ORIGINAL INVESTIGATION

Carriage of Methicillin-Resistant *Staphylococcus aureus* in Home Care Settings

Prevalence, Duration, and Transmission to Household Members

Jean-Christophe Lucet, MD, PhD; Xavier Paoletti, PhD; Christine Demontpion, RN; Marie Degrave, RN; Dominique Vanjak, MD; Corinne Vincent, MSc; Antoine Andremont, MD, PhD; Vincent Jarlier, MD, PhD; France Mentré, MD, PhD; Marie-Hélène Nicolas-Chanoine, MD, PhD; for the Staphylococcus aureus *Résistant à la Méticilline en Hospitalisation A Domicile (SARM HAD) Study Group*

Background: Several studies have documented prolonged colonization with hospital-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) after hospital discharge. However, information is lacking about factors associated with prolonged MRSA colonization and MRSA transmission to household contacts.

Methods: From February 2003 to March 2004, adult inpatients (except obstetric patients) were screened for MRSA carriage before discharge to home health care. Bivariate and multivariate analyses were performed to evaluate rates and risk factors of MRSA carriage at discharge, MRSA clearance within 1 year, and MRSA transmission to household contacts.

Results: We identified MRSA in 191 of the 1501 patients screened before discharge to home health care (12.7%). Of the 148 patients with MRSA who were observed, 75 cleared the organism within 1 year, with an estimated median time to clearance of 282 days (95% confidence interval [CI], 233-313 days). Clearance of MRSA was associated with self-sufficiency in daily activities (hazard ratio, 0.63; 95% CI, 0.40-1.00) ($P=.049$). Of the 188 included household contacts, 36 acquired MRSA (19.1%). Factors associated with household MRSA acquisition were older age (adjusted odds ratio, 1.71 per life decade; 95% CI, 1.32-2.21) ($P=.001$) and participation in the health care of the index patient (adjusted odds ratio, 3.58; 95% CI, 1.33-9.62) ($P=.01$).

Conclusions: Hospital-acquired MRSA carriage was common at discharge to home health care and was frequently prolonged. Transmission occurred in nearly 20% of household contacts and was associated with older age and participation in health care of the index patient. Household contacts should apply infection control measures similar to those recommended in the hospital setting.

Arch Intern Med. 2009;169(15):1372-1378

Author Affiliations: Infection Control Unit (Dr Lucet), Biostatistics Department (Drs Paoletti and Mentré and Ms Vincent), and Laboratoire de Bacteriologie (Dr Andremont), Bichat-Claude Bernard Hospital, Assistance Publique–Hôpitaux de Paris (AP-HP), Paris, France; Microbiology Department (Mss Demontpion and Degrave and Dr Nicolas-Chanoine) and Infection Control Unit (Dr Vanjak), Beaujon Hospital, AP-HP, Clichy, France; Université Paris 7–Denis Diderot (Drs Andremont and Nicolas-Chanoine); and Microbiology Department, Pitié-Salpêtrière Hospital, AP-HP (Dr Jarlier), Paris.
Group Information: The SARM HAD Study Investigators are listed on page 1377.

METHICILLIN-RESISTANT *Staphylococcus aureus* (MRSA) is common in hospitals in most countries.[1] The incidence of MRSA infection is increasing, and new patterns of spread are emerging. Thus, in the last decade, community-acquired MRSA strains have caused hospital outbreaks and sometimes replaced older strains previously responsible for hospital-acquired MRSA infections.[2,3]

See Invited Commentary at end of article

Conversely, hospital-acquired MRSA strains can spread outside the health care system. Several studies have found prolonged carriage of hospital-acquired MRSA after discharge.[4,5] Patients with major health problems are increasingly discharged to home health care, which creates new opportunities for the transmission of hospital-acquired MRSA.[6,7] Anecdotal reports and a retrospective study[8] have documented transmission of hospital-acquired MRSA from discharged patients to household contacts. However, no information is available on the rate or risk factors of MRSA transmission to household contacts.[9] The objectives of the present prospective multicenter study were to determine (1) the prevalence and risk factors of hospital-acquired MRSA carriage at hospital discharge to home health care; (2) the duration of hospital-acquired MRSA carriage and the factors associated with clearance within 1 year; and (3) the rate and risk factors of MRSA transmission to household contacts.

METHODS

SETTING

The Assistance Publique–Hôpitaux de Paris (AP-HP) is a network of 47 public teaching hos-

©2009 American Medical Association. All rights reserved.

Downloaded From: http://archinte.jamanetwork.com/ on 05/22/2013

pitals in the Paris area that provides primary and tertiary care to 15 million people. The AP-HP home health care system has 16 coordinating units and 50 nurses who arrange admissions to home health care and determine home health care needs with the attending physicians. There are 25 home health care units with 210 nurses and about 6800 admissions per year (excluding obstetric patients). The mean (median) duration of home health care in 2002 was 27.3 (23.8) days.

All 16 coordinating units and 25 home health care units agreed to participate in the study. From February 2003 to March 2004, the coordinating units required MRSA screening of patients scheduled for discharge to home health care. Informed consent for MRSA screening was waived by the institutional review board because MRSA screening was considered a component of standard care and of an institutional MRSA-control program.

PATIENTS AND HOUSEHOLD CONTACTS

All patients admitted to AP-HP hospitals for longer than 48 hours and scheduled for discharge to home health care were screened for MRSA carriage within 3 days before discharge. Patients were not eligible for screening if they were younger than 18 years or were admitted to home health care for obstetric care or after outpatient evaluation or inpatient care for less than 48 hours. Screening samples consisted of a nasal swab and swabs of any chronic skin lesions.

Patients with positive MRSA findings were eligible for the study. A study physician visited the patient at home within 1 to 7 days after discharge to home health care and asked for informed consent. Exclusion criteria were consent denial and hospitalization or death before the study inclusion visit. Included patients are called *index patients* hereinafter. *Household contacts* were individuals spending at least 8 hours per day in the same home as the index patient. Their informed consent was sought during the home visit for inclusion of the index patient. The only exclusion criterion for household contacts was consent denial.

MRSA SURVEILLANCE

Carriage of MRSA by the index patients was monitored for 1 year or until the organism was cleared. Home health care nurses collected surveillance samples and recorded clinical data within the first month after hospital discharge and then once a month until discharge from home health care. Subsequently, a study nurse obtained surveillance samples every 3 months. Surveillance samples included a nasal swab and swabs of any chronic skin breaks. If surveillance cultures were negative for MRSA, a second set of surveillance samples was tested 1 week later, with negative results defining MRSA clearance and ending the study in that patient. Decontamination of MRSA carriers with mupirocin or other agents was not used.

A nasal swab was obtained from included household contacts at the same times as the surveillance samples were obtained from the index patient. No effort was made to confirm MRSA carriage in a previously negative household contact or to confirm MRSA clearance in a previously MRSA-positive household contact. Household contact surveillance was stopped if MRSA clearance occurred in the index patient or the patient left the study for another reason (death, acute-care hospitalization, or withdrawal at patient's request).

CLINICAL STUDY VARIABLES

For eligible patients, the following information was abstracted from the medical record created for home health care admission: age, sex, presence of chronic skin lesions, Karnofsky score,[10] date of hospital admission, and main diagnosis.

For included patients, the following data were recorded at the first home visit by the study physician: date of home health care admission, Karnofsky score, need for help with daily activities (eg, housework, shopping for food, and meal preparation), presence and type of chronic skin breaks, presence of invasive devices (eg, urinary devices, central or peripheral venous catheters, and gastric tubes), parenteral treatment if any, immunosuppression if any, current antibiotic treatment, and number of household contacts. During subsequent home visits, the following information was obtained: Karnofsky score, presence and type of chronic skin breaks, presence of invasive devices, parenteral treatment or antibiotic treatment since the previous visit, and full-time hospitalization since the previous visit.

For included household contacts, the following information was obtained at inclusion: age, sex, employment in a health care facility, relation to the index patient (partner or spouse, parent, child, other), whether he or she shared the same bedroom and bed as the index patient, and whether he or she provided health care to the index patient, eg, personal hygiene assistance.

MICROBIOLOGICAL TESTS

Swabs were spread on Chapman agar incubated at 37°C in aerobic atmosphere for 24 to 48 hours. Colonies suspected to be *S aureus* (ie, positive findings in the mannitol test) were identified using the coagulase test and tested for antibiotic susceptibility using the agar disk diffusion method, interpreted as recommended by the French Antibiogram Committee (http://www.sfm.asso.fr). *Staphylococcus aureus* was categorized as susceptible to methicillin if the inhibition zone diameter around the cefoxitin disk (30 µg) was 27 mm or larger and as resistant to methicillin if the diameter was smaller than 25 mm. If the diameter was 25 or 26 mm, additional tests were performed to detect either the *mecA* gene[11] or penicillin binding protein 2a production.

STATISTICAL ANALYSIS

The prevalence of MRSA carriage was estimated as the proportion of patients who had MRSA in nasal swabs and/or chronic skin lesion swabs among all eligible patients with at least 1 screening sample (nasal and/or chronic skin lesion). We used the *t* test and χ^2 test to compare age, sex, and presence of chronic skin lesions in screened and unscreened eligible patients. The prevalence of MRSA carriage was also estimated in a subsample of patients with both a nasal swab and swabs of any chronic skin lesions.

Variables associated with MRSA carriage were identified using logistic regression on data from all eligible patients who had at least 1 screening sample. Bivariate analyses were performed to identify variables with $P < .20$. These variables were entered into a backward stepwise multivariate model.

The Kaplan-Meier survival curve of MRSA carriage after hospital discharge was plotted in the overall population of index patients. Patients with persistent MRSA carriage were censored at death, hospitalization, or consent withdrawal or 12 months after hospital discharge, whichever occurred first. Median time to MRSA clearance was estimated from this survival curve. Factors predicting the time to MRSA clearance were looked for in the same patient population using a Cox model with both baseline variables and time-dependent covariates. Time dependent covariates were analyzed as yes/no covariates, starting at the value at the time of hospital discharge and then changed, if needed, at the time of follow-up visits (every month until clearance or loss to follow-up). After bivariate analyses

©2009 American Medical Association. All rights reserved.

Downloaded From: http://archinte.jamanetwork.com/ on 05/22/2013

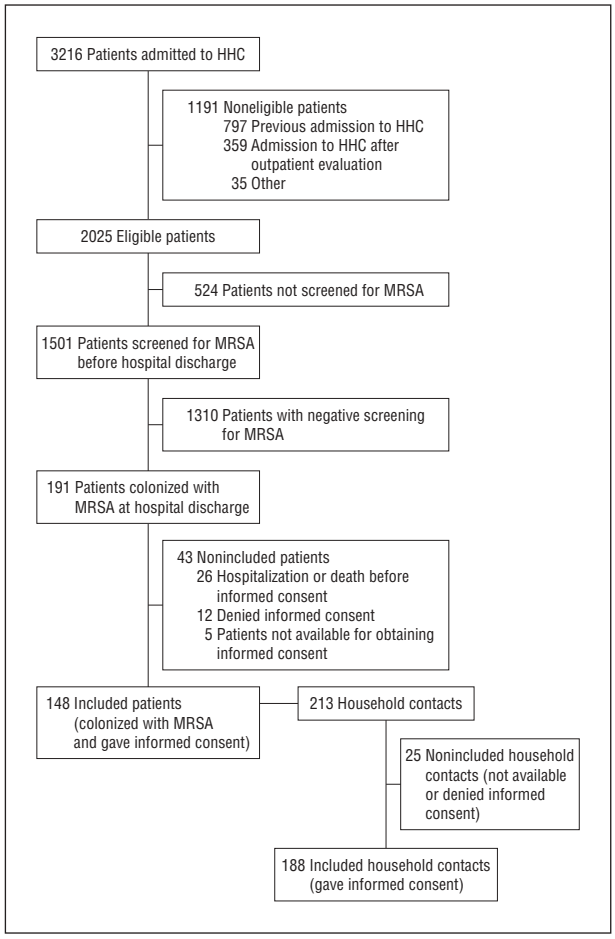

Figure 1. Flowchart of patients admitted to home health care (HHC) and screened for methicillin-resistant *Staphylococcus aureus* (MRSA) just before hospital discharge and of their household contacts.

to identify factors with $P < .20$, these factors were entered into a backward stepwise multivariate model.

Transmission of MRSA was defined as any MRSA-positive swab in any household contact during the study. Factors associated with MRSA transmission were identified using logistic regression. After bivariate analyses, 2 backward stepwise multivariate analyses were performed, one including household contact variables and the other, index patient variables identified by bivariate analyses. These 2 analyses identified factors independently associated with MRSA transmission, which were then entered into a final backward stepwise multivariate model. Statistical analyses were performed using SAS software, version 9.1 (SAS Institute Inc, Cary, North Carolina).

RESULTS

MRSA CARRIAGE

During the 14-month study period, 3216 patients were admitted to home health care, including 2025 who were eligible for the study. Of these 2025 patients, 1501 had at least 1 MRSA screening sample before hospital discharge (74.1%). **Figure 1** shows reasons for ineligibility or absence of predischarge screening. Patients with and without predischarge screening were not different in age, sex, or presence of chronic skin lesions (data not shown).

Table 1. Distribution of Screening Specimens and MRSA Carriers in Patients With and Without Chronic Skin Lesions

Sample Source	Total	Patients With MRSA, No. (%)
Patients with chronic skin lesion		
Nasal and skin lesion swabs	503	108 (21.5)
Skin lesion swab only	65	12 (18.5)
Nasal swab only	254	36 (14.2)
Subtotal	**822**	**156** (19.0)
Patients without chronic skin lesion		
Nasal swab	679	35 (5.2)
Total	**1501**	**191** (12.7)

Abbreviation: MRSA, methicillin-resistant *Staphylococcus aureus*.

Of the 1501 patients with at least 1 screening sample, 191 had MRSA (12.7%; 95% confidence interval [CI], 11.0%-14.5%). The distribution of screening specimens is summarized in **Table 1**. Of the 1182 patients with full screening sample sets (nasal swab plus skin swab of any chronic lesions), 143 had MRSA (12.1%; 95% CI, 10.3%-14.1%). Among the 1501 screened patients, 822 had chronic skin lesions (55%), of whom 568 had swabs taken from those lesions, which showed MRSA in 120 (21.1%; 95% CI, 17.8%- 24.5%). Of the 679 patients without skin lesions, 35 had MRSA in nasal swabs (5.2%; 95% CI, 3.5%-6.9%).

FACTORS ASSOCIATED WITH MRSA CARRIAGE AT ADMISSION TO HOME HEALTH CARE

The 191 patients with MRSA carriage before hospital discharge were compared with the 1310 noncarriers. Presence of chronic skin lesions, older age, worse Karnofsky score, and longer hospital stay were associated with MRSA carriage in bivariate analyses. There was a significant association between the main diagnosis and MRSA carriage (**Table 2**).

In the final multivariate analysis (Table 2), factors independently associated with MRSA carriage at hospital discharge were chronic skin lesions (adjusted odds ratio [aOR], 3.5; 95% CI, 2.3-5.2) ($P < .001$), older age (aOR for each additional decade, 1.2; 95% CI, 1.1-3.1) ($P = .003$), longer duration of hospital stay (aOR for each additional 10-day period, 1.1; 95% CI, 1.05-1.14) ($P < .001$), neurologic main diagnosis (aOR, 5.4; 95% CI, 2.5-11.4) ($P < .001$), and cardiovascular or other main diagnosis (aOR 2.7; 95% CI, 1.3-5.7) ($P = .008$).

FOLLOW-UP OF MRSA CARRIERS

Of the 191 MRSA carriers at hospital discharge, 148 were included (Figure 1). Among them, 137 had nasal swabs and swabs of any skin lesions taken within the first month of home health care. The remaining 11 patients were readmitted or died before collection of the first sample and were censored at time 0 in the survival analysis of MRSA clearance.

The 148 included patients had a mean (SD) age of 70 (15) years. There were 73 men (49%), 126 patients with skin lesions (85%), and 9 patients with immunosuppression (6%). Clearance of MRSA occurred within 1 year of

©2009 American Medical Association. All rights reserved.

Downloaded From: http://archinte.jamanetwork.com/ on 05/22/2013

Table 2. Variables Associated With MRSA Carriage at Hospital Discharge to Home Health Care[a]

Characteristic	MRSA Carriage (n=191)	No MRSA Carriage (n=1310)	Bivariate Analysis		Multivariate Analysis	
			OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Men	102 (50.8)	733 (56.0)	1.05 (0.77-1.42)	.78	NA	NA
Chronic skin lesions	156 (81.7)	666 (50.8)	4.15 (2.84-6.06)	<.001	3.46 (2.31-5.16)	<.001
Age, mean (SD), y[b]	71 (15)	66 (16)	1.26 (1.14-1.40)		1.18 (1.06-1.31)	<.001
Karnofsky score, mean (SD)[c]	51 (19)	57 (18)	0.84 (0.77-0.91)	<.001	NA	NA
Length of stay, mean (SD), d[d]	48 (49)	28 (31)	1.13 (1.09-1.18)	<.001	1.10 (1.05-1.14)	<.001
Main diagnosis				<.001		NA
Cancer	44 (23.1)	531 (40.5)	NA		NA	
Neurology	60 (31.4)	178 (13.6)	NA		NA	
Hematology	5 (2.6)	101 (7.7)	NA		NA	
Cardiovascular	35 (18.3)	170 (13.0)	NA		NA	
Orthopedic	3 (1.6)	52 (4.0)	NA		NA	
AIDS	1 (0.5)	45 (3.4)	NA		NA	
Other	43 (22.5)	233 (17.8)	NA		NA	
Main diagnosis in risk categories[e]						
Low	9 (4.7)	198 (15.1)	1 [Reference]	NA	1 [Reference]	NA
Moderate	44 (23.1)	531 (40.5)	1.82 (0.87-3.80)	.007	1.88 (0.88-4.02)	.10
Substantial	78 (40.8)	403 (30.8)	4.26 (2.09-8.67)	.001	2.71 (1.29-5.69)	.008
High	60 (31.4)	178 (13.6)	7.42 (3.57-15.38)	<.001	5.35 (2.51-11.38)	<.001

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; OR, odds ratio; MRSA, methicillin-resistant *Staphylococcus aureus*; NA, not applicable.
[a] Unless otherwise indicated, data are given as number (percentage) of patients.
[b] Statistical findings are per additional 10 years of age.
[c] Statistical findings are by decile of worse Karnofsky score.
[d] Statistical findings are per additional 10 days of hospital stay.
[e] Risk categories for MRSA carriage were as follows: low risk: hematologic, orthopedic, or AIDS diagnosis; moderate risk: cancer diagnosis; substantial risk: cardiovascular or other diagnosis; and high risk: neurologic diagnosis.

hospital discharge in 75 of the 148 patients. Of the 73 remaining patients, 29 had MRSA-positive samples at the end of the study period; 37 were withdrawn from the study because they died or required long-term hospital admission; and 7 withdrew their consent to the study. **Figure 2** shows the survival curve of MRSA carriage over time. The estimated mean time to MRSA clearance, estimated from the Kaplan-Meier survival curve, was 246 days (95% CI, 222-270 days), and the median time was 282 days (95% CI, 233-313 days).

In the bivariate survival analysis, the only baseline variable associated with MRSA clearance was self-sufficiency in daily activities (**Table 3**). No time-dependent covariate was associated with MRSA clearance. In the final multivariate model, only self-sufficiency in daily activities was associated with MRSA clearance (hazard ratio, 0.63; 95% CI, 0.40-1.00) (*P*=.049).

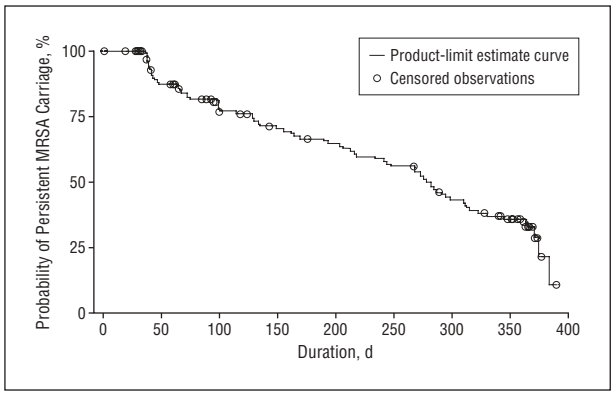

Figure 2. Time to methicillin-resistant *Staphylococcus aureus* (MRSA) clearance in 148 MRSA carriers admitted to home health care then monitored for 1 year.

HOUSEHOLD CONTACTS

There were 213 household contacts for the 148 included patients (1.4 per index patient), of whom 188 agreed to participate in the study. Their mean (SD) age was 51 (24.5) years (age range, 1-89 years); 84 were male (45%), and 4 worked in health care facilities (2%). Their relationship to the index patient was partner or spouse in 85 cases (45%), child in 53 cases (28%), parent in 8 cases (4%), and other in 42 cases (22%). Only 25 household contacts shared the same bed (13%), and 20 others the same bedroom (11%) as the index patient; 112 provided health care to the index patient (60%).

Of the 188 household contacts, 36 acquired MRSA (19.1%; 95% CI, 13.8%-25.5%). None of these MRSA-positive contacts experienced MRSA infection. Of the 137 observed index patients, 32 had 1 MRSA-positive contact, and 2 had 2 MRSA-positive contacts. The prevalence of MRSA carriage in the 36 MRSA-positive household contacts was higher within the first 59 days after the index patient returned home (26 of 35, 75%) than between days 60 and 89 (18 of 29, 62%), days 90 and 120 (20 of 36, 56%), days 130 and 209 (13 of 25, 52%), days 210 and 269 (9 of 17, 53%), or days 270 to 365 (7 of 15, 50%). Of the 36 MRSA-positive household contacts, 33 had at least 2 MRSA-positive screening swabs, and 26 had persistent MRSA carriage defined as at least 2 consecutive positive screening samples. Thirteen household contacts had at least 3 MRSA-positive screenings, and 4 were persistent MRSA carriers throughout the study period.

©2009 American Medical Association. All rights reserved.

Downloaded From: http://archinte.jamanetwork.com/ on 05/22/2013

Table 3. Analysis of Variables Associated With Persistent MRSA Carriage in 148 Index Patients[a]

Characteristic	Persistent MRSA Carriage[b] (n=73)	Clearance of MRSA (n=75)	Bivariate Analysis		Multivariate Analysis	
			HR (95% CI)	*P* Value	aHR (95% CI)	*P* Value
Baseline Variables						
Men	37 (50.7)	36 (48.0)	0.95 (0.60-1.50)	.82	NA	NA
Needs help for daily activities	42 (57.5)	37 (49.3)	0.63 (0.40-1.00)	.049	0.63 (0.40-1.00)	.049
Chronic skin lesions	65 (89.0)	61 (81.3)	0.61 (0.34-1.09)	.10	NA	NA
Age[c]	NA	NA	0.90 (0.82-1.10)	.87	NA	NA
Karnofsky score[d]	NA	NA	1.00 (0.90-1.10)	.70	NA	NA
Procedure						
Intravenous catheter	17 (23.3)	9 (12.0)	1.00 (0.50-2.01)	.99	NA	NA
Gastric tube	10 (19.7)	8 (10.7)	1.01 (0.49-2.12)	.97	NA	NA
Urinary device	24 (32.9)	14 (18.7)	0.86 (0.48-1.54)	.61	NA	NA
Subcutaneous injection	40 (54.8)	31 (41.3)	0.80 (0.50-1.26)	.34	NA	NA
Time-Dependent Covariates						
Antibiotic therapy	NA	NA	1.18 (0.42-3.03)	.73	NA	NA
Chronic skin lesions	NA	NA	1.04 (0.53-2.07)	.91	NA	NA
Any invasive procedure	NA	NA	1.45 (0.61-3.49)	.40	NA	NA
Karnofsky score	NA	NA	1.00 (0.99-1.02)	.23	NA	NA

Abbreviations: aHR, adjusted hazard ratio; CI, confidence interval; HR, hazard ratio; MRSA, methicillin-resistant *Staphylococcus aureus*; NA, not applicable.
[a] Unless otherwise indicated, data are given as number (percentage) of patients.
[b] Patients censored.
[c] Statistical findings are per additional 10 years of age.
[d] Statistical findings are by decile of worse Karnofsky score.

Table 4. Variables Associated With MRSA Acquisition in Household Contacts of Home Health Care Patients[a]

Characteristic	Household Contacts		Bivariate Analysis		Multivariate Analysis	
	MRSA Acquired (n=36)	MRSA Not Acquired (n=152)	OR (95% CI)	*P* Value	OR (95% CI)	*P* Value
Household Contact						
Men	13 (36)	71 (47)	0.64 (0.30-1.37)	.25	NA	NA
Spouse or partner of index patient	28 (78)	57 (38)	5.83 (2.49-13.67)	<.001	NA	NA
Provides health care to index patient	29 (81)	83 (55)	3.44 (1.42-8.34)	<.001	3.58 (1.33-9.62)	.01
Age, mean (SD), y[b]	69 (17)	48 (24)	1.60 (1.29-1.99)	<.001	1.71 (1.32-2.21)	<.001
Shares same bed or bedroom	7 (19)	38 (25)	0.72 (0.29-1.78)	.48	NA	NA
Index Patient						
Needs help for daily activities	19 (53)	73 (48)	1.21 (0.58-2.50)	.61	NA	NA
Chronic skin lesions	29 (81)	121 (80)	1.06 (0.43-2.65)	.90	NA	NA
Age, mean (SD), y[b]	76 (12)	63 (18)	1.90 (1.34-2.71)	.003	NA	NA
Karnofsky score, mean (SD)[c]	45 (19)	52 (17)	0.79 (0.63-0.99)	.04	NA	NA

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; MRSA, methicillin-resistant *Staphylococcus aureus*; NA, not applicable; OR, odds ratio.
[a] Unless otherwise indicated, data are given as number (percentage) of patients.
[b] Statistical findings are per additional 10 years of age.
[c] Statistical findings are by decile of worse Karnofsky score.

The 36 household contacts who acquired MRSA were compared with the 152 household contacts with no MRSA-positive screening samples (**Table 4**). In the bivariate analyses, household contact–related variables significantly linked to MRSA acquisition by household contacts were older age, being the spouse or partner of the index patient, and providing health care to the index patient; and index patient–related variables were older age and worse Karnofsky score.

In the first multivariate model including household contact–related variables, older age (aOR, 1.71; 95% CI, 1.32-2.21) ($P<.001$) and providing health care to the index patient (aOR, 3.58; 95% CI, 1.33-9.62) ($P=.01$) were associated with MRSA transmission. In the second multivariate model including index patient–related variables, older age was the only variable associated with MRSA transmission (aOR, 1.82; 95% CI, 1.26-2.62) ($P<.001$). In the final model including significant variables in either of the 2 previous models, only age of the contact (aOR, 1.71; 95% CI, 1.32-2.21) ($P=.001$) and providing health care to the index patient (aOR, 3.58; 95% CI, 1.33-9.62) ($P=.01$) were significantly associated with MRSA transmission.

MICROBIOLOGICAL TESTS

The MRSA isolates of index patients and of their household contacts had identical antibiotic susceptibility patterns. These susceptibility patterns were typical for hospital-acquired MRSA strains.

©2009 American Medical Association. All rights reserved.

Downloaded From: http://archinte.jamanetwork.com/ on 05/22/2013

COMMENT

In this large, multicenter, 1-year study, the prevalence of MRSA carriage was high (12.7%) at discharge to home health care; MRSA carriage was prolonged; and transmission to household contacts was common (19%), particularly in older contacts who provided health care to the index patient. The high rate of MRSA carriage can be ascribed to the characteristics of our study population, which included advanced age, low Karnofsky scores, a mean 4-week hospital stay before discharge to home health care, and chronic skin lesions in about half the patients. All of these characteristics are known risk factors for MRSA acquisition.[12,13] Among them, older age, longer hospital stay, and presence of chronic skin lesions were associated with MRSA carriage.

The 12.7% prevalence of MRSA carriage among our home health care patients may not reflect the prevalence among all patients receiving home health care. We studied patients who had been hospitalized. Conceivably, patients admitted to home health care after outpatient evaluation (most of whom are patients with cancer in our home health care system) may have lower prevalences of MRSA carriage. In addition, we did not include obstetric patients.

Of the 148 patients included in the follow-up study, 55% cleared the MRSA within the 1-year study period, the estimated median duration of MRSA carriage being 282 days. This proportion is similar to that found in another study by our group[5] in which we surveyed MRSA-positive patients at readmission to our hospital. In the present study, the only factor associated with persistent MRSA carriage was lack of self-sufficiency in daily activities. Chronic skin lesions were common in index patients, which resulted in low power for detecting an influence of this factor on persistent MRSA carriage.

We found that 19% of household contacts acquired MRSA at some time during the study period, in keeping with findings from a retrospective single-center study.[8] Variables independently associated with MRSA transmission to household contacts were older age of household contacts and providing health care to the index patient. Age of the index patient and age of the household contacts were closely correlated, and being the spouse or partner of the index partner was associated with MRSA acquisition in the bivariate analysis. Further work is needed to determine why older age was associated with MRSA transmission. Older age may merely reflect a greater need for help with personal hygiene and therefore greater opportunities for transmission.

Providing health care to the index patient increased the risk of MRSA transmission. Sharing the same bed or bedroom, in contrast, was not associated with MRSA transmission. Thus, MRSA may be preferentially transmitted to contacts who are at high risk for hand contamination during care procedures. Therefore, household members should observe the same recommendations as health care workers do, most notably regarding hand hygiene.[14]

None of the household contacts in our study experienced infection due to MRSA. Whether acquisition of nasal carriage of hospital-acquired MRSA by household contacts constitutes a public health problem requires further investigation. Infection with hospital-acquired MRSA has been described in health care workers and household contacts.[15] However, the number of cases is small compared with the increasing dissemination of community-acquired MRSA. Whether recommendations for stopping the transmission of hospital-acquired MRSA in the home health care setting are valid for community-acquired MRSA carriers is unclear. Most of the index patients in our study were older individuals, and many had chronic skin lesions. By contrast, community-acquired MRSA carriage has been reported in younger individuals without underlying diseases.

Our study has several limitations. First, only 61% of patients with chronic skin lesions had a complete screening set at hospital discharge, possibly resulting in failure to identify potential index cases. Second, most of our

SARM HAD Study Investigators

Microbiologists

Anani Akpabie, MD (Hôpital Emile Roux, Limeil Brévannes), Laurence Armand-Lefèvre, PharmD (Hôpital Bichat-Claude Bernard, Paris), Adel Benali, MD (Hôpital Saint-Joseph, Paris), Anne Casetta, MD (Hôpital Hôtel Dieu, Paris), Françoise Delisle, MD (Hôpital Tenon, Paris), Catherine Doit, PharmD (Hôpital Robert Debré, Paris), Jean-Luc Donay, PharmD (Hôpital Saint-Louis, Paris), Catherine Dupeyron, PharmD (Hôpital Albert Chenevier, Créteil), Isabelle Durand, PharmD (Hôpital René Muret-Bigottini, Sevran), Agnès Ferroni, PharmD (Hôpital Necker, Paris), Nicolas Fortineau, PharmD (Hôpital Bicêtre, Le Kremlin-Bicêtre), Eliane Garrabe, MD (Hôpital Bégin, Saint-Mandé), Jérôme Gravisse, MSc (Hôpital Lariboisière, Paris), Beate Heym, MD, PhD (Hôpital Ambroise Paré, Boulogne Billancourt), Michèle Hornstein, MD (Hôpital d'Avicenne, Bobigny), Marie-Laure Joly-Guillou, MD, PhD (Hôpital Louis Mourier, Colombes), Najiby Kassis, MD (Hôpital Paul Brousse, Villejuif), Jean-Luc Koeck, MD (Hôpital du Val de Grâce, Paris), Valérie Lalande, PharmD (Hôpital Saint-Antoine, Paris), Christine Lawrence, PharmD (Hôpital Raymond Poincaré, Garches), Léa Lebrun, MD (Hôpital Antoine Béclère, Clamart), Patrick Legrand, MD (Hôpital Henri Mondor, Créteil), Christine MacNab, MD (Hôpital Percy, Clamart), Latifa Noussair, MD (Hôpital Beaujon, Clichy), Isabelle Podglagen, PharmD, PhD (Hôpital Européen Georges-Pompidou, Paris), Isabelle Poilane, PharmD, PhD (Hôpital Jean Verdier, Bondy), Laurence Prots, PharmD (Hôpital Cochin, Paris), Jérôme Robert, MD, PhD (Hôpitial Pitié Salpêtrière, Paris), Hoang Vu Thien, MD (Hôpital Armand Trousseau, Paris), and Schehrazade Zaouche, PharmD (Hôpital Corentin-Celton, Issy les Moulineaux).

Home Health Care Staff

Régis Patte, MD, Maria Rodriguez, RN, Michèle Treguer, RN, and Brigitte Silvera RN (Assistance Publique–Hôpitaux de Paris).

Hospital Information System

Pascal Machuron, MSc, and Olivier Geenen, MSc (Assistance Publique–Hôpitaux de Paris).

©2009 American Medical Association. All rights reserved.

Downloaded From: http://archinte.jamanetwork.com/ on 05/22/2013

index patients were older individuals with severe disabilities. We did not include obstetric patients or patients admitted to home health care after outpatient evaluation. In these 2 populations, the prevalence of MRSA carriage at home health care admission may be lower than in our study population. Similarly, the duration of MRSA carriage may be shorter and transmission to household contacts less likely when the index patients are younger, self-sufficient individuals. Third, index patients who were readmitted during the study were censored at the time of readmission. Therefore, we could not determine whether these patients were at high risk for MRSA infection, as suggested by other studies.[16] Fourth, we were not able to establish the role of systemic antibiotics for MRSA eradication in index patients owing to the small number of patients receiving antibiotic treatment. Finally, we did not use molecular analysis to confirm that the MRSA strains acquired by contacts were identical to the strains in the corresponding index patients. However, the antibiotic susceptibility patterns were the same. Furthermore, only 4 of the 188 household contacts were health care workers, and none of these 4 were colonized with MRSA.

In conclusion, colonization with hospital-acquired MRSA was common at hospital discharge to home health care, and transmission of the organism occurred in about one-fifth of household contacts. However, since no household contact developed MRSA infection, and only 4 were persistent MRSA carriers, the risk for further propagation of infection by household members appears to be small.

Accepted for Publication: April 28, 2009.
Correspondence: Jean-Christophe Lucet, MD, PhD, Unité d'Hygiène et de Lutte contre l'Infection Nosocomiale, GH Bichat-Claude Bernard, 75877 Paris, CEDEX 18, France (jean-christophe.lucet@bch.aphp.fr).
Author Contributions: *Study concept and design:* Lucet, Andremont, Jarlier, Mentré, and Nicolas-Chanoine. *Acquisition of data:* Demontpion, Degrave, Vanjak, Andremont, and Nicolas-Chanoine. *Analysis and interpretation of data:* Lucet, Paoletti, Vincent, Jarlier, Mentré, and Nicolas-Chanoine. *Drafting of the manuscript:* Lucet, Paoletti, Demontpion, Degrave, Vincent, Mentré, and Nicolas-Chanoine. *Critical revision of the manuscript for important intellectual content:* Paoletti, Vanjak, Andremont, Jarlier, Mentré, and Nicolas-Chanoine. *Statistical analysis:* Paoletti, Vincent, and Mentré. *Obtained funding:* Vanjak, Andremont, and Nicolas-Chanoine. *Administrative, technical, and material support:* Lucet, Demontpion, Degrave, Jarlier, and Nicolas-Chanoine. *Study supervision:* Lucet and Nicolas-Chanoine.
Financial Disclosure: None reported.
Funding/Support: This study was supported by grants P020408 and COL02009 from the Programme Régional de Recherche Clinique, Direction de la Recherche Clinique, AP-HP, Paris, France (a publicly funded nonprofit organization).
Previous Presentation: This study was presented in part at the 45th Interscience Conference on Antimicrobial Agents and Chemotherapy; December 16-19, 2005; Washington, DC.

REFERENCES

1. Grundmann H, Aires-de-Sousa M, Boyce J, Tiemersma E. Emergence and resurgence of methicillin-resistant *Staphylococcus aureus* as a public-health threat. *Lancet*. 2006;368(9538):874-885.
2. Chini V, Petinaki E, Foka A, Paratiras S, Dimitracopoulos G, Spiliopoulou I. Spread of *Staphylococcus aureus* clinical isolates carrying Panton-Valentine leukocidin genes during a 3-year period in Greece. *Clin Microbiol Infect*. 2006; 12(1):29-34.
3. Maree CL, Daum RS, Boyle-Vavra S, Matayoshi K, Miller LG. Community-associated methicillin-resistant *Staphylococcus aureus* isolates causing healthcare-associated infections. *Emerg Infect Dis*. 2007;13(2):236-242.
4. Sanford MD, Widmer AF, Bale MJ, Jones RN, Wenzel RP. Efficient detection and long-term persistence of the carriage of methicillin-resistant *Staphylococcus aureus*. *Clin Infect Dis*. 1994;19(6):1123-1128.
5. Scanvic A, Denic L, Gaillon S, Giry P, Andremont A, Lucet JC. Duration of colonization by methicillin-resistant *Staphylococcus aureus* after hospital discharge and risk factors for prolonged carriage. *Clin Infect Dis*. 2001;32(10):1393-1398.
6. Lescure FX, Locher G, Eveillard M, et al. community-acquired infection with healthcare-associated methicillin-resistant *Staphylococcus aureus*: the role of home nursing care. *Infect Control Hosp Epidemiol*. 2006;27(11):1213-1218.
7. Rozenbaum R, Silva-Carvalho MC, Souza RR, et al. Molecular characterization of methicillin-resistant *Staphylococcus aureus* disseminated in a home care system. *Infect Control Hosp Epidemiol*. 2006;27(10):1041-1050.
8. Calfee DP, Durbin LJ, Germanson TP, Toney DM, Smith EB, Farr BM. Spread of methicillin-resistant *Staphylococcus aureus* (MRSA) among household contacts of individuals with nosocomially acquired MRSA. *Infect Control Hosp Epidemiol*. 2003;24(6):422-426.
9. Davis KA, Stewart JJ, Crouch HK, Florez CE, Hospenthal DR. Methicillin-resistant *Staphylococcus aureus* (MRSA) nares colonization at hospital admission and its effect on subsequent MRSA infection. *Clin Infect Dis*. 2004;39(6):776-782.
10. Karnofsky DA, Brurchenal JH. The clinical evaluation of chemotherapeutics in cancer. In: Macleod C, ed. *Evaluation of Chemotherapeutic Agents*. New York, NY: Columbia University Press; 1949:191-205.
11. Jaffe RI, Lane JD, Albury SV, Niemeyer DM. Rapid extraction from and direct identification in clinical samples of methicillin-resistant staphylococci using the PCR. *J Clin Microbiol*. 2000;38(9):3407-3412.
12. Lucet JC, Chevret S, Durand-Zaleski I, Chastang C, Regnier B; Multicenter Study Group. Prevalence and risk factors for carriage of methicillin-resistant *Staphylococcus aureus* at admission to the intensive care unit: results of a multicenter study. *Arch Intern Med*. 2003;163(2):181-188.
13. Harbarth S, Sax H, Fankhauser-Rodriguez C, Schrenzel J, Agostinho A, Pittet D. Evaluating the probability of previously unknown carriage of MRSA at hospital admission. *Am J Med*. 2006;119(3):275.e15-275.e23.
14. Gorwitz RJ, Jernigan DB, Powers JH, Jernigan JA; Participants in the CDC-convened experts' meeting on management of MRSA in the community. Strategies for clinical management of MRSA in the community: summary of an experts' meeting convened by the Centers for Disease Control and Prevention. http://www.cdc.gov/ncidod/dhqp/pdf/ar/CAMRSA_ExpMtgStrategies.pdf. Accessed April 28, 2009.
15. Eveillard M, Martin Y, Hidri N, Boussougant Y, Joly-Guillou ML. Carriage of methicillin-resistant *Staphylococcus aureus* among hospital employees: prevalence, duration, and transmission to households. *Infect Control Hosp Epidemiol*. 2004; 25(2):114-120.
16. Datta R, Huang SS. Risk of infection and death due to methicillin-resistant *Staphylococcus aureus* in long-term carriers. *Clin Infect Dis*. 2008;47(2):176-181.

©2009 American Medical Association. All rights reserved.

Downloaded From: http://archinte.jamanetwork.com/ on 05/22/2013