

Contrasting Methicillin-Resistant *Staphylococcus aureus* Colonization in Veterans Affairs and Community Nursing Homes

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PURPOSE: To compare the prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) nares colonization, the patterns of MRSA acquisition, and the risk for subsequent MRSA infection between a hospital-based, Department of Veterans Affairs (VA) nursing home care unit (NHCU) and community-based nursing homes.

PATIENTS AND METHODS: In this prospective study, 148 residents of three community nursing homes and 55 residents of a VA NHCU had their anterior nares swabbed; repeat cultures were obtained from hospitalized patients and/or individuals colonized with MRSA. Subjects were followed up prospectively for 1 year to note hospitalizations and the development of MRSA infections.

RESULTS: The prevalence of MRSA colonization was significantly higher in the VA NHCU than in the community nursing homes (mean \pm SD 30.3% \pm 11% versus 9.9% \pm 4%). The rate of MRSA nares colonization was similar in the two settings. Acquisition of MRSA took place in both the long-term care facilities and hospitals, with 23.8% of incident cases occurring during a hospitalization. Only 3 of the 27 individuals colonized at baseline developed an MRSA infection. A trend toward an increased rate of infection was seen in colonized individuals residing in the community nursing homes versus those in the VA NHCU (relative risk 4.67; 95% CI 0.55 to 39.9). Forty-seven percent of the 55 subjects hospitalized were colonized at some point during the study. In contrast to residents of the VA NHCU, MRSA colonization in the community facilities was a marker for high mortality.

CONCLUSIONS: Outcomes from colonization may be different in the VA NHCU population and the community nursing home population.

Over the past 20 years, nursing homes have been recognized as potential reservoirs of methicillin-resistant *Staphylococcus aureus* (MRSA).¹⁻³ Early isolates of MRSA in the United States came from nursing home residents.⁴ Nursing home epidemics have been described,⁵ and hospital-based outbreaks have identified nursing home residents as index cases.⁶ Unfortunately, there is little information from long-term care facilities about the prevalence of MRSA colonization or the risk of subsequent infection in MRSA-colonized residents to guide infection-control policies in these settings. This lack of information has led to contradictory infection-control policies ranging from attempts to exclude MRSA-colonized individuals from long-term care facilities to practices that ignore the phenomenon of MRSA colonization altogether.⁷

More recently, several authors have reported their experience with MRSA in long-term care units managed by the Department of Veterans Affairs (VA). These studies⁸⁻¹⁰ have documented high endemic rates of MRSA colonization, ranging between 15% and 34%, despite great geographic differences. Results have been applicable to long-term care systems managed by the VA, but the generalizability of this information to the vast majority of nursing homes has been questioned.^{1,11} The experience of MRSA in community-based long-term care facilities has been less well studied. Thomas et al³ documented prevalence rates of MRSA colonization at 6.0% to 7.3% in a Los Angeles community nursing home, and Hsu¹² found prolonged colonization and a stable prevalence rate of about 9% in an urban facility. Neither study attempted to quantify the risk of MRSA infection in the colonized individuals.

We undertook a 1-year, prospective, cohort study in 4 long-term care facilities (1 VA and 3 community based) to contrast the prevalence of MRSA colonization, patterns of MRSA acquisition, and the risk of infection between residents of the VA facility and the residents of the community nursing homes. The results are intended to help infection-control practitioners and clinicians understand whether VA-based studies on MRSA colonization can be used to manage the spread and movement of MRSA in their communities.

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METHODS

Location

The study was conducted in four long-term care facilities located in Durham, North Carolina. One facility was a hospital-based, VA-managed, 120-bed nursing home care unit (NHCU) that is physically attached to a VA hospital. At the study's inception, the unit housed 58 residents. About one half of the residents were long-term boarders. The other half were receiving treatment for chronic illness, undergoing respite care, or receiving long-term rehabilitation. All residents were admitted from the VA hospital or from surrounding communities. Medical care was provided by VA staff physicians and internal medicine housestaff. The residents were admitted exclusively to the attached VA hospital when they needed hospital services.

The other three facilities were community-based, for-profit, nursing homes owned by a corporation that manages long-term care facilities throughout the United States. All three homes were freestanding buildings, and were separate from any hospital facility. Each nursing home had approximately 125 beds, was licensed in the state of North Carolina, and operated at full capacity throughout the study. All of the community facilities had formal rehabilitation services, but the majority of the residents and all of the study participants in the community facilities were long-term boarders. Residents were admitted from either the community or one of three local hospitals: a tertiary medical center, a community hospital, or the VA hospital. Medical care in these facilities was provided by community physicians. Hospitalizations took place at all three of the previously noted hospitals.

Patient Selection

After residents with active MRSA infections were excluded, the remaining individuals ($n = 421$) residing in the study facilities from December 17, 1991 through January 22, 1992, were eligible for study. The study was described to potential subjects to obtain informed consent. The families of competent, consenting individuals were notified of the subject's intention to participate in the study. For patients unable to comprehend the basic study information, consent forms and a letter describing the study were mailed to their families or guardians, who were later contacted by telephone to solicit proxy consent. The consent process and study design were approved by the Duke University Institutional Review Board, the Durham VA Medical Center Institutional Review Board, and the Durham Regional Hospital Ethics Committee.

Procedure

Consenting residents had their anterior nares swabbed once during the recruitment period. Nares cultures alone were chosen to determine coloniza-

tion status because the technique was minimally intrusive to potential subjects and maximally acceptable to the participating nursing homes. Subjects were followed up prospectively for 1 year to note hospitalizations and the development of MRSA infections. Hospitalizations were identified by a daily phone call to each facility's administrative office. Repeat cultures of the anterior nares were performed within 24 to 48 hours of hospital admission and upon return to any of the participating long-term care facilities. Serial anterior nares cultures were performed every 3 months on subjects identified as colonized with MRSA during any point of the study. Although we recognized that this approach to serial cultures would be insensitive to short-term, transient colonization, we were primarily interested in the risk of infection occurring in long-term care residents experiencing prolonged colonization. Subjects discharged home or to another long-term care facility had their anterior nares cultured in the 24 hours prior to their final discharge. All subjects who continued to reside in the study facilities had follow-up anterior nares cultures after 1 year.

Culture Technique

All anterior nares cultures were obtained using two sterile, rayon-tipped swabs stored in a sterile transport system with 1 mL of modified Stuart's bacterial transport medium (Culturette II, Becton Dickinson Microbiology Systems, Cockeysville, Maryland). The swabs were streaked on an in-house prepared mannitol-salt agar plate and incubated in ambient air at 35°C for 48 hours. Yellow- and pink-pigmented colonies with a yellow halo were then subcultured to 5% sheep blood agar plates for subsequent testing with staphaurex latex reagent (Murex Diagnostics, Dartford, England). Staphaurex-positive colonies were Gram's stained and tested for both catalase and free coagulase activity using rabbit plasma with ethylenediaminetetraacetic acid (Becton Dickinson Microbiology Systems). Isolates identified as *S aureus* (catalase and coagulase positive gram-positive cocci) were then tested for methicillin-resistance on Mueller-Hinton agar containing 4% sodium chloride (NaCl) and 6 µg/mL oxacillin (Becton Dickinson Microbiology Systems). *S aureus* strains resistant to methicillin were designated MRSA, whereas *S aureus* strains susceptible to methicillin were designated MSSA. All bacteriologic studies were performed at the Duke University Medical Center Clinical Microbiology Laboratory.

Measurements

MRSA infections, identified by chart review of the hospitalized subjects, were defined when all of the

following criteria were present: evidence of inflammation, the presence of MRSA in cultures from the site of inflammation, and treatment of an MRSA infection by the personal physician. The bacteriologic studies used to diagnose MRSA infections were performed by the microbiology laboratories at the admitting hospitals.

Demographic information and potential risk factors for the outcomes of interest were identified by a baseline, blinded review of the nursing home records. Functional status measures were abstracted from the most recent Minimum Data Set, the Patient Assessment Instrument, and/or nursing notes. A modified Resource Utilization Groups-II (RUGS-II) ADL Index score was derived using self-performance and current support scores in transfers, toileting, and eating (Schneider D, personal communication, 1992). The RUGS-II ADL Index score ranges from 3 to 10, with 3 being the least dependent and 10 being the most dependent.¹³ Demographic information for non-participants was provided by the administrative staff of each facility.

Itemized hospital charges were obtained from the business offices of each non-VA hospital and were used to derive charges for total hospitalization and antibiotics (not including administration or monitoring charges). VA costs were estimated from the VA cost-distribution report for the 1991 fiscal year. This report represents the average daily costs for hospitalization within a bed section in the VA Medical Center. VA drug costs were derived from VA unit dose price lists and equivalent unit dose charges from the community hospital.

Statistical Analysis

Differences between participants and nonparticipants in the study facilities were assessed first. Comparisons were then made between VA NHCU residents and community nursing home residents. Groups were compared using Student's *t*-tests (for continuous variables), chi-square analysis (for categorical variables), and nonparametric techniques when the assumption of normality was violated. A Kaplan-Meier product-limit estimator was used to estimate the duration of colonization. Incidence rates were compared using exact tests based on the binomial distribution. One-sided tests were used to assess the associations between MRSA colonization and the rates of death or infection. All other tests were two-sided.

To control for differences in follow-up, average incidence rates were calculated per patient-year of follow-up. The patient-year calculations depended on the outcome of interest. Onset of infection was estimated by the date of hospital admission for an MRSA infection. If a subject experienced more than one MRSA infection, only the first was used in the calcu-

lation of infection rates. Onset of colonization was estimated by the date halfway between the last negative nares culture and the first positive culture. Non-colonized patient-time for subjects who died or were discharged was derived by subtracting the date of inception from the date halfway between the last negative culture and the date of death or discharge. The subjects not colonized at baseline who were discharged or died without any follow-up nares cultures (37 for MRSA; 40 for MSSA) were excluded from analyses estimating the acquisition rates, but included in analyses estimating the rates of death or infection.

Univariate analyses and stepwise logistic regression were used to test for associations between predetermined potential risk factors and MRSA colonization. The variables of interest were age, sex, urinary incontinence, fecal incontinence, presence of a pressure sore, functional status, presence of a feeding tube, presence of an indwelling urinary catheter, and chronic antibiotic suppression. Hospitalization and antibiotic use in the 6 months prior to the study onset were also evaluated for an association with baseline MRSA colonization. Hospitalization during the study period was evaluated for an association with the acquisition of MRSA. Variables having univariate associations with a *P* value ≤ 0.1 were considered for further analysis using logistic regression models. In all analyses, differences were considered statistically significant at the *P* = 0.05 level.

RESULTS

Recruitment

Consent was obtained for participation from 221 of the 421 (52%) potential subjects. Of the remaining 200 individuals, 24 refused to participate and 17 had family members refuse. The largest group of the nonparticipants (*n* = 159) were people whose families or guardians did not respond to efforts to obtain proxy consent. Eighteen of the 221 individuals initially consented but were subsequently excluded when they were transferred or discharged prior to the baseline culture survey. This left 203 participants; 55 in the VA and 148 in the community nursing homes. When stratified by the site of residency, the participants and nonparticipants were similar in terms of their age, race, sex, payment source (Medicaid versus non-Medicaid), and nursing home length of stay).

Subjects

There were no significant differences in age, race, sex, functional status, or percent participating among subjects from each of the community nursing homes. Participants in the VA nursing home care unit were significantly younger, more functional, less likely to be female, less likely to have a dementia syndrome, and less likely to experience bowel or bladder incontinence

than those in the community nursing homes. However, they did not differ significantly in race, frequency of chronic antibiotic suppression, nor the rate of hospitalizations during the study period (Table I).

Prevalence of *Staphylococcus aureus* Colonization

The prevalence rates of MRSA and MSSA colonization in the three community nursing homes were similar. The baseline rates of MRSA colonization in each of the community facilities were 3.4% in facility 1, 11.0% in facility 2, and 10.6% in facility 3. Baseline rates of MSSA colonization were 19.0% in facility 1, 11.0% in facility 2, and 10.6% in facility 3. At closeout, the rates of MRSA colonization in the community nursing homes were 10.3% in facility 1, 17.7% in facility 2, and 8.0% in facility 3. Closeout MSSA colonization rates were 20.0% in facility 1, 32.4% in facility 2, and 32.0% in facility 3. These colonization rates did not differ significantly among the three facilities (Fisher's exact test; $P > 0.1$). Because of these similarities, all subsequent analyses cluster together results from the non-VA facilities and compare them with the results found in the VA facility.

At baseline, the prevalence of nares colonization with MRSA in the VA NHCU exceeded three times the prevalence seen in the community nursing homes (27.3% versus 8.1%; $P < 0.001$)—a difference that persisted at closeout (33.3% versus 11.7%; $P = 0.012$). The proportion with at least one anterior nares culture positive for MRSA at any point during the study was twice as high in the VA NHCU as it was in the community nursing homes (38.0% versus 18.2%; $P = 0.003$). There were no differences in the prevalence of colonization with all *Staphylococcus aureus* strains (MRSA + MSSA) at baseline (VA 40.0% versus community 33.1%; $P = 0.36$) or at closeout (VA 44.4% versus community 39.4%; $P = 0.64$), (Table II).

MRSA Colonization

Predictors (Table III). When the primary site of residence (VA versus community) was controlled for,

TABLE I

Variable	Study Population		P Value
	VA (n = 55)	Community (n = 148)	
Mean age (y)	68.7 ± 13.2	78.7 ± 9.8	<0.001
Sex (% female)	5.5	71.6	<0.001
Race (% black)	40.0	29.7	0.165
Mean functional status (RUGS-II ADL Index*)	4.2 ± 1.9	6.4 ± 2.4	<0.001
Dementia (%)	43.6	67.6	0.002
Feeding tube (%)	9.1	10.8	0.721
Fecal incontinence (%)	14.5	49.3	<0.001
Urinary incontinence (%)	21.8	56.1	<0.001
Indwelling bladder catheter (%)	3.6	12.8	0.056
Chronic antibiotic suppression (%)	9.1	8.8	0.945
Mean LOS (d)	219 ± 237.5	1022.9 ± 1068	<0.001
Hospitalizations (per 1,000 days)	1.51	1.43	0.58
Pressure sores (%)	5.5	10.8	0.244

Mean values are reported ± standard deviation.

*The Resource Utilization Groups-II (RUGS-II) ADL Index score ranges from 3 to 10, with 3 being the least dependent and 10 being the most dependent.¹³

VA = Department of Veterans Affairs nursing home care unit; LOS = length of stay.

TABLE II

Staphylococcus aureus Colonization by Residence

Variable	VA NHCU		Community Nursing Homes	
	MRSA	MSSA	MRSA	MSSA
Baseline point prevalence (%)	27.3	12.7	8.1*	25.0
Follow-up point prevalence (%)	33.3	11.1	11.7†	27.7

Sample sizes: baseline: VA, n = 55; community, n = 148; follow-up: VA, n = 27; community, n = 94.

* $P < 0.001$ versus VA NHCU MRSA rate.

† $P = 0.012$ versus VA NHCU MRSA rate.

MRSA = methicillin-resistant *Staphylococcus aureus*; MSSA = *S aureus* strains susceptible to methicillin; VA NHCU = Department of Veterans Affairs nursing home care unit.

several other factors remained associated with baseline MRSA colonization: the presence of a pressure sore, fecal incontinence, and hospitalization during the 6 months prior to the study's onset. Factors not associated with baseline MRSA colonization were urinary incontinence, the presence of feeding tubes, chronic antibiotic suppression, sex, and functional status. Exposure to an antibiotic in the 6 months prior to the study onset was associated with MRSA colonization on univariate analysis, but was not significantly associated with colonization after controlling for other variables.

During the study, 6 incident cases of MRSA colonization occurred in the VA NHCU (incidence rate 0.325 per patient year), while 15 noncolonized residents in the community nursing home became colonized with MRSA (incidence rate 0.159 per patient year; relative risk VA versus community = 2.0; 95% CI 0.91 to 4.57). This difference was not statistically significant. Five (2 VA versus 3 commu-

TABLE III
Predictors of MRSA Colonization (Logistic Regression Model*)

Variable	Odds Ratio	95% Confidence Interval	P Value
Baseline			
Community nursing home resident	0.14	(0.04; 0.44)	<0.001
Pressure sore	6.09	(1.77; 20.94)	0.004
Fecal incontinence	4.16	(1.34; 12.98)	0.014
Hospitalization in previous 6 months	3.11	(1.16; 8.40)	0.025
Acquisition			
Community nursing home resident	0.74	(0.24; 2.33)	0.61
Hospitalization during study	6.17	(2.21; 17.21)	<0.001
Indwelling urinary catheter	6.80	(2.05; 22.52)	0.002

*Controlled for primary site of residence (Department of Veterans Affairs nursing home care unit versus community nursing homes).
MRSA = methicillin-resistant *Staphylococcus aureus*.

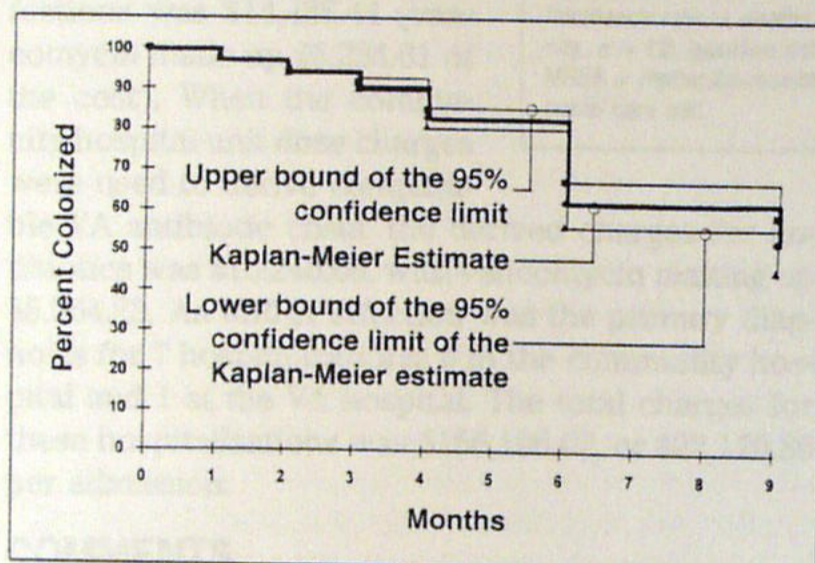


Figure. Kaplan-Meier estimate of the duration of methicillin-resistant *Staphylococcus aureus* colonization (primary patient residence either Department of Veterans Affairs nursing home care unit or community nursing homes) with 95% confidence bands (n = 47).

nity) of the incident cases (23.8%) were acquired during a hospitalization.

Only two of the factors studied by univariate analysis were significantly associated with the acquisition of MRSA colonization. These were hospitalization during the study period and the presence of an indwelling urinary catheter. Variables not associated with the acquisition of MRSA colonization included age, sex, the presence of feeding tubes, urinary incontinence, fecal incontinence, functional status, and chronic antibiotic suppression.

Duration. Twenty-three of the 47 subjects colonized with MRSA (incident + prevalent) had follow-up cultures performed 3 months after the first positive culture. Colonization lasting longer than 3 months was found in 96% ± 4.1%. Thirteen of the colonized individuals were followed up for 1 year, 7 of whom (54%) remained colonized for the duration of the study (Figure).

Hospitalization. There were 55 individuals hospitalized during the study for a total of 81 hospitalizations. Nares cultures were obtained for all but 2 of the admissions. Admission nares cultures were positive

for MRSA in 33% (6/18) and 33% (20/61) of the hospital admissions from the VA NHCU and the community nursing homes, respectively. At some point during the study period, 47% ± 6.7% of the hospitalized subjects were colonized or infected with MRSA (10/15 from the VA NHCU and 16/40 from the community nursing homes).

Mortality. As expected in this population, there was a high rate of death resulting from a number of causes. During the study, 28.6% (58/203) of the original cohort

died while residing in the study facilities. There was a significant difference between the VA NHCU and the community nursing homes in the proportion of subjects dying (14.5% VA and 33.7% community; $P < 0.01$). Community nursing home residents colonized with MRSA at baseline had a rate of death from comorbid disease unrelated to MRSA infection that was 3.5 times that seen in the noncolonized residents (95% CI 2.5 to 5.2) (Table IV). This association between MRSA colonization and comorbidity deaths was not seen in residents of the VA NHCU (relative risk-colonized versus noncolonized = 0.84; 95% CI 0.19 to 3.68) or in residents colonized with MSSA (results not shown).

MRSA Infections

Seven individuals experienced MRSA infections during the year of study. One individual experienced 2 separate infections. Two cases of MRSA urinary tract infections and 1 MRSA pneumonia were diagnosed and treated, but were associated with other organisms of potential causation and could not be unequivocally implicated as MRSA infections. The remaining 5 infections unequivocally resulted from MRSA. There were 3 cases of MRSA bacteremia/sepsis, 1 postoperative MRSA osteomyelitis, and 1 postoperative MRSA soft-tissue infection. No subjects were hospitalized with infections caused by MSSA.

Risk. The rate of MRSA infection in those colonized at baseline was 6.4 times higher than those not colonized (95% CI 2.3 to 18.0). Three of the 27 individuals colonized at baseline were diagnosed with and treated for MRSA infections. We were unable to detect any statistically significant increase in the rate of MRSA infection associated with baseline MRSA colonization in residents of the VA NHCU (relative risk colonized versus noncolonized 2.1; 95% CI 0.14 to 30.3), but baseline colonized residents in the community nursing homes experienced a rate of infection that was 15 times that seen in noncolonized residents (95% CI 3.3 to 73.3). The

rate of infection in those colonized at baseline was higher in the community than in the VA (relative risk community versus VA 4.7; 95% CI 0.55 to 39.9), but this was not statistically significant (Table IV).

Cost. The 7 individuals who developed MRSA infections were hospitalized 11 times for the treatment of their MRSA infections. The total charge for these hospitalizations was \$319,915.53. The total charge for antibiotics to treat the infections was \$14,488.44 (vancomycin made up \$5,234.61 of the cost). When the community hospital unit dose charges were used to derive comparable VA antibiotic costs, the derived charges for antibiotics was \$16,240.06, with vancomycin making up \$5,964.23. An MRSA infection was the primary diagnosis for 7 hospitalizations; 6 in the community hospital and 1 at the VA hospital. The total charges for these hospitalizations was \$155,196.02, or \$22,170.86 per admission.

COMMENTS

Our study contrasts MRSA colonization and infection in a VA long-term care facility and community nursing homes in a single geographic area. We found significant differences in the epidemiology of MRSA between the two settings. The prevalence of MRSA in the VA NHCU was three times that seen in the community homes, despite similar rates of acquisition and similar rates of colonization with all *S aureus* strains (MRSA + MSSA). Although the total number of MRSA infections was small, the rate of MRSA infection among those subjects colonized at baseline was six times that seen in those not colonized with MRSA at baseline. The difference in the rate of subsequent infection among residents in the VA NHCU and the community nursing homes was not statistically significant, but there was a trend toward increased infections in colonized subjects residing in the community nursing homes. The different rates of colonization and infection seen in the two settings may reflect how confounding risk factors are distributed between the two populations, but emphasize the need to consider these differences in clinical decisions to institute control measures.

Our analysis of risk factors suggests that hospital admission is an important marker for MRSA colonization in the long-term care setting. Over 40% of the subjects hospitalized from both the VA and the community were

colonized with MRSA at some point during the study, the rates of colonization at hospital admission were high, and prior hospitalization was associated with baseline colonization. Fecal incontinence, pressure sores, and the presence of an in-dwelling bladder catheter were also associated with MRSA colonization.

The occurrence of MRSA infection appeared to have a significant impact on the overall health of the cohort. An MRSA infection was treated in 11 of the 81 hospitalizations, and hospitalizations where an MRSA infection was the primary diagnosis accounted for at least \$150,000 in hospital charges. Two infections contributed to the death of the infected individuals, but 1 of these patients also had a concomitant terminal illness (AIDS). MRSA colonization at baseline was predictive of subsequent diagnosis and treatment of an MRSA infection, but this relationship did not reach statistical significance in the VA NHCU.

Previous studies of MRSA colonization in long-term care settings have not directly compared residents of VA NHCUs and residents of community nursing homes. They have, however, documented prevalence rates and risks of infection similar to those seen in our study. Strausbaugh et al⁹ found a prevalence of 34% in their study of a VA NHCU. Bradley et al¹⁰ studied a VA NHCU and documented a 39% prevalence of MRSA colonization and an annual infection rate of 6% among the patients known to be colonized. Muder et al⁸ studied residents in a VA long-term care unit and found the risk of staphylococcal infection in MRSA-colonized subjects to be 3.6 times that seen in non-colonized subjects. Studies in community nursing homes have been restricted to settings where MRSA was felt to pose endemic or epidemic problems. Nonetheless, they have also found prevalence rates similar to those seen in our study. In Hsu's¹² study of

TABLE IV

Rate of MRSA Infection and Non-MRSA Deaths

Variable	VA NHCU	Community Nursing Homes
MRSA infection*		
Baseline colonized with MRSA (incidence rate)	1/11.3 (0.089 per patient-year)	2/4.84 (0.413 per patient-year)
Baseline not colonized with MRSA (incidence rate)	1/22.98 (0.043 per patient-year)	3/112.7 (0.026 per patient-year)
Non-MRSA deaths†		
Baseline colonized with MRSA (incidence rate)	2/11.4 (0.175 per patient-year)	8/6.2 (1.29 per patient-year)
Baseline not colonized with MRSA (incidence rate)	5/23.9 (0.209 per patient-year)	41/113.7 (0.360 per patient-year)

*Incidence rate = incident cases of MRSA infection/ patient-years not infected. Samples sizes = colonized: VA, n = 15; community, n = 12; not colonized: VA, n = 40; community, n = 136.

†Incidence rate = deaths/ patient-years alive. Sample sizes = baseline colonized: VA, n = 15; community, n = 12; baseline not colonized: VA, n = 35; community, n = 136.

MRSA = methicillin-resistant *Staphylococcus aureus*; VA NHCU = Department of Veterans Affairs nursing home care unit.

a community nursing home, the prevalence of MRSA colonization was 9%, whereas Thomas et al³ found a prevalence of about 7%.

A variety of risk factors for MRSA colonization in residents of long-term care facilities have also been identified in previous studies. These have included the following: male sex, poor functional status, urinary incontinence, pressure sores, the presence of an intravenous catheter, and the concurrent use of antibiotics.^{2,11,14} Our study found associations between MRSA colonization and some of these same predictors on univariate analysis, but they were not independent of pressure sores, fecal incontinence, hospitalizations, and the presence of an indwelling urinary catheter. The discrepancies between the risk factors identified in our study and the findings of previous authors may be due to the sites of culture (nares only versus more extensive), the cohort studied, the distribution of independent variables in the two settings (eg, few women in the VA and few men in the community), and the sample size.

Several important limitations must be considered in the interpretation of our results. First, because MRSA colonization and infections were relatively infrequent, our estimates of the risk of infection are imprecise. Second, there was a great deal of nonparticipation in the community setting. However, we could find no differences in simple demographic variables between participants and nonparticipants. Third, the study may overestimate the importance of hospitalization as a marker for MRSA colonization. Hospitalized patients were cultured more frequently and MRSA-infected individuals had to be hospitalized for treatment. This relationship between hospital admission and colonization does not imply causality, and the association may reflect underlying host factors or more exposure to other risk factors. Fourth, clinically diagnosed and treated MRSA infections were used as the outcome in this study. There were several infections where it was difficult to distinguish "true" infection with MRSA versus sites of infection where MRSA-positive cultures reflected only colonization. Lastly, we did not perform genetic typing of MRSA isolates to document the source of acquired colonization. We feel, however, that the timing of acquisition was a reasonable indicator of hospital versus long-term care facility acquisition, and the expense of genetic typing was prohibitive.

Our results do not support the practice of barring MRSA-colonized individuals from admission to nursing homes. The surveillance cultures needed to effectively enforce such a policy are probably cost prohibitive. Restricting admissions for colonized individuals denies them access to more appropriate levels of care, and the practice is ultimately flawed in its neglect of the pool of unrecognized MRSA-colonized

individuals who are already in the nursing homes. Fully 75% of the incident cases of MRSA colonization seen in our study took place in the long-term care facilities. At present, universal precautions, if conscientiously exercised by staff and patients alike, appear to be the most viable measures to control the transmission and spread of MRSA in the long-term care setting.

Targeted surveillance cultures of high-risk individuals and infection-control interventions undertaken during transfers between nursing homes and hospitals may diminish both the spread and morbidity of MRSA colonization. In both the VA and in the community, colonized individuals move back and forth between acute and long-term care with great frequency. Hospital-based isolation and surveillance of nursing home residents with pressure sores, indwelling catheters, and fecal incontinence could identify colonized individuals, allow for proper isolation measures in the hospital-setting, and help direct evaluation and treatment of infections. Improved communication of colonization status between the hospital caregivers and nursing home caregivers would allow both hospitals and nursing homes to reinforce their policies and practices for individuals who are known to be colonized. Targeted surveillance could be used to reinforce the use of universal precautions for individuals colonized with MRSA in the long-term care setting.

The impact of MRSA on the health of long-term care residents warrants thoughtful investigation and development of strategies to manage colonized individuals. Knowledge of the carrier status may help clinicians target infection control efforts, evaluate infections, and institute antibiotic therapy. Interventions that effectively eradicate colonization may also reduce the risk of infection. As attempts are made to more fully understand the impact of MRSA colonization on long-term care residents and the potential impact of infection control measures on MRSA-related illness, increased attention must also be given to non-VA long-term care facilities. These settings are distinct, the residents are dissimilar, and the cost-to-benefit ratios may vary among sites.

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