Title of the project:

Optimizing Detection of MRSA Carriage

Principal investigator and team members:

Yohei Doi (principal investigator)

Diana Pakstis (research director)

Charma Chaussard (research coordinator)

Jessica O'Hara (laboratory technician)

Kathleen Shutt (biostatistician)

Organization

University of Pittsburgh

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James Cleeman, MD

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Structured abstract

Purpose: Nasal swab culture is the standard method for identifying methicillin-resistant *Staphylococcus aureus* (MRSA) carriers. However, this method is known to miss a substantial portion of those carrying MRSA elsewhere. We hypothesized that the additional use of a sponge to collect skin culture samples would significantly improve the sensitivity of MRSA detection.

Scope: This was a 2-year, single-site clinical study in which hospitalized patients with known MRSA infection were prospectively enrolled.

Methods: Hospitalized patients with recent MRSA infection were enrolled and underwent MRSA screening of the forehead, nostrils, pharynx, axilla, and groin with separate swabs and the forehead, axilla, and groin with separate sponges. Staphylococcal cassette chromosome *mec* (SCC*mec*) typing was conducted by polymerase chain reaction (PCR).

Results: In total, 109 subjects were enrolled, and 105 of them were included in the analysis. At least one specimen from 56.2% of the patients grew MRSA. Among patients with at least one positive specimen, the detection sensitivities were 79.7% for the swabs and 64.4% for the sponges. Notably, 86.4% were detected by a combination of sponges and nasal swab, and 72.9% were detected by a combination of pharyngeal and nasal swabs, whereas only 50.9% were detected by nasal swab alone ($p < 0.0001$ and $p = 0.0003$, respectively). Most isolates had SCC*mec* type II (59.9%) and IV (35.7%). No correlation was observed between the SCC*mec* types and collection sites.

Conclusion: It was concluded that screening with a sponge significantly improved MRSA detection when it was used in addition to screening with the standard nasal swab.

Key words: MRSA, active surveillance, sponge, body surface, SCC*mec* typing

Purpose

Specific Aim 1: Define methicillin-resistant *Staphylococcus aureus* (MRSA) colonization patterns among patients in an acute care hospital and investigate the sensitivity of a sponge-based screening method.

Specific Aim 2: Identify the difference in colonization patterns of community-associated (CA-MRSA) and healthcare-associated (HA-MRSA) strains by determining the genotypes of the strains colonizing various anatomic sites.

Scope

Background and context: Early detection of carriers of methicillin-resistant *Staphylococcus aureus* (MRSA) among hospitalized patients is crucial in preventing further spread of this organism. The standard method for identifying MRSA carriers is a swab culture of the nostrils. In addition to the nostrils, MRSA frequently colonizes the skin and directly causes skin and soft tissue infections, including surgical site infections. The addition of a second screening method has been shown to improve the sensitivity of detecting MRSA carriage. The use of sponge in lieu of swab enables sampling of a large skin area and generally improves the detection sensitivity of a skin-colonizing pathogen. The study hypothesis was that the use of sponge to collect MRSA on the skin would significantly improve the sensitivity of MRSA detection.

Settings and participants: The study was conducted at a single acute care hospital in Pittsburgh, Pennsylvania. Inpatients with a clinical culture specimen that grew MRSA within the previous 10 days were eligible to participate. Informed consent was obtained from and documented for each subject. The study was approved by the Institutional Review Board of the University of Pittsburgh (PRO10060148).

Methods

Study design: This was a single-center, cross-sectional study that compared the sensitivities of MRSA detection for swab and sponge specimens among inpatients who were known to be infected or colonized with this organism.

Data sources/collection: The demographic and clinical data of the subjects were extracted from the hospital electronic medical record system and entered into an Access database.

The microbiology data generated in the study laboratory were entered into an Excel database. The two sets of data were merged and analyzed using the SAS software.

Interventions: Study specimens were collected from the subjects once. The subjects underwent collection of screening specimens, three using sponge (Polywipe) and five using nylon swabs. The specimens were cultured on MRSA screening plates to determine positivity. The type of MRSA (CA vs HA) was determined by molecular methods (PCR and sequencing, as appropriate). The results from the study did not affect the clinical care of the subjects, because they had already been known to be infected or colonized with MRSA.

Measures: Sensitivities of each screening method in detecting MRSA colonization were calculated. Composite sensitivities were also calculated, as appropriate.

Limitations: This was a single-center study. Only inpatients with known MRSA infection or colonization were enrolled; thus, specificities and predictive values of each screening method could not be calculated.

Results

Principal findings: In total, 109 subjects were enrolled. Of the 109 subjects, four subjects were excluded for not meeting inclusion criteria or having a positive control specimen. Among 105 subjects for whom the data could be analyzed, 51 (51.4%) were men and 93 (88.7%) were White. The mean age was 51.7 years (range, 20 to 78 years). Fifty-nine (56.2%) were in surgical units and 46 (43.8%) were in medical units. The sources of the positive clinical culture were as follows: n=14 abscess (13.3%), 21 blood (20.0%), 11 bronchoalveolar lavarge/bronchial washing (10.5%), 5 drainage (4.8%), 13 sputum (12.4%), 5 urine (4.8%), 33 wound (31.4%), and 4 others (3.8%). Of the 105 subjects, the sensitivities for MRSA colonization were as follows: forehead by sponge, 23.8%; axilla by sponge, 14.3%; groin by sponge, 15.2%; nostrils by swab, 28.6%; buccal mucosa by swab, 29.5%; forehead by swab, 7.6%; axilla by swab, 6.7%; and groin by swab, 11.4%. Among the 105 subjects, 59 (56.2%) were positive in any specimen (swab or sponge). Within this group, the sensitivity of nostril swab, the current standard of care, was 50.9%. In comparison, the composite sensitivities of nostril plus another site were as follows: buccal mucosa by swab, 72.9% ($p = 0.0003$); forehead by sponge, 64.4% ($p = 0.005$); axilla by sponge, 66.1% ($p = 0.003$), groin by sponge, 66.1% ($p = 0.003$); any of the three sponge sites, 86.4% ($p < 0.0001$).

There was no statistically significant difference between prior receipt of anti-MRSA agents and the positivity of the study specimens.

Of the 59 patients, 34 had MRSA with SCC*mec* type II (commonly found in healthcare-associated infections) and 21 had MRSA with SCC*mec* type IV (commonly found in community-associated infections). Two subjects had both MRSA with type II and type IV, and two subjects had MRSA that was non-typeable. When comparing the distribution of type II and type IV isolates, there was a trend toward higher frequency of colonization in the buccal mucosa for type II isolates over type IV isolates (58.8% vs 38.1%; $p = 0.17$), but no differences were observed for the remaining study specimens.

Discussion: The study yielded several salient findings. First, the data confirmed the less-than-optimal sensitivity of nasal swab culture in detecting MRSA carriage (50.9%), even using subjects with any positive screening specimen as the denominator. Of all subjects with recent MRSA infection, only 28.6% had a positive nasal swab culture despite the inclusion of a broth enrichment process. In the actual clinical setting, when nasal swabs are inoculated directly onto a selective agar, the sensitivity is likely to be even lower. This raises concerns about the effectiveness of this active screening approach. Second, screening of skin colonization with sponge, which in practice could be performed by using one sponge with serial sampling of the forehead, axilla, and groin, yielded higher sensitivity in detecting MRSA colonization than did the nasal swab. However, the sensitivity achieved by sampling of the skin with sponge (64.4%) did not appear sufficient to be used as the sole method in the screening of MRSA colonization. Third, the best sensitivities were achieved by combining the nasal swab with a second method: sampling of the skin with a sponge (86.4%) or sampling of the pharynx with a swab (72.9%).

The screening isolates mostly had SCC*mec* type II or type IV. MRSA with SCC*mec* type IV primarily is reported in patients with community-associated infections that often present as skin and soft tissue infections. However, the study did not find distinct patterns of colonization between subjects with SCC*mec* type II isolates and type IV isolates. This may be due to the fact that, even for those with SCC*mec* type IV isolates, the study specimens were collected well into their hospitalizations.

Conclusion and implication: Sensitivity of nasal swab culture for screening of MRSA carriage was low, but it could be improved significantly by adding a second method of sampling either the skin or the pharynx.

This approach would require more resources, but the resources may be justified and beneficial in reducing transmission in settings with moderate rates of MRSA infection.

List of publications and products

Publication: Lee CS, Montalmont B, O'Hara JA, Syed A, Chaussard C, McGaha TL, Pakstis DL, Lee JH, Shutt KA, Doi Y. Screening of methicillin-resistant *Staphylococcus aureus* colonization using sponge. 2014. *Infection Control and Hospital Epidemiology*; in press.

Products: Not applicable

Final Invention Report for R03 HS21521-02

There are no inventions that have been filed in association with the grant.