Surveillance of colonization and infection with *Staphylococcus aureus* susceptible or resistant to methicillin in a community skilled-nursing facility

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Background: Methicillin-resistant *Staphylococcus aureus* (MRSA) is an important nosocomial pathogen in acute care hospitals and long-term care facilities. Few studies have been reported in private skilled nursing facilities (SNFs) not experiencing outbreaks of infections caused by MRSA.
Methods: From a 149-bed SNF with no outbreaks, we report a 1-year prospective surveillance study of *S. aureus* colonization and infection, with focus on *S. aureus* phenotypes, both methicillin susceptible (MS) and methicillin resistant (MR). Nasal and stool or rectal screening cultures were done on admission, and all patients underwent screening on at least a quarterly basis for 1 year.
Results: Overall, 35% of patients were colonized at least once with *S. aureus*, (72% MS, 25% MR, and 3% mixed phenotypes), 94% of the MRSA were ciprofloxacin resistant. Nasal colonization with any *S. aureus* was more frequent, but 13% of patients had positive results only in rectal specimens. Twenty-one percent of the newly admitted and 15% of continuing patients acquired colonization during their stay in the SNF. Colonization was transient or persistent, persisted longer in the nares compared with colonization in rectal specimens, and was more stable for methicillin-susceptible *S. aureus*. Nine percent of patients had development of infection with *S. aureus*. There was no indication that MRSA colonization led to more infections than methicillin-susceptible *S. aureus*. Of the 13 infected patients in whom cultures had previously been obtained, seven (54%) had been colonized by the same phenotype strains.
Conclusions: In this private SNF, endemic *S. aureus* infections occur at a low frequency, reflecting a moderate level of colonization with *S. aureus*. However, a trend showing gradual increases in frequencies of colonization and infection is of concern and suggests that in this SNF, future intervention could become warranted. (AJIC Am J Infect Control 1997;25:312-21)

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Since 1970 methicillin-resistant *Staphylococcus aureus* (MRSA) has become an important nosocomial pathogen in acute care hospitals (ACH). In recent years reports from long-term care facilities (LTCF) of colonization and infection with these organisms have increased; most of these have been conducted in Veterans Affairs (VA)–affiliated LTCF.[1] Few studies[2-4] have been conducted in private skilled nursing facilities (SNFs), which represent the large majority of the LTCF in this country. Whether ACH are the source of MRSA in LTCF is

not clear. Some suggest that MRSA strains are introduced into LTCF by patients who have become colonized or infected in the ACH before transfer to the LTCF.[5] Conversely, other studies suggested that patients entering an ACH colonized with MRSA were transferred from LTCF.[6,7] Occasional episodes of transmission from colonized medical personnel have been reported.[8] Studies from VA hospitals have shown that 5% to 15% of colonized patients will have development of MRSA infections,[7] which are often difficult to treat when they occur. This is especially true of MRSA that are also resistant to ciprofloxacin (CR). However, little data are available regarding the endemic frequency of MRSA colonization in community SNF settings. Whether the incidence of colonization with MRSA has increased over time in SNFs is also not clear. To derive potential strategies for control, additional data are needed to determine whether colonization and infection frequencies are indeed changing in the setting of the SNF.

The anatomic sites of colonization may also be important. However, evaluation of nares versus rectal swabs for detection and for monitoring colonization longitudinally has not been reported in a community SNF. Furthermore, significant questions remain with regard to the relationship of colonization to subsequent infection and the pathogenicity of methicillin- resistant strains of *S. aureus*.

In a community SNF we conducted a 1-year prospective surveillance study of *S. aureus* colonization and infection, with focus specifically on strain phenotypes both sensitive and resistant to methicillin and ciprofloxacin. We evaluated the frequencies of colonization over time by anatomic sites, the referral sources of admission, colonization status on admission, and patient debility levels. We also examined the persistence of colonization and the relation between colonization and infection.

METHODS

Study facility and population

A private 149-bed SNF in Orange County, California, was selected for study. The facility has three floors; the first floor (30 beds) houses primary care patients with Alzheimer's disease, whereas the second (60 beds) and third floors (59 beds) are reserved for patients with other diagnoses. The patients on the second floor are more debilitated than those on the first or third floors. Nursing staff rotate in all three floors. The occupancy rate during the study period was 95% to 100%; the average length of stay was 117 days.

Surveillance of infections

The overall study design was observational surveillance. Routine infection control surveillance was conducted by regular SNF personnel following published guidelines.[9] Study personnel prospectively received from the SNF infection control nursing supervisor the infection surveillance data developed by the SNF personnel, including nursing logs, medical charts, microbiologic studies, and other laboratory reports. Records of antibiotic treatment were obtained from the pharmacy and nursing logs. Most prescriptions were 7 to 14 days; therefore for purposes of analyses presented in this report, we have presented the antibiotic utilization frequencies simply by numbers of prescriptions, without analysis for total grams or total days. For purposes of this study, a presumptive infection episode was recorded when symptoms and signs were considered by the SNF nursing staff and the patient's private physician to represent infection, and antibiotic treatment was initiated. Clinical diagnoses were supplemented by laboratory tests ordered by the patient's private physician, such as blood counts, chest radiograms, urinalyses, and bacterial cultures. Study personnel did not examine patients or influence diagnostic or treatment modalities. Routine cultures for diagnosis of suspected infections were performed by a single commercial laboratory. Review of the epidemiologic pattern of infection episodes revealed no seasonal trends or apparent focal clusters within the SNF; instead, the infections seemed to represent a low-level, endemic incidence.

Colonization surveillance of patients with *S. aureus*

Screening surveillance cultures for colonization of patients' microbial flora with *S. aureus* were done every 3 months on all patients. Newly admitted or readmitted patients were screened on admission (or within 72 hours). The sources of screening cultures included swabs taken from anterior nares (both sides with one swab) and swabs from stool or rectal area. Few patients had wounds or indwelling vascular lines; therefore wounds or vascular catheters were not included in the study cultures.

Colonization definitions

For overall study analyses, colonization was defined in a patient with any surveillance culture re-

Table 1. Colonization and infection frequencies by *S. aureus* MR and MS phenotypes, and quinolone prescriptions, by year of surveillance

Phenotype	1989	1990–1992	1993–1994	*p* Value
Colonization frequencies–% of patients				
MRSA	ND	7.9*	9.7†	NS
MRCR.SA	ND	5.4*	9.0†	S
MS.SA	ND	ND	25	
Multi-strains	ND	ND	1.0	
All SA	ND	ND	35	
MRSA/SA (%)	ND	ND	28	
MRCR/MRSA (%)	ND	68	93	NS
Infection frequencies–% of patients				
MR.SA	ND	1.6	3.9	S
MRCR.SA	ND	1.4	3.6	S
MS.SA	ND	2.6	4.1	NS
Multi-strains	ND	0.2	0.8	
Not known	ND	–	–	
All SA	4.6	4.2	8.8	S
MRSA/SA (%)	ND	38	53	NS
MRCR/MRSA (%)	ND	88	92	NS
Quinolone‡				
Prescriptions (% of all prescriptions)	18	21	17	NS

SA, S. aureus.
*Data from screening cultures by oxacillin salt media, the rest were screened by mannitol salt media.
†Data limited to surveillance set No. 5, oxacillin salt media.
‡Ciprofloxacin plus norfloxacin.

sult positive for *S. aureus* at least once, from nares or stool. From colonized patients repeat cultures were obtained every 3 to 4 weeks to assess persistence. For patients who were in the SNF long enough to undergo two or more surveillance cultures, colonization definitions were as follows (modified from Bradley et al.[6]): (1) *Persistent colonization* was defined as patients with three or more consecutive positive culture results with the same phenotype (periods of 3 to 4 months or more). (2) *Partial persistent* was defined as patients with 2 consecutive culture results positive for the same phenotype, but additional follow-up cultures were not done (e.g., patient discharged), or one or more episodes with two consecutive positive culture results, followed by or interspersed with one or more negative culture results. (3) *Intermittent* was defined as positive culture results on two or more occasions, but no two consecutive positive results of the same phenotype. (4) *Transient colonization* was defined as only one positive culture result during the entire study period.

Microbiology methods

Screening culture swabs from anterior nares and stool were placed in standard commercial culturettes with holding media and held at 4° C until they were plated, within 1 to 4 hours. In our previous study of this SNF (1990–1992), oxacillin salt media was used to screen only for MRSA, which did not provide a denominator of total patients colonized with any *S. aureus*. Therefore in this study the swabs were plated on mannitol salt agar media to screen for all *S. aureus*. In addition, to compare the results with results from 1990 to 1992 (22 months), for one of the surveillance sets (set no. 5), all specimens were plated on oxacillin salt agar in addition to mannitol salt agar media. The recovery rate of MRSA from mannitol salt (9.0% of patients) was not significantly different from that of oxacillin salt (9.7%). The oxacillin salt results are summarized in Table 1.

Suspected isolates of *S. aureus* were confirmed by the catalase test and the tube coagulase test. The antimicrobial susceptibilities of all isolates of *S. aureus* were confirmed by standardized disc-diffusion procedures in Mueller-Hinton agar plates, and zone diameters were measured after 20 to 24 hours incubation at 35° C, according to National Committee for Clinical Laboratory Standards guidelines.[10] Isolates were confirmed as methicillin resistant (MR) and CR when 1 μg oxacillin and 5 μg ciprofloxacin disc produced zones of less than 10 mm and less than 15 mm, respectively. All *S. aureus* from colonization surveillance cultures were saved and harvested from a fresh subculture on trypticase soy agar plates with 5% sheep blood for storage in fetal bovine serum at −70° C.

Table 2. Colonization of patients by *S. aureus:* distribution of strains by MR and MS phenotypes (1993 to 1994)

Survey No.	No. of cultures obtained	Colonizing SA phenotypes (no. of patients)†			
		MRSA	MSSA	Multiple strains‡	Total (%)
Continuing patients					
1.	110	9	21	1	31 (28)
2	117	10	22	1	33 (28)
3.	109	7	32	0	39 (36)
4.	111	9	36	2	47 (42)
5.	134	16	35	1	52 (39)
Totals	581 (100)	51 (9)	146 (25)	5 (1)	202 (35)
(%) Total SA		(25)	(72)	(3)	(100)
Newly admitted patients	182 (100)	12 (7)	33 (18)	2 (1)	47 (26)
(%) Total SA		(26)	(70)	(4)	(100)

SA, S. aureus.
*Many patients were surveyed more than once; a total of 189 patients were included in the five surveys.
†A patient with one or more positive culture(s) in either one or both nares and stool is considered as colonized.
‡Two or more phenotypes were detected.

Data analysis

Colonization frequencies were calculated either as the number of colonizations per 100 specimens or per 100 patients screened. Discrete data were compared by chi-square and Fisher's exact tests when appropriate. A p value of less than 0.05 was considered significant. Data analyses were performed by EPI Info Software (Centers for Disease Control and Prevention, Atlanta, Ga.).

RESULTS

Patient population surveyed

During the 1-year study period five surveillance culture sets were obtained from all patients at 3-month intervals. A total of 189 continuing patients (vs new patients) were surveyed, many more than once, and a total of 182 newly admitted patients were also surveyed on admission or within 3 days after admission. Altogether 354 patients were surveyed. The mean age of the patients was 79 years, and 72% were women. Eighty percent of the residents were admitted by transfer from an ACH.

Distribution of colonization with *S. aureus* by MR phenotypes

For the continuing patients, as shown in Table 2, the majority (72%) of the total colonizing *S. aureus* were susceptible to methicillin (MS phenotype), whereas 25% were resistant (MR phenotype), and only a few patients carried multiple strains (3%). Table 2 also presents the distribution of MR and MS phenotypes for newly admitted patients in comparison with the continuing patients; the overall patterns were quite similar.

The frequencies of colonization with *S. aureus* for continuing patients increased gradually with each subsequent survey except the final one. The frequencies for colonization with any *S. aureus* strain in the first two surveys were significantly lower than in the last two (Table 2; 28% vs 41%, $p < 0.05$). Colonization frequencies of MR strains also were higher than 2 years previously (9.7% vs 7.9%), although the increments did not reach statistical significance (Table 1). Ninety-four percent of the MRSA isolates were CR, which also represents an increasing trend compared with 2 years previously (88%). Nevertheless colonization of patients with *S. aureus* tended to increase over time, and the mean frequency for the continuing patients was significantly higher than that for the newly admitted patients (35% vs 26%, $p < 0.05$) (Table 2).

Distribution of colonization by sampling sites

As shown in Table 3, of the 204 patients who had both nares and stool/rectal swab specimens surveyed (during the quarterly culture screening and the follow-up cultures), 142 culture pairs (70%) had *S. aureus* colonization in nares only, 27 (13%) in stool only (70% vs 13%, $p < 0.05$), and 35 (17%) in both sites. Thus total recovery of all *S. aureus* strains was more frequent from nasal specimens (87%) than the stool specimens (30%). The colonization patterns of *S. aureus* in newly admitted patients' nares and stools were the same pattern as for the continuing patients. The distribution of various antimicrobial resistance phenotypes in nares and stools also followed a similar pattern.

Table 3. Colonization of patients by *S. aureus*; distribution of MR and MS phenotypes strains by sampling site

Patient group	Site of positive culture result	Phenotypes (no. of patients) MRSA	MSSA	Multi-strains	Total (%)
Continuing patients	Nares only	26	112	4	142 (70)
	Stool only	7	20	0	27 (13)
	Both	16	18	1	35 (17)
Total		49 (27%)	150 (74%)	5 (2%)	204 (100%)
Newly admitted patients	Nares only	7	21	1	29 (67)
	Stool only	3	2	1	6 (14)
	Both	13	5	0	8 (19)
Total		13 (30%)	28 (65%)	2 (5%)	43 (100%)

Table 4. Colonization with MR and MS phenotypes of *S. aureus* in newly admitted patients, by patient referral source

Referral source	Phenotypes of colonized patients (no. of patients) MRSA	MSSA	Multi-strains	Total colonized All SA No.	(%)	Not colonized patients No.	(%)	Grand total patients No.	(%)
ACH	9	25	1	35	75	106	78	141	77
LTCF	1	5	1	7	15	5	4	12	6
Community	0	2	0	2	6	9	7	11	7
Others	1	1	0	2	4	3	2	5	3
Unidentified	1	0	0	1	2	12	9	13	7
Total	12	33	2	47	100	135	100	182	100

SA, S. aureus.

Colonization by referral source of patients admission

As shown in Table 4, of the 182 patients newly admitted during the study period, 141 (77%) were referred directly from an ACH. Of the 47 colonized patients, 35 (75%) were newly admitted from ACH. On the other hand, of the 135 noncolonized patients, from whom *S. aureus* was never isolated, 106 (78%) were newly admitted from ACH. Thus similar proportions of colonized and noncolonized patients were admitted from an ACH (75% vs 78%, $p > 0.05$). However, a significantly greater proportion of colonized patients came from other LTCF than did the noncolonized patients (15% vs 4%, $p < 0.05$). Furthermore, patients admitted from LTCFs had significantly higher *S. aureus* colonization frequency than patients admitted from ACHs (58% vs 25%, $p < 0.05$) (Table 4), although the sample size of admissions from LTCF was small.

Distribution of colonization by patient mobility levels

As shown in Table 5, of the 301 patients with mobility level data available, 72 (24%) were ambulatory. Eighteen of these 72 ambulatory patients were colonized with *S. aureus* (25%). On the other hand, among the nonambulatory patients (bed, bed/chair, or variable status), 116 of 229 (51%) were colonized, a significantly higher proportion than in ambulatory patients ($p < 0.05$). Most of the nonambulatory patients were housed on the second-floor, where 55% of patients were colonized, compared with lower colonization frequencies on the first floor (15%) and the third floor (30%).

Acquisition of *S. aureus* colonization

Of the 182 newly admitted patients, 47 (26%) were colonized with *S. aureus* (25% MR) on admission, and 28 (21%) of the noncolonized patients acquired colonization after being admitted to the facility. Sixteen (57%) of these 28 patients acquired colonization in the first follow-up culture. For newly admitted patients who were not colonized on admission, the length of stay until colonization was detected ranged from 8 days to 175 days, with a mean of 47 days. Fifteen percent of continuing patients also acquired colonization during their stay in the nursing facility.

Table 5. Colonization of all patients by *S. aureus*; distribution of MR and MS phenotypes strains by patient

	Phenotypes of colonized patients (no. of patients)			Total colonized all SA		Not colonized patients		Grand total patients	
Referral source	MRSA	MSSA	Multi-strains	No.	(%)	No.	(%)	No.	(%)
Ambulatory	3	15	0	18	25	54	75	72	24
Chair/bed	4	31	7	42	51	40	49	82	27
Bed	4	13	5	22	52	20	48	42	14
Variable status	7	29	13	49	47	56	53	105	35
Total	18	88	25	131	44	170	56	301	100

SA, S. aureus.
*Two or more phenotypes were detected during the study period (different phenotypes at different follow-up cultures).

Table 6. Persistence of colonization with *S. aureus* by MR and MS phenotypes

				Follow-up cultures obtained			
				No. of patients			
S. aureus phenotype	Total patients initially colonized*	Follow-up culture not obtained	Persistance category†	1	2‡	≥3	Subtotal (%)
MR	38	15					23 (100)
			Persistent	–	0	6	6 (26)
			Partial persistence	5	0	1	6 (26)
			Intermittent	0	0	1	1 (4)
			Transient	4	3	3	10 (44)
MS	121	33					88 (100)
			Persistent	–	2	22	24 (27)
			Partial persistence	13	3	10	26 (30)
			Intermittent	1	3	9	13 (15)
			Transient	12	5	8	25 (28)
Multi-strains	3	1					2 (100)
			Partial persistence	0	0	1	1 (50)
			Transient	1	0	0	1 (58)
Total	162	49		36	16	61	113

*A patient with one or more positive culture results in either one or both nares and stool is considered as colonized.
†See text for definitions.
‡Time elapsed for the three culture sets (initial screen positive, plus two follow-up cultures) was 3 to 4 months.

Persistence of colonization and change in antibiotic resistance phenotype

The study design called for colonized patients to undergo repeat cultures 3 to 4 weeks after the initial colonization (in addition to the quarterly surveillance of all patients). As shown in Table 6, of the 162 colonized patients, 49 (30%) did not undergo follow-up cultures, mostly because of early discharge. Of patients colonized with MR phenotypes and with follow-up cultures, 56% showed persistence or partial persistence or intermittent colonization (see definitions in Methods), compared with 72% for patients colonized with MS phenotype. On average, *S. aureus* colonization tended to persist longer in the nares compared with rectal/stool specimens. Of patients who underwent four or more follow-up culture sets after the initial detection of colonization, 64% of the nares continued to have positive results in four or more cultures; however, in the stool/rectal specimens, only 32% had four or more positive culture results ($p < 0.05$). In the nares, the mean duration range was >234 ± 78 days (range 11 to 326+ days); in the stool or rectal specimens, the mean duration was >180 ± 67 days (range 8 to 291+ days).

The stability of *S. aureus* strains by various antimicrobial resistance phenotypes is shown in Table 7. Because of concern regarding acquisition of ciprofloxacin resistance in MRSA strains, we have examined the stability of CR and MR phenotypes (Table 7). Of the 52 patients persistently

Table 7. Changes in resistance phenotype pattern during follow-up period

Follow-up phenotypes	Initial colonization: phenotypes (no. of patients)					
	MRCR	MRCS	MSCR	MSCS	Multi-strains	Total
MRCR	6 (50%)	0	1	1	0	12
MRCS	0	0 (0%)	0	1	0	1
MSCR	4	0	11 (92%)	3	0	14
MSCS	2	1	0	47 (90%)	0	53
Multi-strains	0	0	0	0	1	1
Total	12 (100%)	1 (100%)	12 (100%)	52 (100%)	1 (100%)	81

colonized with susceptible strains (MSCS phenotype), the same phenotypes were persistent in the follow-up culture in 47 patients (90%); all 11 of 12 (92%) patients with methicillin-sensitive, ciprofloxacin-resistant phenotypes also retained the same phenotypes. In contrast, colonization with MRCR phenotype was the least stable in the follow-up cultures; of the 12 patients who continued to have positive results, only six (50%) had the same MRCR phenotype. Overall, MS *S. aureus* phenotype colonization appeared more stable than MRSA phenotypes.

Clearance of colonization

For the 162 patients colonized on at least one occasion, 57 (35%) had at least one negative culture result before the end of the study period. Thirty percent of these patients had been treated with an antibiotic after colonization and before the negative culture results.

Colonization and subsequent development of infection

As shown in Table 8, of 354 patients surveyed, 32 (9%) had development of infections with *S. aureus* during the 1-year study. Of these infections, 10 (31%) were wound and soft tissue infections, followed by respiratory infections (n = 8) and urinary tract infections (n = 7). The frequency of infections caused by *S. aureus* was higher than 2 years previously (9% vs 4%), although the use of quinolone antibiotics decreased slightly (Table 1).

During this 1-year study MR and MS strains each accounted for 14 and 15 cases of the total *S. aureus* infections, respectively. There was no indication that MRSA caused more infections than methicillin-susceptible *S. aureus* (MSSA) (44% for MR; 47% for MS). Many of the patients who had development of infections as a result of *S. aureus* had previously had persistent colonization. Of the 13 infected patients who had been previously included in a culture survey and found to be colonized with *S. aureus*, 7 of 13 (54%) later had development of infection by the same phenotypic strains as had been identified in the prior culture survey. Patients colonized with MRSA were no more likely to have development of subsequent infection than patients with MSSA strains (3/7 vs 4/6, $p > 0.05$). Two patients with persistent stool/rectal colonization later became infected as compared with four patients with persistent nasal colonization. One patient had both nares and stool colonization.

DISCUSSION

Few studies of colonization with MRSA have been conducted in private, community SNFs. In 1986 in eight rural Wisconsin nursing homes, Sheckler and Peterson[11] found no MRSA colonization. Thomas et al.[4] surveyed a private SNF in Los Angeles on two occasions at a 3-month interval and found MRSA colonization frequencies of 6.6% and 9.1%. In 1991 in a community nursing home in Chicago surveyed over 15 months, Hsu[12] found that an average of 24% of the patients carried *S. aureus* and 35% of the isolates were MRSA (8.7% of all patients). In 1991 in a VA LTCF study, Muder et al.[7] reported that 31% and 13% of the patients carried *S. aureus* and MRSA in their nares.

Our study in a community SNF in Orange County, Calif., has been carried out over more than 3 years. In the 1993 to 1994 study of continuing patients in SNF, we found that an average of 35% of the patients carried *S. aureus*, and 25% of these were MRSA; that is, over the entire period, 9.7% of all patients were colonized with MRSA. Most (94%) of the MRSA isolates were also resistant to ciprofloxacin. The colonization frequency of all *S. aureus* including MRSA increased gradually over this last 1-year surveillance period. The prevalence of MRCR strains was higher than the

Table 8. Prior colonization and subsequent infection with MR and MS *S. aureus*, by site of infection

Site of infection and prior colonization	Phenotypes (no. of patients)			
	MRCR	MSCR	Not known	Total (%)
Urinary tract	5	0	2	7 (21)
Positive pcc/Total pcc done	1/3	–	ND	
Respiratory	2	6	0	8 (25)
Positive pcc/Total pcc done	1/1	3/4	–	
Wound/Soft tissue	4	5	1	10 (310
Positive pcc/Total pcc done	1/3	1/2*	ND	
Other†	3	4	0	7 (21)
Positive pcc/Total pcc done	ND	ND	–	
Total Infections (%)	14 (44)	15 (47)	3 (9)	32 (100)
Total positive pcc/Total pcc done	3/7	4/6	–	7/13

pcc, Prior colonization culture result; *ND*, no prior colonization culture done.
*Eyes and wound.
†Other sites included three eyes, two vaginal, one gastrointestinal, and one multiple sites.

prevalence 2 years previously, even though the percentage of ciprofloxacin prescriptions declined slightly. The MRSA nares colonization frequency in our study (8.8%) was comparable to that reported by Thomas et al.[4] and Hsu[12] in private LTCFs, but it was lower than the frequency found in a VA LTCF by Muder et al.[7] Thus MR colonization frequencies may vary at different times and in different facilities.

It is pertinent to address the epidemiologic virulence of MRSA compared with MS strains. Collopy et al.[13] found that MRSA strains were more likely than MSSA to be colonizing patients in the private SNF they studied. On the other hand, in our study of continuing patients in SNF, MRSA accounted for a significantly lower proportion of *S. aureus* colonization than MSSA (25% vs 72%, $p < 0.05$). Differences in facilities, patient populations, and antibiotic utilization patterns may explain the differing results, although no data are available (clinical, epidemiologic, antibiotic usage, or experimental assays) to permit specific evaluation of potential differences in the virulence of antibiotic-resistant phenotype strains. However, the findings suggest that it may be reasonable for infection control purposes to monitor colonization with *S. aureus*, especially MR strains, at periodic intervals to detect increasing prevalence and permit possible intervention such as increasing emphasis on infection control defensive measures.

Little has been reported about the persistence of MRSA colonization in patients in community SNF and the optimal site for obtaining screening cultures to detect MRSA and to follow colonization. In the ACH setting Walsh et al.[14] reported that the most useful sites for detecting MRSA colonization were wounds, tracheostomy sites, and sputum from intubated patients. Some authors have suggested that the anterior nares may be the most common site of colonization[15] and yet may be a less important reservoir of colonization over longer time periods because nasal colonization can be transient. On the other hand, Rimland and Roberson[16] suggested that, in their VA Medical Center, rectal colonization was of equal or perhaps greater importance as a reservoir for MRSA because it may be more difficult to eradicate from this site. Many studies, however, did not include both nares and stool specimens in colonization screening and therefore may have underestimated the true colonization frequency.[1,4,7,17] Our study did not include wound specimens; therefore our figures could also have underestimated the true frequencies. However, the proportion of patients in our SNF with wounds was small, and any potential underestimate would have been small.

Our study was designed to include assessment of the relative value of nares as compared with rectal culture sites both for prevalence screening and for assessing the persistence of colonization. We found that nares specimens detected significantly higher *S. aureus* colonization frequency than stool swabs. However, use of nares alone, without stool specimens, would have missed 13% of *S. aureus* colonizations, and half of those missed were resis-

tant strains. We also found that in either nares or stool swabs, colonization could be either transient or persistent. The duration of colonization for MRSA in the nares was generally longer than in the rectal specimens. Nevertheless, a high percentage of patients in SNF are incontinent of stool; persistent colonization in rectal specimens may contaminate the environment and the hands of personnel and may readily serve as a reservoir for dissemination of *S. aureus*, including MR strains.

In our study, a significantly higher proportion of continuing patients than newly admitted patients were colonized by *S. aureus*. This implies acquisition of *S. aureus* during the nursing home stay, because 21% of newly admitted patients who were not colonized on admission acquired colonization after being admitted to the facility. Of these about half acquired colonization within 1 month after admission, and the average length of stay for acquisition of *S. aureus* colonization was 47 days. The distribution of antimicrobial pattern phenotypes in newly admitted patients was similar to those in continuing patients. The average stay in this SNF was 3 months, which is long enough to acquire colonization by strains in the facility. In a VA LTCF Bradley et al.[6] reported that 10% of the new admission acquired colonization while in the facility.

In our study the majority of the patients were admitted from ACH. Our data showed that colonized patients were no more likely to be admitted from ACH than were noncolonized patients. However, colonized patients were significantly more likely to be admitted from other LTCFs than were noncolonized patients.

It is pertinent to note that in some patients with persistent or intermittent colonization, the resistance phenotype was different at different times. Whether these changes reflected loss or gain of resistance factors by the same strain or simply acquisition of another strain, and whether the MSSA phenotypes, when evaluated by specific genotyping, were truly more likely to persist as compared with the MRSA phenotype, requires further investigation by use of molecular typing. Of interest was the finding that one third of the colonized patients had negative culture results by the end of the study, most with no relation to antibiotic therapy.

With regard to infections caused by *S. aureus* in our SNF study, 8.8% of all patients had development of *S. aureus* infections, and of these 53% were due to MRSA. In VA LTCF studies, Spindel et al.[18] and Muder et al.[7] found annual total *S. aureus* infection rates of approximately 4.3% and 7.6% respectively, of which about 41% and 75% were due to MRSA. Thus the analogous *S. aureus* infection frequency in our SNF was slightly higher than in these VA LTCF studies.

Some investigators have suggested that MRSA strains may be less virulent than MSSA,[13] whereas others have indicated that MRSA are more virulent.[7] In our study we could not demonstrate any differences in the ability of sensitive or resistant strains to cause infection. However, our numbers were too small for critical analysis. Furthermore, no one was hospitalized or died of MRSA infection during the study period. Muder et al.[7] suggested that underlying host factors are likely to be the most important factors leading to progression from colonization to infection. Similarly, in our study colonized patients who subsequently had development of infection were significantly more debilitated. Of patients with *S. aureus* infections, seven of 13 (53%) had been colonized previously with the same phenotype that later caused infection. Thus persistent colonization in debilitated patients is both a predictor and a risk factor for development of infection with *S. aureus* in the SNF setting; potential prevention and control measures should focus on the more debilitated patients. The low-to-moderate level of colonization and infection found in our study certainly does not constitute an epidemic situation in this SNF. However, the gradual increase in colonization and in infection frequencies over the past 3 years is of concern and suggests that in this SNF, specific intervention strategies could become warranted in the future.

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