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Research Brief

Predictive characteristics of methicillin-resistant *Staphylococcus aureus* nares screening tests for methicillin resistance among *S. aureus* clinical isolates from hospitalized veterans

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For patients with possible *Staphylococcus aureus* infection, providers must decide whether to treat empirically for methicillin-resistant *S. aureus* (MRSA). Nares MRSA colonization screening tests could inform decisions regarding empiric MRSA-active antibiotic use.[1,2]

The negative predictive value (NPV) of MRSA nares tests has varied greatly among studies, [1–9] from 45%[3] to 99%.[4] Despite increasing attention to the tests' potential clinical utility, especially for respiratory infections, [10] factors that influence its NPV remain largely unstudied. Accordingly, we assessed multiple clinical variables as correlates of MRSA nares tests' NPV for methicillin resistance among clinical *S. aureus* isolates.

Methods

This retrospective cohort study involved inpatients at the Minneapolis Veterans Affairs Medical Center (MVAMC), a 207-bed facility with 48 rehabilitation beds. According to a Veteran Affairs national directive, during the study period (2013–2016) patients underwent MRSA nares screening using either polymerase chain reaction (PCR, Xpert MRSA, Cepheid, Sunnyvale, CA) or culture (CHROMagar, Becton Dickinson, Franklin Lakes, NJ) on admission, discharge, and transfer (2013–2015), or only on admission and intensive care unit (ICU) transfer (2016). After institutional review board approval, the clinical cohort was assembled by querying a microbiology laboratory database to identify inpatient *S. aureus* isolates, excluding "stool," "rectal," "vaginal," "genital," "throat," "nares," and "nasal" as likely colonization, not infection.[4] Of 1,039 total *S. aureus* clinical isolates, 445 were represented by patient replicates; only the most recent isolate per patient was retained. Of 594 remaining unique isolates, 36 were excluded (35 lacked MRSA nares testing and 1 yielded both MRSA and MSSA). The final population comprised 558 patients (96% male; mean age, 66.7 years).

Oxacillin-resistant clinical isolates (ie, MRSA) identified using Vitek 2 (bioMèrieux, Marcy-l'Étoile, France) were categorized by time interval between nares screening and clinical isolate specimen collection (≤30 or >30 days), patient location (ICU, medical ward [medical], rehabilitation/spinal cord unit [rehabilitation]), specimen type (respiratory, blood, skin/soft tissue, urine, bone/joint, or urine), and nares test method (PCR or culture).

Primary outcomes included the sensitivity, specificity, positive predictive value (PPV), and NPV of nares tests for the MRSA status of the isolate's status. Overall NPV was calculated by considering (1) only the most recent prior nares test and (2) all nares tests from 12 months prior to clinical isolate specimen collection. All other analyses used only the nares test immediately prior to isolate specimen collection. The Fisher exact test (2-tailed) was used for between-subcategory comparisons. Multivariable analysis was used to assess jointly patient location, time interval, and their interaction term.

Results

Of the 558 *S. aureus* clinical isolates, 38% were MRSA. The NPV of the nares tests for MRSA was 81.0% (95% confidence interval [CI], 78.1–83.6) when only the most recent nares test was considered, and this value increased negligibly to 82.6% (95% CI, 78.5–86.1) when any positive nares test in the prior 12 months was considered. By contrast, test performance varied substantially by clinical subgroup (Table 1).

Time interval

Compared with nares tests collected >30 days before clinical isolate specimen collection (n = 86, 25.4%), tests collected at a shorter interval (≤30 days: n = 472, 84.6%) had a significantly higher NPV (82.8% [95% CI, 78.4–86.7] vs 72.2% [95% CI, 60.4–82.1]; $P = .046$).

Location

Nares tests from rehabilitation patients had significantly lower NPV (68.2% [95% CI, 60.9–74.7]) than those from the ICU (88.6% [95% CI, 79.0–94.2]; $P = .02$) or medical patients (82.7% [95% CI, 79.3–85.6]; $P = .01$).

Specimen

Test performance varied somewhat (albeit nonsignificantly) by specimen type. The NPV ranged from 75% (95% CI, 64.3–83.4) for urine to 84% (95% CI, 77.2–89.1) for bone and joint specimens.

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Table 1. Performance Characteristics of Methicillin-Resistant *Staphylococcus aureus* Nares Screens in Relation to Clinical Variables

Variable	Subcategory (No. of Isolates)	Sensitivity, % (95% CI)	Specificity, % (95% CI)	PPV % (95% CI)	NPV % (95% CI)
None (total)	None (N = 558)	63.2 (56.3–69.7)	96.0 (93.3–97.8)	90.5 (85.0–94.2)	81.0 (78.1–83.6)
Interval[a]	≤30 d (N = 472)	67.6 (60.2–74.4)	95.6 (92.5–97.6)	90.3 (84.0–94.7)	82.8 (78.4–86.7)
	>30 d (N = 86)	39.4 (22.9–57.9)	98.1 (89.9–99.9)	92.9 (66.1–99.0)	72.2 (60.4–82.1)
Location[b]	Medical (N = 409)	65.3 (57.1–72.9)	95.8 (92.5–97.9)	89.9 (83.2–94.1)	82.7 (79.3–85.6)
	Rehabilitation/spinal cord unit (N = 92)	54.3 (39.0–69.1)	97.8 (88.5–99.9)	96.15 (77.9–99.4)	68.2 (60.9–74.7)
	Intensive care unit (N = 57)	68.8 (41.3–88.9)	95.1 (83.5–99.4)	84.6 (57.8–95.7)	88.6 (79.0–94.2)
Specimen[c]	Respiratory (N = 90)	73.2 (57.1–85.8)	95.9 (86.0–99.5)	93.8 (79.2–98.3)	81.0 (72.0–87.7)
	Blood (N = 99)	61.8 (43.6–77.8)	96.9 (89.3–99.6)	91.3 (72.3–97.7)	82.9 (75.9–88.2)
	Skin/soft tissue (N = 281)	61.5 (51.5–70.9)	96.6 (92.8–98.8)	91.4 (82.7–96.0)	81.0 (77.0–84.5)
	Urine (N = 62)	64.3 (44.1–81.4)	88.2 (72.6–96.7)	81.8 (63.3–92.2)	75.0 (64.3–83.4)
	Bone/joint (N = 26)	20.0 (0.5–71.6)	100 (83.9–100.0)	N/A[d]	84.0 (77.2–89.1)
Method[e]	PCR (N = 395)	67.3 (59.4–74.6)	95.0 (91.4–97.4)	89.7 (83.3–93.9)	81.7 (78.0–84.8)
	Culture (N = 163)	51.8 (38.0–65.3)	98.1 (93.4–99.8)	93.6 (78.2–98.3)	79.6 (74.8–83.6)

Note. PPV, positive predictive value; NPV, negative predictive value; PCR, polymerase chain reaction.
[a]Time interval between collection of the index culture and collection of the nares screening test.
[b]Patient location at the time of the index culture collection.
[c]Specimen type of the index culture that yielded *S. aureus*.
[d]N/A, not applicable due to insufficient sample size.
[e]Method used for nares screening test (both PCR and culture were used during the study).

PCR versus culture

The NPV was similar for PCR-based versus culture-based nares tests, i.e., 81.7% (95% CI, 78.0–84.8) versus 79.6% (95% CI, 74.8–83.6), respectively ($P = 0.6$).

Other subcategories

In a multivariate model that included location and time interval, location remained a significant predictor of MRSA status overall ($P < .01$), whereas time interval did not ($P = .13$). Stratification by location identified time interval as a significant predictor of NPV for the rehabilitation unit ($P = .03$) but not medical wards ($P = .66$) or the ICU ($P = .46$).

Discussion

This retrospective cohort study involving MVAMC inpatients assessed MRSA nares screening tests for predicting MRSA status of clinical *S. aureus* isolates. We identified a significantly higher nares-test NPV in 2 subgroups: clinical isolate specimens obtained from ICU or medical ward (vs rehabilitation) patients, and nares tests done within 30 days (vs >30 days) of isolate specimen collection.

Our study has demonstrated a higher MRSA proportion among clinical isolates (38%) than all but 2[3,7] of 9 referenced studies.[1–9] Because NPV varies inversely with targeted condition prevalence (here, MRSA), our comparatively low overall NPV may reflect our comparatively high overall MRSA prevalence. Likewise, the comparatively low nares screen NPV from the rehabilitation unit may reflect that unit's higher MRSA fraction among *S. aureus* isolates (50.0%) compared with the ICU (28.1%) or medical wards (36.7%).

Our study has several limitations. First, because it was hypothesis generating, observed differences between subgroups require confirmation. Second, certain subgroups were small, limiting power. Third, the distinctive veteran population may limit generalizability. Fourth, we included all clinical isolates, regardless of whether they represented active infections. Finally, all subjects had an *S. aureus* clinical isolate. Inclusion of other subjects predictably would increase the test's NPV due to the lower pretest probability of MRSA.

In summary, we found a significantly higher NPV for MRSA nares screening tests performed within 30 days of *S. aureus* clinical isolate specimen collection and in units with lower MRSA prevalence (ICU and medical, vs rehabilitation). Use of MRSA nares tests in empiric antibiotic selection may benefit from consideration of factors influencing test performance, including time since nares test and background MRSA prevalence.

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Conflicts of interest. All authors report no conflicts of interest relevant to this article.

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Increased time spent on terminal cleaning of patient rooms may not improve disinfection of high-touch surfaces

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Organisms causing healthcare-associated infections (HAIs) are prevalent on high-touch surfaces in hospital rooms.[1] Quality of surface disinfection varies widely due to surfaces, disinfectant, and pressure for quick turnaround times in busy hospitals.[2] The need for quick terminal cleaning may impact bioburden reduction and ultimately affect HAI rates. The Association for the Healthcare Environment recommends that 20–45 minutes be dedicated to terminal room cleaning after a patient is discharged. This recommendation was previously not validated for impact on microbial load.[3] A larger study of hospital room disinfection examined the relationship between time spent cleaning and level of disinfection achieved as quantified by aerobic bacterial colony (ABC) counts of 5 high-touch surfaces.

Methods

The study was conducted in an acute-care Veterans Affairs (VA) hospital in Temple, Texas. Single-occupancy rooms previously occupied for at least 48 hours prior to discharge were used. Precleaning and postcleaning samples were collected from 5 high-touch surfaces: bedrail, tray table, call button, toilet seat, and bathroom handrail. All rooms were sampled for ABC as described previously.[4] Surfaces were manually disinfected by environmental management services (EVS) personnel using 1 of 3 disinfectants: (1) sodium hypochlorite 10% solution (SH; Dispatch, Clorox Healthcare Services, Pleasanton, CA), (2) hydrogen peroxide + paracetic acid (HPA; Oxycide, Ecolab, St Paul, MN), and (3) quaternary ammonium compound (QAC; Virex II 256, Diversey, Sturtevant, WI). Sampling plates were incubated for 24 hours at 35°C. Aerobic bacterial colonies were counted or deemed too numerous to count (TNTC) when colony count exceeded 200. Of 450 samples, 43 were censored at a value of 200. Actual cleaning time was measured by stopwatch. Cleaning instructions limited time to 25 minutes or time was unrestricted. For analysis, cleaning time data were placed in 3 categories: (1) limited arm (restricted to 25 minutes), (2) unrestricted–moderate arm (<45 minutes taken), and (3) unrestricted–high arm (≥45 minutes taken).

Aerobic bacterial colony counts were modeled as a function of cleaning time category, disinfectant, precleaning ABC count (z-transformed), and sample surface location, in a Bayesian negative binomial mixed-effects censored regression model using the 'brms' package in R version 3.5.1 software.[5] A random intercept for interaction of disinfectant and EVS staff was used to account for 12 EVS staff cleaning >1 room with potentially different disinfectants. A normal(0,5) prior was specified for fixed effects, a Student_t(3,0,10) was specified for standard deviation parameter group-level effects, and a γ(0.01, 0.01) was specified for the negative binomial shape parameter. All chains converged, and Rhat was 1.0 for each parameter estimate. Results were reported as incident rate ratio (IRR) compared to limited time. An IRR = 1 indicated

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