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Major article

Duration of colonization with methicillin-resistant *Staphylococcus aureus* in an acute care facility: A study to assess epidemiologic features

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Key Word:
Colonization interval

Background: Patients with a history of methicillin-resistant *Staphylococcus aureus* (MRSA) colonization or infection are often presumed to remain colonized when they are readmitted to the hospital. This assumption underlies the hospital practice that flags MRSA-positive patients so that these patients can be placed in contact isolation at hospital admission and, when necessary, be given the appropriate empirical therapy and/or antibiotic prophylaxis.

Methods: To determine the duration of and factors associated with MRSA colonization among patients following discharge, we designed a cohort study of patients hospitalized between October 1, 2007, and July 31, 2009, at the Atlanta Veterans Affairs Medical Center, a 128-bed acute care facility. We defined 3 cohorts: cohort A; patients with both a MRSA infection during hospitalization and nasal colonization at discharge; cohort B; patients with a MRSA infection but no nasal colonization at discharge; and cohort C; patients only nasally colonized at discharge. We collected information on demographic characteristics, underlying conditions, infections, and antibiotic use. We cultured nasal swabs obtained from patients at home. We calculated hazard ratios (HR), comparing cohorts A, B, and C after controlling for other factors.

Results: We obtained 231 swabs (23 in cohort A, 34 in cohort B, and 174 in cohort C). We documented MRSA colonization in 92 (39.9%) of the 231 patients who returned swabs. The median duration of colonization was 33.3 months. Factors significantly associated with persistent MRSA colonization were (1) total duration of hospital stay from previous admissions prior to study entry and (2) a member of cohort A who had a longer duration of colonization compared with cohorts B and C ($P < .001$).

Conclusion: Our data suggest that higher initial inocula of bacteria may be an important determinant of persistent colonization with MRSA.

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Patients with a history of methicillin-resistant *Staphylococcus aureus* (MRSA) colonization or infection are often presumed to remain colonized when they are readmitted to the hospital, usually defined as within 6 months after a previous hospitalization. This assumption underlies the hospital practice that flags MRSA-positive patients so that these patients can be placed in contact isolation at hospital admission and, when necessary, be given the appropriate empirical therapy and/or antibiotic prophylaxis.[1] However, the duration of MRSA colonization in patients who have had MRSA infections compared with those who are simply colonized is unclear.[2] The few available studies of the duration of MRSA carriage after hospital discharge have produced varying results in estimating the duration of MRSA colonization, ranging from a median of 5 months to 48 months or longer.[1-4] A recent study suggested that nearly half of all MRSA-colonized patients remain colonized at 1 year; 21% remain colonized at 4 years.[5] Some of the colonized patients in this study received systemic or topical

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antimicrobial agents active against MRSA as part of their therapeutic or decolonization regimen that could have led to underestimates of the duration of colonization. If factors associated with prolonged MRSA colonization could be determined, screening could be targeted and made more efficient.

The Veterans Health Administration issued a MRSA directive in January 2007 to reduce health care-associated MRSA infections in acute care facilities. The directive focuses on limiting MRSA transmission within the Veterans Affairs (VA) hospitals using active surveillance through nasal screening, implementation of contact isolation precautions for those found to be positive on admission, and hand hygiene measures.

The overall objective of this study was to determine the duration of and risk factors associated with MRSA colonization among patients discharged from the Atlanta VA Medical Center (VAMC) from October 1, 2007, through October 31, 2009, following either MRSA infection during preceding hospitalization or with MRSA colonization. We also attempted to determine whether initial characterization of MRSA as either infection or colonization was a determinant of the duration of colonization.

METHODS

Background

The Atlanta VAMC is a 128-bed, acute care facility with approximately 500 admissions per month located in Decatur, Georgia. After the MRSA directive was instituted at the Atlanta VAMC on October 1, 2007, we conducted prospective surveillance of all true infections. This MRSA infection surveillance was performed by one of the coauthors (D.R.), who followed up on any clinical culture with MRSA to determine infection status using Centers for Disease Control and Prevention definitions of infection,[6] regardless of whether the infection was hospital acquired or not. Under this directive, a nasal swab was obtained on initial arrival or transfer to the ward or intensive care unit for each admission. The swab was then sent to the microbiology laboratory for analysis using the BD GeneOhm MRSA real-time PCR system (BD Diagnostics, Sparks, MD), demonstrated to have a high sensitivity and specificity in clinical validation studies. If positive, the patient was placed in contact isolation precautions either in a private room or in a room with other MRSA-positive patients. On discharge from the hospital, a nasal swab was obtained and cultured on CHROMagar MRSA agar assay (BD Diagnostics).

Patients and study design

We conducted an Institutional Review Board-approved cohort study by using electronic medical record review of patients hospitalized between October 1, 2007, and July 31, 2009, who had a positive MRSA discharge culture. A hospitalized patient was defined as an individual who was admitted to and remained in the Atlanta VAMC for at least 24 hours. We also included patients who were admitted with a documented MRSA infection during at least 1 hospitalization in that period, regardless of their MRSA colonization status. Therefore, our initial study population included patients with only MRSA colonization of their nares documented in at least 1 discharge record, only MRSA infection during the preceding hospitalization, or both infection and nasal colonization. We used the first microbiology laboratory-confirmed MRSA infection or nasal colonization at discharge to determine the patients' infection and colonization status. MRSA infection was defined as a positive microbiologic culture in a resident with clinical signs, symptoms, or treatment for infection. MRSA colonization was defined as a positive microbiologic culture from a nasal swab in a resident without clinical evidence of infection, in accordance with the Centers for Disease Control and Prevention MRSA surveillance criteria.[5] Patients admitted to the psychiatric ward at the Atlanta VAMC were excluded from this study. Follow-up began on the day of discharge from the hospital, and every patient was followed until July 31, 2011, or until their death, whichever occurred earlier. Unless death occurred, all patients had at least 18 months of follow-up.

Patient identifiers were collected on a master list maintained on a secure server with restricted access. Before the data collection process began, we assigned each patient a unique study identification number to protect their privacy. Based on laboratory information extracted from patients' existing medical records, we defined 3 mutually exclusive comparison cohorts:

- Cohort A: patients who had both a MRSA infection and nasal colonization at discharge;
- Cohort B: patients who had a MRSA infection but no nasal colonization at discharge; and
- Cohort C: patients who did not have a MRSA infection but had nasal colonization at discharge.

Information including demographic characteristics, underlying conditions, functional status, previous and current infections, and antibiotic use from patients in cohorts A, B, and C was collected and entered into an electronic database. Demographic information included age ($<$60, 60-69, 70-79, or $\geq$ 80 years), race/ethnicity, sex, location at admission to the Atlanta VAMC (home, nursing home, or some other hospital), number of previous admissions within the past 8 years ($\geq$3, 2, 1, or none), and hospitalization within 6 months of study inclusion. We recorded information regarding presence of any admission wounds and diagnosis of MRSA bloodstream infection during hospitalization. We obtained history of any type of cancer, coronary artery disease, chronic obstructive pulmonary disease, diabetes mellitus, HIV infection, hemodialysis, and stroke by medical record review. We also collected data on the presence of any medical devices at discharge (gastrostomy tube, urinary catheter, peripherally inserted central catheter line, intravenous line, or tunneled catheter), surgical wounds at discharge, and number of antibiotics prescribed at discharge. Information pertaining to the patients' social history included current and past intravenous drug abuse, homelessness within 3 months of study inclusion, and incarceration within 3 months of study inclusion.

MRSA determination

We obtained a single nasal swab from patients at home and included information on the method to culture the nose. The nasal swabs were returned by priority mail or during regular clinical visits upon return to the VA Hospital. Patients were familiar with the procedure because of initial swab during admission (per the 2007 directive). Patients were also informed of the in-home swab at discharge and were given instructions for the procedure by the project officer. Small financial incentives ($5 vouchers) were offered to patients. If patients did not return swabs within 1 week, they were contacted a second time by mail. Returned swabs were cultured on CHROMagar MRSA agar assay (BD Diagnostics).

Statistical analysis

Statistical analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC). Descriptive frequencies and χ^2 tests were performed to examine any significant differences in demographic and other factors between those who were MRSA positive and MRSA negative at follow-up. For categorical variables, we calculated crude odds ratios and 90% confidence intervals. We included