MAJOR ARTICLE

Comparison of Both Clinical Features and Mortality Risk Associated with Bacteremia due to Community-Acquired Methicillin-Resistant *Staphylococcus aureus* and Methicillin-Susceptible *S. aureus*

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Background. The majority of research about community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) infection has focused on skin and soft-tissue infections. No literature has been published on the clinical features and outcomes of adult patients with CA-MRSA bacteremia in comparison with patients with community-acquired methicillin-susceptible *S. aureus* (CA-MSSA) bacteremia.

Methods. From 1 January 2001 through 31 December 2006, the demographic data and outcome of 215 consecutive adult patients admitted to a tertiary care center in Taiwan with *S. aureus* bacteremia (age, >16 years) who fulfilled the criteria for community-acquired *S. aureus* bacteremia were collected for analysis.

Results. The mean age ($\pm$SD) was 56.8 $\pm$ 20.5 years. There were 30 patients (14%) with CA-MRSA bacteremia and 185 (86%) patients with CA-MSSA bacteremia. Cutaneous abscess (odds ratio, 5.46; 95% confidence interval, 1.66–17.94) and necrotizing pneumonia (odds ratio, 24.81; 95% confidence interval, 2.63–234.03) were the independent predictors of CA-MRSA bacteremia; endovascular infection was the only independent predictor of CA-MSSA bacteremia. After Cox regression analysis, the independent significant risk factors for 30-day mortality included increased age, shock, and thrombocytopenia (<100,000 cells/μL). After adjustment, the day 30 mortality of patients with CA-MRSA bacteremia was not significantly higher than that of patients with CA-MSSA bacteremia (adjusted hazard ratio, 1.01; 95% confidence interval, 0.30–3.39; $P = .986$). Most (92%) of 25 available CA-MRSA isolates were multilocus sequence typing 59.

Conclusions. The number of adult patients with CA-MRSA bacteremia increased with time, and the disease was associated with more necrotizing pneumonia and cutaneous abscess but less endovascular infection than was CA-MSSA bacteremia. Patients with CA-MRSA bacteremia did not have higher mortality than did patients with CA-MSSA, even though most of the patients with CA-MRSA bacteremia did not receive empirical glycopeptide therapy.

Over the past few decades, a number of studies have shown that the clinical characteristics of patients infected with methicillin-resistant *Staphylococcus aureus* (MRSA) differ from those of patients with methicillin-susceptible *S. aureus* (MSSA) bacteremia. Patients with MRSA bacteremia are typically older, are more likely to have a history of MRSA colonization, and are hospitalized for a longer period [1–3]. Several studies, including 1 meta-analysis, have suggested that MRSA bacteremia is associated with a significantly higher mortality rate and length of hospitalization than is MSSA bacteremia [2–5].

In recent years, community-acquired MRSA (CA-MRSA) infections have emerged worldwide [6, 7]. A number of studies have shown differences between CA-MRSA infections and health care–associated MRSA infections. CA-MRSA cases are more likely to involve skin and soft-tissue infection but are less likely to involve bacteremia than are health care–associated MRSA cases,

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and CA-MRSA isolates may harbor staphylococcal cassette chromosome *mec* (SCC*mec)* type IV or type V [6, 7]. CA-MRSA strains causing life-threatening infections, such as necrotizing pneumonia and necrotizing fasciitis, were frequently found to carry the Panton-Valentine leukocidin (PVL) genes [8–10]. CA-MRSA strains have become the predominant cause of skin and soft-tissue infections in people seeking medical help at emergency departments in United States hospitals; such strains are usually associated with inadequate initial antibiotic therapy [11].

The majority of research about CA-MRSA infections has focused on skin and soft-tissue infections. In recent years, more and more cases of invasive CA-MRSA infection involving bacteremia have been reported [8, 12–14]. One retrospective series from Australia, which included adult patients, reported 15 episodes of CA-MRSA bacteremia, and the clinical features of CA-MRSA bacteremia seem to be similar to those of CA-MSSA bacteremia [13]. Another retrospective adult CA-MRSA bacteremia study from Taiwan showed more diabetes mellitus, chronic obstructive lung disease, and renal insufficiency among patients with CA-MRSA bacteremia than among the CA-MSSA group; however, the authors did not perform PVL and SCC*mec* analysis of their MRSA isolates, so some cases of nosocomial MRSA may have been misclassified as CA-MRSA [14].

MRSA is prevalent in Taiwan and accounts for >60% of the *S. aureus* isolates in most major hospitals [15]. Multilocus sequence typing 59, SCC*mec* V, and PVL–positive MRSA comprise the major clone of CA-MRSA infection in Taiwan, and that clone has been introduced into hospitals [16, 17]. Despite this, studies comparing adult CA-MRSA and CA-MSSA bacteremia have not been forthcoming. The present study was undertaken to investigate the clinical features and prognosis of patients with CA-MRSA bacteremia, compared with those of patients of CA-MSSA bacteremia.

PATIENTS, MATERIALS, AND METHODS

Patient selection. National Taiwan University Hospital (Taipei) is a university hospital with 2500 beds and provides both primary and tertiary care in northern Taiwan, with an average of ~67,000 patient discharges per year. The annual emergency department census typically records >100,000 visits. A central microbiology laboratory is responsible for management of all clinical specimens. Positive blood culture results are reported by telephone to the attending physicians in charge, once bacterial growth has been detected and before the results of antimicrobial susceptibility testing and the final organism identification are available. From 1 July 2004 through 31 December 2006, a prospective observational program was conducted for all patients aged >16 years with positive *S. aureus* blood cultures within 48 h after their arrival at the emergency department. All patients with blood culture results positive for *S. aureus* and compatible clinical findings were defined as having cases of true bacteremia. To increase the statistical power of the comparison, we included retrospective data of consecutive *S. aureus* bacteremia at the National Taiwan University Hospital emergency department from 1 January 2001 through 30 June 2004. Patients with community-onset *S. aureus* bacteremia were identified from a laboratory database maintained in the computer system at National Taiwan University Hospital.Affected patients who had been hospitalized for >48 h or who had been discharged from any hospital within the 48 h before receiving the infection diagnosis were defined as having hospital-acquired bacteremia and were excluded from this study. We included patients with community-acquired *S. aureus* bacteremia who had not resided in a long-term care facility, had not been hospitalized in an acute care facility, had not been treated with use of central intravenous catheters or long-term venous access devices, had not used urinary catheters, had not used other long-term percutaneous devices, had not undergone prior surgical procedures, and were not receiving dialysis within 1 year before onset of *S. aureus* bacteremia.

Data collection. All patients were evaluated using a structured recording form. The clinical course of infection and infection foci of bacteremia were evaluated and recorded according to information supplied by primary care physicians and medical records. The diagnosis of the infection focus of bacteremia was based on clinical, bacteriological, and radiological investigations. Deep-seated infected foci were defined as any of the following: infective endocarditis, mycotic aneurysm, osteomyelitis, septic arthritis, pyomyositis, necrotizing pneumonia or empyema, and abscess formation in any deep organ, such as the liver or kidney. Modified Duke's criteria were applied for infective endocarditis [18]. Necrotizing pneumonia was diagnosed according to clinical and radiological findings of a single or multiple cavitary lesions demonstrated in chest radiographs or chest CT scans. Cutaneous abscess was defined as collections of pus within the dermis and deeper skin tissues [19]. If no infection focus could be identified, the bacteremia was classified as being primary bacteremia.

The following data were recorded for each patient: age, sex, underlying illness, severity of illness classified with Charlson comorbidity score [20], history of hospitalization or outpatient department involvement within the previous year, existence of percutaneous device catheter, initial laboratory finding, empirical antimicrobial therapy used before blood culture and susceptibility test results were available, antimicrobial agents used, outcome, and length of hospital stay. The patients were assessed for 30-day status of survival or mortality by follow-up at outpatient clinics. For those patients who did not come to outpatient clinics, telephone contacts were made to confirm their survival status.

Microbiological laboratory procedures. Identification of *S.*

aureus was based on colony morphology; Gram stain, positive catalase reaction, and slide agglutination test results (bioMérieux) [21]; and/or results obtained with the Phoenix system (Becton Dickinson). The disk diffusion susceptibility test was used in this study, and the antibiotics tested included oxacillin, vancomycin, minocycline, levofloxacin, ciprofloxacin, tetracycline, trimethoprim-sulfamethoxazole, gentamicin, amikacin, clindamycin, and rifampin [22]. Resistance to oxacillin was confirmed by detection of the presence of the *mecA* gene by PCR. The presence of the PVL gene *lukF-lukS* was investigated by PCR, with use of a primer described elsewhere [23]. Presence of the SCC*mec* elements (I–V) and the *mec*A gene was determined by methods described elsewhere [24, 25]. Multilocus sequence typing was performed as described elsewhere [26].

Statistical analyses. Annual prevalence rates of CA-MSSA and CA-MRSA bacteremia were calculated as the number of cases of CA-MSSA and CA-MRSA bacteremia, respectively, per 1000 emergency department visits. The increasing trend via time of prevalence was examined by a Poisson regression analysis. The demographic distribution and clinical features of patients with CA-MSSA and CA-MRSA bacteremia were compared. Means ($\pm$SD) were calculated for continuous variables. Percentages were used for categorical variables. The associations between the potential risk factors and CA-MRSA and CA-MSSA bacteremia were investigated using univariate and multivariate logistical regression analyses. Crude and adjusted ORs and the corresponding 95% CIs were calculated. The cumulative survival time between the day of the first blood culture results that were positive for *S. aureus* and death, the last outpatient clinic visit, or the last telephone contact during the study period was calculated by the Kaplan-Meier method for patients with CA-MSSA or CA-MRSA bacteremia. The difference in 30-day cumulative survival of patients with CA-MRSA and CA-MSSA bacteremia was tested by Wilcoxon rank-sum test. The potential factors associated with survival of patients with community-acquired *S. aureus* bacteremia were examined by the Cox proportional hazards regression analysis. The proportional hazard assumption was tested by examining whether there was significant interaction between prognostic factors and time. Data were analyzed with SPSS software, version 10.0 (SPSS), for Windows.

RESULTS

Patients, risk factors, and clinical features. From 1 January 2001 through 31 December 2006, there were 580 nonduplicated, consecutive, adult patients with community-onset *S. aureus* bacteremia. Of these, 215 patients (37.1%) matched the criteria of community-acquired *S. aureus* bacteremia. The mean ($\pm$SD) patient age was 56.8 $\pm$ 20.5 years. There were 30 patients (14%) with CA-MRSA bacteremia and 185 patients (86%) with CA-MSSA bacteremia. The annual prevalence of CA-MRSA and CA-MSSA bacteremia in the emergency department is shown in figure 1. The prevalence of CA-MRSA bacteremia significantly increased, at a rate of 32% per year ($P = .016$, by test for trend), whereas the prevalence of CA-MSSA bacteremia remained stable over time ($P = .144$, by test for trend).

The demographic data of all patients with CA-MRSA and CA-MSSA bacteremia is summarized in table 1. There was no statistical difference in sex, age, and underlying comorbidities between patients with CA-MRSA bacteremia and patients with CA-MSSA bacteremia. For other associated infection sites, CA-MRSA bacteremia was more typically associated with superficial skin and soft-tissue infections (OR, 2.69; 95% CI, 1.07–6.79; $P = .044$), cutaneous abscess (OR, 6.36; 95% CI, 1.97–20.5; $P = .004$), and necrotizing pneumonia (OR, 3.40; 95% CI, 0.96–12.11; $P = .069$). Patients with CA-MSSA bacteremia were significantly more likely to have endocarditis or mycotic aneurysm.

Multivariate analysis revealed that cutaneous abscess (OR, 5.46; 95% CI, 1.66–17.94) and necrotizing pneumonia (OR, 24.81; 95% CI, 2.63–234.03) were the 2 independent factors for prediction of CA-MRSA bacteremia (table 1). Endocarditis and mycotic aneurysm were the only independent negative predictors of CA-MRSA bacteremia (OR, 0.08; 95% CI, 0.01–0.69) (table 1).

Treatment and outcome. Four (13.3%) of the 30 patients with CA-MRSA bacteremia received glycopeptides during the first 48 h of hospitalization, before culture and susceptibility test results were available, and another patient received initial treatment with doxycycline. The other 25 patients (83%) did

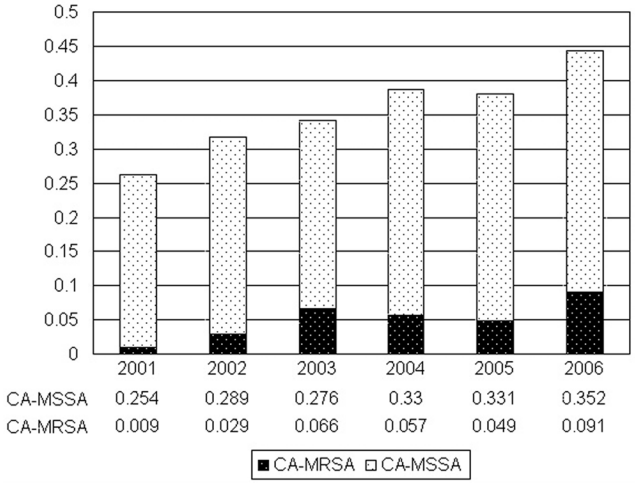

Figure 1. Annual prevalence of community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) and community-acquired methicillin-susceptible *S. aureus* (CA-MSSA) bacteremia expressed as cases per 1000 emergency department visits (2001–2006).

Table 1. Comparison of clinical characteristics, empirical antibiotic use, and outcome for patients with community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) and community-acquired methicillin-susceptible *S. aureus* (CA-MSSA) bacteremia.

Characteristic	CA-MRSA (n = 30)	CA-MSSA (n = 185)	Univariate OR (95% CI)	Multivariate OR (95% CI)
Age, mean years ± SD	55.3 ± 20.3	57.1 ± 20.6	0.99 (0.98–1.02)	…
Male sex	21 (70.0)	128 (69.2)	1.07 (0.46–2.47)	…
Comorbid condition				
Diabetes mellitus	10 (33.3)	49 (26.5)	1.38 (0.61–3.17)	…
Cancer	1 (3.3)	10 (5.4)	0.60 (0.07–4.89)	…
Liver cirrhosis	1 (3.3)	14 (7.6)	0.42 (0.05–3.33)	…
Cardiovascular accident	4 (13.3)	14 (7.6)	1.88 (0.57–6.15)	…
Bed-ridden status	3 (10.0)	18 (9.7)	1.03 (0.28–3.74)	…
Injection drug use	4 (13.3)	30 (16.2)	0.80 (0.26–2.44)	…
Charlson comorbidity score >3	4 (13.3)	27 (14.6)	0.90 (0.29–2.78)	…
No underlying disease	11 (36.7)	50 (27.0)	1.56 (0.70–3.51)	…
Infection focus[a]				
Without deep-seated focus				
Primary bacteremia	1 (3.3)	25 (13.5)	0.22 (0.03–1.69)	…
Pneumonia[b]	3 (10.0)	24 (13.0)	0.75 (0.21–2.65)	…
Superficial skin and soft tissue	8 (26.7)	22 (11.9)	2.69 (1.07–6.79)[c]	…
Cutaneous abscess	6 (20.0)	7 (3.8)	6.36 (1.97–20.50)[d]	5.46 (1.66–17.94)[d]
Urinary tract infection	1 (3.3)	3 (1.6)	2.09 (0.21–20.80)	…
With deep-seated focus				
Osteomyelitis or septic arthritis	5 (16.7)	38 (20.5)	0.77 (0.28–2.16)	…
Endocarditis or mycotic aneurysms	3 (10.0)	54 (29.2)	0.27 (0.08–0.93)[c]	0.08 (0.01–0.69)[c]
Other deep-seated abscess[e]				
Pyomyositis or necrotizing fasciitis	4 (13.3)	30 (16.2)	0.80 (0.26–2.44)	…
Necrotizing pneumonia or empyema	4 (13.3)	8 (4.3)	3.40 (0.96–12.11)	24.81 (2.63–234.03)[d]
Epidural abscess	1 (3.3)	6 (3.2)	1.03 (0.12–8.86)	…
Inactive empirical antibiotic therapy	25 (83.3)	13 (7.0)	66.15 (21.73–201.43)[d]	…
Outcome				
7-Day mortality[f]	1 (3.3)	16 (8.7)	0.36 (0.05–2.84)	…
30-Day mortality[f]	3 (10)	24 (13.2)	0.73 (0.21–2.60)	…
Length of hospitalization ⩾30 days	17 (56.7)	91 (49.2)	1.35 (0.62–2.94)	…

NOTE. Data are no. (%) of patients, unless otherwise indicated.

[a] Patients may have had >1 infection focus.

[b] Patients with pulmonary infiltrates without cavitations on radiography and without empyema were classified as having pneumonia. Cases with necrotizing pneumonia and empyema were not included in the classification of pneumonia.

[c] $.01 < P < .05$.

[d] $P < .01$.

[e] Patients with MRSA bacteremia with other deep-seated abscess not shown included perirenal abscess MRSA (n = 1) , prostate abscess MRSA (n = 1), splenic abscess MSSA (n = 1), liver abscess MSSA (n = 1), and purulent pericarditis MSSA (n = 1).

[f] One patient lost to follow up before day 7, and 3 patients lost to follow-up before day 30.

not receive an agent active against MRSA during the first 48 h of empirical treatment. Most patients (172 patients [93%]) with CA-MSSA bacteremia received an empirical antimicrobial agent active against MSSA during the first 48 h of hospitalization, including 166 patients (90%) who received a β-lactam and 6 patients (3%) who received a glycopeptide. After identification and susceptibility of *S. aureus* strains isolated from blood cultures, patient treatment was adjusted accordingly (e.g., treatment with oxacillin or cefazolin with or without gentamicin for MSSA bacteremia and treatment with glycopeptide with or without gentamicin for MRSA bacteremia).

There were 212 patients who confirmed their survival ⩾30 days after the onset of bacteremia, by follow-up at outpatient clinics or by telephone contact. The follow-up was quite complete, because only 3 patients were censored before 30 days (1 patient each was lost to follow-up at 1, 9, and 22 days). Kaplan-Meier survival curves for patients with CA-MRSA and CA-MSSA bacteremia are shown in figure 2. The 30-day cumulative survival was 90% for patients with CA-MRSA bacteremia and was 86.9% for patients with CA-MSSA bacteremia; no significant difference was evident ($P = .582$, by Wilcoxon rank-sum test). Univariate analysis identified age, female sex, altered men-

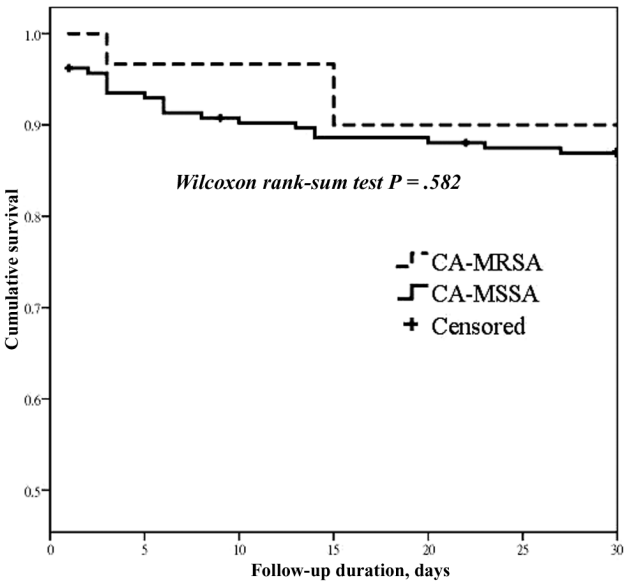

Figure 2. Kaplan-Meier survival curves, at 30 days, for patients with community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) and community-acquired methicillin-susceptible *S. aureus* (CA-MSSA) bacteremia.

tal status, shock, acute renal failure, respiratory failure, thrombocytopenia level <100,000 cells/μL, and band form $\geqslant$10% in WBC classification as predictors of 30-day mortality ($P < .05$). The results of Cox multivariate regression analysis suggested that age, shock, and thrombocytopenia level <100,000 cells/μL remained as risk factors for 30-day mortality (table 2).

There was no significant difference between the mortality rate of patients with CA-MRSA and that of patients with CA-MSSA bacteremia (hazard ratio, 0.74; 95% CI, 0.22–2.45; $P = .619$) after 30 days of follow-up. The proportional hazard assumption was met ($P = .475$). Methicillin-resistance was not a significant predictor of mortality after adjustment for the effects of other variables (adjusted hazard ratio, 1.01; 95% CI, 0.30–3.39; $P = .986$).

Bacteriological study including PVL gene and SCC-mec. From 30 patients with CA-MRSA bacteremia, 25 nonduplicate MRSA isolates were available for further bacteriologic study. In multilocus sequence typing analysis, 92% (23 of 25) were ST 59. Twenty-four CA-MRSA isolates carried the SCC*mec* type IV or V gene, and SCC *mec* was nontypeable in 1 isolate. The distribution of PVL gene carriage, antimicrobial susceptibilities, and SCC*mec* type in CA-MRSA isolates are shown in table 3. CA-MRSA isolates with SCC*mec* V were more likely to carry the PVL gene than were isolates with SCC*mec* IV ($P < .05$) (table 3). All CA-MRSA isolates were susceptible to trimethroprim-sufamethoxazole, vancomycin, levofloxacin, minocycline, and rifampin.

DISCUSSION

To our knowledge, this is the first report of a case series that compares adult patients with CA-MRSA bacteremia with adult patients with CA-MSSA bacteremia in a nonoutbreak setting. In adults, CA-MRSA–causing bacteremia is uncommon [27, 28]. In previous studies of CA-MRSA infection with a high

Table 2. Univariate and multivariate analysis of risk factors associated with 30-day mortality for patients with community-acquired methicillin-resistant *Staphylococcus aureus* bacteremia.

	Hazard ratio (95% CI)	
Risk factor	Univariate	Multivariate
Age (every 1 year)	1.03 (1.00–1.05)[a,b]	1.03 (1.01–1.06)[a,c]
Female sex	2.19 (1.03–4.67)[b]	…
Liver cirrhosis	2.48 (0.86–7.17)	…
Congestive heart failure	3.04 (0.92–10.10)	…
No underlying disease	0.57 (0.22–1.51)	…
Charlson comorbidity score >2	1.47 (0.64–3.36)	…
Shock	16.04 (6.06–42.43)[c]	11.72 (4.30–31.95)[c]
Altered mental status	4.94 (2.29–10.66)[c]	…
Acute renal failure	3.61 (1.67–7.78)[c]	…
Respiratory failure	6.27 (2.93–13.42)[c]	…
Band form in WBC classification $\geqslant$10%	6.92 (3.24–14.75)[c]	…
Platelet level, <100,000 cells/μL	4.43 (2.07–9.47)[c]	3.28 (1.46–7.37)[c]
Methicillin resistance	0.74 (0.22–2.45)	…
Inactive empirical antibiotic	1.32 (0.46–3.82)	…

[a] Mortality increased 3% every year.
[b] $.01 < P < .05$.
[c] $P < .01$.

Table 3. Molecular typing and antimicrobial susceptibility of available community-acquired methicillin-resistant *Staphylococcus aureus* isolates.

Variable	Staphylococcal cassette chromosome *mec* Type IV (n = 14)	Staphylococcal cassette chromosome *mec* Type V (n = 10)	P
Panton-Valentine leukocidin gene			.001
Positive	4 (28.6)	10 (100)	
Negative	10 (71.4)	0 (0)	
Multilocus sequence typing			.459
ST 59	12 (85.7)	10 (100)	
Other ST			
ST 1	1 (7.1)	0 (0)	
ST 30	1 (7.1)	0 (0)	
Susceptibility[a] to non–β-lactam			
Trimethoprim-sulfamethoxazole	14 (100)	10 (100)	
Minocycline	14 (100)	10 (100)	
Levofloxacin	14 (100)	10 (100)	
Rifampin	14 (100)	10 (100)	
Ciprofloxacin	14 (100)	8 (80)	.163
Amikacin	13 (92.9)	10 (100)	1.000
Gentamicin	9 (64.3)	10 (100)	.053
Tetracycline	4 (28.6)	3 (30)	1.000
Erythromycin	2 (14.3)	0 (0)	.493
Clindamycin	1 (7.1)	1 (10)	1.000

NOTE. Data are no. (%) of patients, unless otherwise indicated. For a single isolate, staphylococcal cassette chromosome *mec* was nontypeable and was not included in this table.

[a] Susceptibility determined by the disk method.

percentage of skin and soft-tissue infections, <5% of the patients were bacteremic [27, 28]. CA-MRSA bacteremia is also uncommon in children [8]. Somewhat contrary to these reports, the present study revealed an increasing prevalence of CA-MRSA bacteremia in Taiwan.

Although PVL and SCC*mec* IV seem to be good epidemiologic markers for CA-MRSA infection in the United States and some other countries [6, 29], the most common CA-MRSA strain in Taiwan, ST 59, may not carry the PVL gene, and some PVL-positive strains belong to SCC*mec* V [16]. This unique characteristic of the predominant CA-MRSA strain in Taiwan is not found in the prevalent European and US CA-MRSA strains. However, ST 59 was detected in a study conducted in San Francisco [30].

In comparison with CA-MSSA bacteremia, CA-MRSA bacteremia in our cohort was more likely to be associated with superficial skin and soft-tissue infections. This supports the notion that bacteremia due to CA-MRSA strains is more likely to involve skin and soft-tissue infections than is bacteremia with other non–CA-MRSA strains, including most health care–associated MRSA bacteremia [31]. In our study, more cutaneous abscess cases were seen in patients with CA-MRSA bacteremia than in patients with CA-MSSA bacteremia. These findings agree with previous findings that cutaneous abscess and furuncles are the most common type of CA-MRSA skin and soft-tissue infection [32, 33]. The finding that necrotizing pneumonia or empyema was common in our patients with CA-MRSA bacteremia is similar to the situation in pediatric patients [8].

In our study, fewer patients with CA-MRSA bacteremia than with CA-MSSA bacteremia presented with infective endocarditis. Likewise, a previous study reported that patients with CA-MSSA bacteremia were more likely than those with CA-MRSA bacteremia to have infective endocarditis [34]. In a multinational prospective study of *S. aureus* infective endocarditis, more cases of MSSA endocarditis than of MRSA endocarditis were community acquired (61% vs. 20%) [35].

With regard to the underlying disease and predisposing factors, our study revealed no difference in underlying disease between patients with CA-MRSA bacteremia and patients with CA-MSSA bacteremia. These findings complement a recent report that no clinical or epidemiological risk factors can reliably distinguish CA-MRSA from CA-MSSA in patients hospitalized for community-acquired *S. aureus* infections [36].

The predictors of mortality in our patients with community-acquired *S. aureus* bacteremia included shock, advanced age, and thrombocytopenia, all of which have been reported [2, 37, 38]. Similar to a previous study [39], we could not link CA-MRSA bacteremia with higher mortality than that associated with CA-MSSA bacteremia after adjusting for confounding factors. In a previous study that compared CA-MRSA and CA-MSSA invasive infection in children [8], the mortality rate was similar, but children with invasive CA-MRSA infections were hospitalized longer than were children with invasive infections caused by CA-MSSA isolates. A neonatal study comparing CA-MRSA and CA-MSSA bacteremia and the mortality rates of the 2 groups of affected patients also showed no significant difference [12].

There are several limitations to our present investigation. First, some patients in our cohort were analyzed retrospectively, creating the possibility of information bias in history collection. However, if we analyze the data of the 109 patients enrolled prospectively, the results were approximately the same as those for the data of all 215 patients. In these 109 patients who were enrolled prospectively, there were more cutaneous abscesses (16.7% vs. 3.3%) and necrotizing pneumonia (16.7% vs. 5.5%) and less endocarditis (5.6% vs. 30.8%) in patients with CA-MRSA bacteremia than in the CA-MSSA group; these results were significantly different in univariate analysis ($P < .05$) but did not reach statistical significance in multivariate analysis (probably because there were not enough cases). Furthermore, the microbiological study did show that the MRSA isolates of

the patients in our present study, collected either prospectively or retrospectively, were all compatible with CA-MRSA typing. Second, the number of cases of CA-MRSA bacteremia may be too small to show the difference of some clinical presentations and outcome in comparison with CA-MSSA bacteremia. Only a study involving a larger number of patients will overcome this limitation.

In conclusion, the number of patients with CA-MRSA bacteremia increased with time, and CA-MRSA bacteremia was associated with more cases of necrotizing pneumonia and cutaneous abscess but fewer cases of endovascular infection than was CA-MSSA bacteremia. Although no significant difference in mortality between CA-MRSA bacteremia and CA-MSSA bacteremia was evident, determining the optimal empirical antibiotic choice in community-acquired *S. aureus* bacteremia is still a challenge to clinicians.

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