Subsequent Wound or Tissue MRSA Infection

Variable	Wound		Tissue	
	%	95% CI	%	95% CI
Prevalence	14.2	10.5–17.9	15.2	10.4–15.3
Sensitivity	64.6	50.4–76.6	65.5	48.2–79.7
Specificity	86.2	81.7–89.7	88.8	83.3–92.7
PPV	43.7	32.1–55.3	51.2	35.9–66.5
NPV	93.6	90.7–96.5	93.5	89.8–97.2

Note. PPV, positive predictive value; NPV, negative predictive value; MRSA, methicillin-resistant *Staphylococcus aureus*.

Table 5. Likelihood Ratios of Nasal Colonization With MRSA for Subsequent Wound or Tissue MRSA Infection

Variable	Wound		Tissue	
	Ratio	95% CI	Ratio	95% CI
Positive likelihood ratio	4.7	3.3–6.0	5.9	3.6–10.3
Negative likelihood ratio	0.4	0.3–0.6	0.4	0.2–0.6

The variables of history of smoking or COPD, previous admission within 30 days, and immunosuppression factors were not significant predictors of a positive MRSA culture swab.

Discussion

In this study, we evaluated the correlation between the MRSA results of nasal swab testing by PCR and of cultures of wound and tissue samples from veterans admitted to the Fargo VAHCS. The results show relatively low sensitivities and PPVs, demonstrating a limited diagnostic value of positive nasal swab for wound and tissue sites with MRSA. In addition, our calculated negative likelihood ratios of 0.4 offers moderate evidence against the presence of MRSA. According to the Bayes theorem and based on our study prevalence (15.2% for tissues and 14.2% for wounds), those who had a positive nasal screen for MRSA only had a moderately increased probability that their wound or tissue site was also colonized with MRSA (posttest probability of 41.2% for tissues and 50.2% for wounds).¹⁷

Because of the high NPVs (93.6% for wounds and 93.5% for tissues), these results indicate that there is reasonably high probability that the subsequent wound and tissue cultures will also be negative. This finding could be valuable for ruling out wound or tissue infection when the nose swab result is negative for MRSA and may help guide the clinician's decision to hold or discontinue MRSA-active agents. By combining this study's finding of high NPVs with an appreciable difference in turnaround times between the nasal swab and the culture in detecting MRSA (~70 minutes for nose swab versus 24–48 hours for wound/tissue culture), clinicians can avoid empirical use of MRSA-targeting agents 1–2 days before the final culture results are available.^{18,19}

Although this study did not investigate whether the MRSA-positive wound and tissue sites were colonized or infected, the study data support using the notion “negative MRSA nose swab indicates no MRSA coverage” as a strategy to avoid overuse of MRSA-targeting agents. The conclusion of this study agrees with

the previously published studies analyzing nasal MRSA colonization and wound and tissue culture results.^{13–15,20–22} In studies specifically analyzing SSTI site culture concordance with nasal swab results, the ability to use predictive values for ruling out MRSA infection have depended on the population size, pretest probability, and disease prevalence.

This study has several limitations. It was a retrospective review conducted at a single VA facility with a limited sample size. However, our findings suggest a strategy for antimicrobial stewardship, and they add to a limited body of research related to MRSA nasal tests and wound and tissue cultures. To confirm our findings in this area, larger prospective studies in different populations are warranted.

In conclusion, the findings of this retrospective study suggest that, in cases of wound or tissue samples for which culture results are pending, a negative MRSA nasal swab can be a valuable indicator for withholding or discontinuing MRSA-active agents.

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