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International Journal of Antimicrobial Agents 32 (2008) 326–332

INTERNATIONAL JOURNAL OF Antimicrobial Agents

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Outcome of patients with meticillin-resistant *Staphylococcus aureus* bacteraemia at an emergency department of a medical centre in Taiwan

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Received 12 March 2008; accepted 14 April 2008

Abstract

The number of patients presenting to the Emergency Department (ED) with meticillin-resistant *Staphylococcus aureus* (MRSA) is increasing, but few studies focus on patients with bacteraemia. From January 2001 to June 2006 the clinical characteristics and outcome of 177 consecutive patients with MRSA bacteraemia visiting an ED of a university hospital were studied. The average age of the patients was 65.8 years. Healthcare-associated MRSA bacteraemia comprised 76.3% of all cases. Catheter-related bacteraemia was the most common type of infection (22.6%), followed by soft tissue infection (20.9%) and primary bacteraemia (15.3%). Different types of infection were significantly related to different outcome. In-hospital mortality was 33.3%, but the mortality decreased to 17.7% when patients with rapidly fatal disease and mortality within 3 days were excluded. All isolates exhibited lower susceptibility to vancomycin (minimum inhibitory concentration (MIC) 1–2 μg/mL). Factors associated with mortality included severity of underlying illness, severity of bacteraemia and persistent bacteraemia. A detrimental effect of elevated MIC could not be demonstrated despite applying several definitions of patient outcome. Patients admitted to the ED with MRSA bacteraemia carry high overall mortality; however, the severity of underlying illness, severity of bacteraemia and persistent bacteraemia are correlated with mortality, but not vancomycin MICs (2 μg/mL) of MRSA isolates.

Keywords: Meticillin-resistant *Staphylococcus aureus*; Bacteraemia; Emergency department

1. Introduction

The number of patients presenting to the Emergency Department (ED) with meticillin-resistant *Staphylococcus aureus* (MRSA) infection is increasing [1], but few studies focus on patients with bacteraemia [2–5]. In Taiwan, the prevalence of MRSA amongst nosocomial staphylococcal infections was ca. 60% [6], and MRSA is an emerging community-acquired pathogen [7]. In our previous study of patients at the ED with MRSA bacteraemia, patients with true community MRSA bacteraemia were rarely seen [5]; however, in recent years the number of these patients has been increasing at our hospital [8]. Concern about MRSA bacteraemia is due to its poor response to glycopeptide treatment [9,10], and many factors are reported to be closely associated with poor response, including severity of illness [10], type of infection [11], persistence of bacteraemia [12] and, notably, increased minimum inhibitory concentrations (MICs) of MRSA isolates [13,14].

Many patients with MRSA bacteraemia have complex underlying illnesses and develop bacteraemia during prolonged hospital stay. Thus, we are interested in the outcome of patients with MRSA bacteraemia treated at the ED. Despite some studies suggesting that blood cultures ordered in the adult ED are rarely clinically useful [15,16], MRSA bacteraemia detected at the ED would usually change the antimicrobial agent at our hospital, where empirical glycopeptide use is not recommended [17]. Moreover, bacteraemia recovered at the ED is usually less complicated compared with nosocomial bacteraemia [18]. However, these patients might not receive complete examinations if rapid mortality occurs. With increasing MRSA bacteraemia aris-

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doi:10.1016/j.ijantimicag.2008.04.011

ing from the community [4,8], we describe the results of our observational study of MRSA bacteraemia at a university hospital ED, focusing on the risk factors for poor patient outcome.

2. Materials and methods

2.1. Hospital setting and patient selection

National Taiwan University Hospital (NTUH) is a 2200-bed, academically affiliated medical centre providing both primary and tertiary care in northern Taiwan. The annual ED census recorded more than 100 000 visits. From January 2001 to May 2002 a prospective study was initiated for all patients aged >16 years with positive *S. aureus* blood cultures within 48 h of arrival at the ED. The study was discontinued due to the epidemic of severe acute respiratory syndrome and was re-started in July 2004. All patients were evaluated using a structured recording form. To complete the whole picture of MRSA bacteraemia at NTUH ED, data from patients with MRSA bacteraemia were retrospectively collected with the same form from June 2002 to June 2004. Thus, all patients with MRSA bacteraemia presenting to the ED from January 2001 to June 2006 were incorporated in this study.

Patients who had been hospitalised for >48 h or discharged from any hospital within 48 h were considered to have nosocomial bacteraemia [5]. Healthcare-associated bacteraemia included bacteraemia related to receiving haemodialysis, chemotherapy or parenteral nutrition on an outpatient basis, nursing home stay, recent surgery or prior hospitalisation within 1 year [5]. Bacteraemia in patients without any of the risk exposures mentioned above was defined as community acquired.

2.2. Data collection

The clinical courses and primary sites of bacteraemia were evaluated according to the information supplied by primary care physicians and medical records. Diagnosis of the infection focus of bacteraemia was based on clinical, bacteriological and radiological investigations. Infective endocarditis (IE) was defined by modified Duke's criteria [19]; catheter-related bacteraemia (CRBSI) was defined as a positive semiquantitative tip culture (≥15 colony-forming units) and/or high clinical suspicion, although differential time to positivity was not applied owing to time to positivity not being routinely recorded; pneumonia was defined as a positive culture for MRSA in purulent sputum samples and the presence of newly developed lung infiltrates; urinary tract infection (UTI) was defined as a positive urine culture and pyuria; orthopaedic infections included osteomyelitis documented by pathology or imaging study with compatible clinical findings, prosthetic joint infection or septic arthritis and/or positive microbiological results obtained according to current suggestions [20]; and soft tissue infection (STI) was defined as clinical soft tissue inflammation plus bacteraemia. If no primary focus could be identified, the bacteraemia was classified as primary.

The following data were recorded for each patient: age; sex; underlying illness; severity of illness classified by McCabe–Jackson criteria [21]; severity of bacteraemia assessed by the Pitt bacteraemia score [22]; septic shock [22]; persistent bacteraemia (defined as positive blood culture after 5 days of glycopeptide treatment); installation of foreign body, including prosthetic joint, pacemaker or intravenous/Foley catheter; debridement, including catheter/foreign body removal or surgical debridement of infected tissue; and metastatic infection, which included documented MRSA infection remote from the original site. Inactive malignancy was not included in the underlying illnesses. For patients not admitted to NTUH, telephone contact was performed to collect the required information.

Use of glycopeptides prior to knowledge of the blood culture results was defined as empirical therapy. Glycopeptide use (either vancomycin or teicoplanin) is the suggested regimen to treat MRSA infection at our institute, and linezolid is under the control of infectious disease physicians. In addition, early initiation of empirical glycopeptide treatment is not encouraged at our institute [17]. Adjustment of vancomycin dosage to achieve a trough level >10 μg/mL is suggested and is monitored by clinical pharmacists.

Several endpoints were used to evaluate the outcome of patients, including in-hospital mortality, 14-day mortality, and mortality excluding patients who died within 3 days, patients with McCabe rapidly fatal disease or patients with mortality not related to MRSA bacteraemia.

2.3. Microbiology and antimicrobial susceptibility

Blood culture specimens were inoculated into BACTEC or BACTEC PLUS culture bottles using the BACTEC 9000 system (Becton Dickinson, Sparks, MA). Identification of *S. aureus* was based on the morphology of colonies grown on trypticase soy agar supplemented with sheep blood (BBL Microbiology Systems, Cockeysville, MD), results of Gram staining and a positive slide or tube coagulase test. Susceptibilities to antimicrobial agents were determined by the standard disk diffusion method [23]. Since 2006, a 30 μg cefoxitin disk (BBL Microbiology Systems) was applied to detect MRSA [24]. Clinical isolates of MRSA were collected and stored at −70 °C in trypticase soy broth (Difco Laboratories, Detroit, MI) supplemented with 15% glycerol. The MICs of vancomycin, teicoplanin, linezolid and daptomycin were further determined by the broth microdilution method for all MRSA isolates [25,26].

2.4. Statistical analysis

Several endpoints of patient outcome were used to evaluate the factors related to poor prognosis amongst patients with MRSA bacteraemia recovered at the ED. The mean and

Table 1
Clinical characteristics and in-hospital and 14-day mortality of 177 patients with meticillin-resistant *Staphylococcus aureus* (MRSA) bacteraemia[a]

Characteristic	Patient group		
	Total ($n = 177$)	In-hospital mortality ($n = 59$)	14-day mortality ($n = 37$)
Age (years) (mean ± S.D.)	65.8 ± 16.2	71.7 ± 12.4[b]	69.5 ± 13.8
Sex (M/F) (n)	105/72	35/24	23/14
Source of patients			
Community	21 (11.9)	3 (5.1)	2 (5.4)
Healthcare-associated	135 (76.3)	45 (76.3)	28 (75.7)
Nosocomial	21 (11.9)	11 (18.6)	7 (18.9)
Persistent bacteraemia > 5 days	35 (19.8)	18 (30.5)[b]	7 (18.9)
Polymicrobial bacteraemia	24 (13.6)	13 (22.0)[b]	11 (29.7)[b]
Foreign body	78 (44.1)	29 (49.2)	19 (51.4)
Debridement	69 (39.0)	14 (23.7)[b]	4 (10.8)[b]
Severity of illness (McCabe classification)			
Rapidly fatal disease	13 (7.3)	11 (18.6)[b]	9 (24.3)[b]
Ultimately fatal disease	93 (52.5)	35 (59.3)	18 (48.6)
Non-fatal disease	71 (40.1)	13 (22.0)	10 (27.0)
Pitt bacteraemia score (mean ± S.D.)	3.57 ± 3.2	5.98 ± 3.7[b]	7.24 ± 3.7[b]
Septic shock	86 (48.6)	49 (83.1)[b]	36 (97.3)[b]
Empirical vancomycin	29 (16.4)	10 (16.9)	6 (16.2)
Type of infection			
Catheter-related	40 (22.6)	13 (22.0)	7 (18.9)
Soft tissue	37 (20.9)	8 (13.6)	4 (10.8)[b]
Primary bacteraemia	27 (15.3)	10 (16.9)	8 (21.6)
Lower respiratory tract	24 (13.6)	16 (27.1)[b]	12 (32.4)[b]
Orthopaedic	16 (9.0)	1 (1.7)	0
Infective endocarditis (IE)	12 (6.8)	5 (8.5)	3 (8.1)
Urinary tract	10 (5.6)	2 (3.4)	2 (5.4)
Endovascular infection other than IE	9 (5.1)	3 (5.1)	0
Biliary tract	2 (1.1)	1 (1.7)	1 (2.7)
Underlying illness/condition			
Diabetes mellitus	65 (36.7)	23 (39.0)	12 (32.4)
End-stage renal disease	44 (24.9)	13 (22.0)	6 (16.2)
Stroke	41 (23.2)	17 (28.8)	12 (32.4)
Heart disease	38 (21.5)	15 (25.4)	8 (21.6)
Active malignancy	35 (19.8)	18 (30.5)[b]	13 (35.1)[b]
Liver cirrhosis	13 (7.3)	4 (6.8)	3 (8.1)
Intravenous drug user	4 (2.3)	0	0
Intravenous catheter use	55 (31.1)	20 (33.9)	12 (32.4)
Foley catheter use	18 (10.2)	9 (15.3)	5 (13.5)
Mortality			
Day 3	24 (13.6)	24 (40.7)	24 (64.9)
Day 7	28 (15.8)	28 (47.5)	28 (75.7)
Day 14	37 (20.9)	37 (62.7)	37 (100)
In-hospital mortality	59 (33.3)	59 (100)	N.A.
Metastatic infection	23 (13.0)	12 (20.3)[b]	5 (13.5)
Vancomycin MIC 2 μg/mL	40 (22.6)	13 (22.0)	9 (24.3)
Vancomycin MIC 1 μg/mL	137 (77.4)	46 (78.0)	28 (75.7)

S.D., standard deviation; N.A., not applicable; MIC, minimum inhibitory concentration.
[a] All data are n (%) unless otherwise stated.
[b] Significantly associated with mortality ($P < 0.05$).

standard deviation were calculated for continuous variables. Percentage was used for categorical variables. Student's t-test was used for comparison of continuous variables, whilst categorical variables were analysed with the χ^2 or Fisher's exact test. Factors associated with death in the univariate analysis ($P < 0.1$) were further evaluated by forward logistic regression. Data were collected in a Microsoft Excel database (Microsoft Excel 2001; Microsoft Corp., Seattle, WA) and analysed with SPSS software for Windows release 10.0 (SPSS Inc., Chicago, IL).

3. Results

From January 2001 to June 2006 a total of 177 patients presenting to NTUH ED with MRSA bacteraemia were included. The clinical characteristics of the patients are summarised in

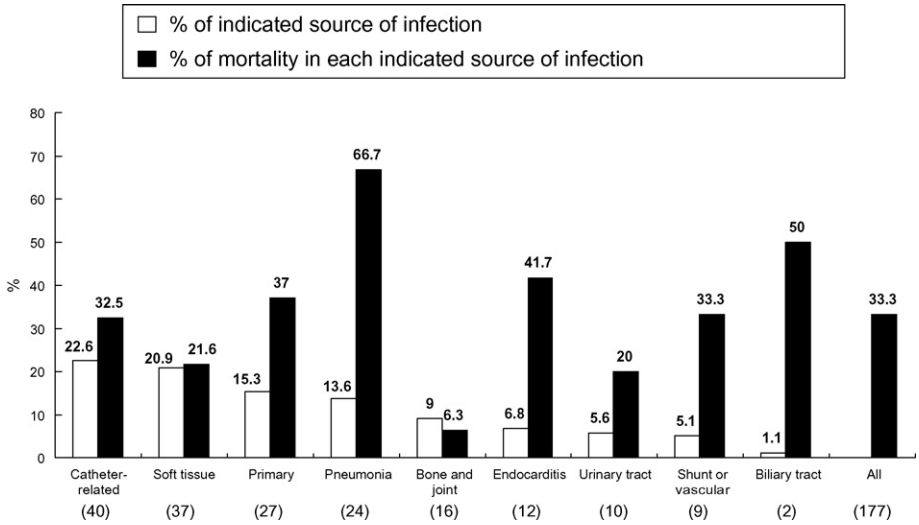

Fig. 1. Distribution of types of infection associated with meticillin-resistant *Staphylococcus aureus* (MRSA) bacteraemia and in-hospital mortality (number in parenthesis indicates number of patients).

Table 1. The mean age was 65.8 years. Fifty-nine percent of the patients were male. Healthcare-associated bacteraemia was most common (76.3%). Twenty percent of patients had bacteraemia lasting >5 days and 13.6% had polymicrobial bacteraemia. Forty-four percent of patients had a foreign body in place at the time of bacteraemia onset and 39% underwent debridement or removal of a foreign body during the course of the episode. Only 29 patients (16.4%) received empirical vancomycin therapy.

CRBSI was the most common type of infection (22.6%), followed by STI (20.9%), primary bacteraemia (15.3%), lower respiratory tract infection (13.6%), orthopaedic infection (9.0%), IE (6.8%), UTI (5.6%), endovascular infection other than IE (5.1%) and biliary infection (1.1%). The most common underlying illnesses were diabetes mellitus (36.7%) and renal insufficiency (24.9%). An intravenous catheter was used in 31.1% of patients. The in-hospital mortality rate was 33.3% and was associated with increased age, persistent bacteraemia, polymicrobial bacteraemia, fewer debridements, rapidly fatal disease according to the McCabe classification, higher Pitt bacteraemia score, septic shock, lower respiratory tract infection, active malignancy and metastatic infection (Table 1).

Analysis of patients who died within 14 days revealed a similar set of risk factors, as well as lower mortality rate amongst patients with STI-associated bacteraemia. Differences in mortality rates amongst different types of infection were significant. For in-hospital mortality, bacteraemia due to lower respiratory tract infection carried the highest mortality (66.7%), whilst bacteraemia secondary to orthopaedic infection carried the lowest (6.3%). The mortality rate amongst different types of infection is shown in Fig. 1.

To explore the efficacy of treatment response, patients who died within 3 days of the ED visit ($n = 24$), with McCabe rapidly fatal disease ($n = 9$) or mortality not related to MRSA bacteraemia ($n = 3$) were excluded. After excluding these patients, 141 patients remained. The in-hospital mortality of this group was 17.7% (Table 2). Fewer risk factors associated with mortality were identified in this group. These included increased age, persistent bacteraemia, ultimately fatal disease and non-fatal disease according to the McCabe classification, higher Pitt bacteraemia score, septic shock, lower respiratory tract infection and metastatic infection. A logistic regression analysis of mortality in this group revealed that age ($P = 0.021$; odds ratio (OR) = 1.07, 95% confidence interval (CI) 1.01–1.13), persistent bacteraemia ($P = 0.024$; OR = 17.52, 95% CI 1.45–211.76), ultimately fatal disease ($P = 0.014$; OR = 7.99, 95% CI 1.53–41.59) and Pitt bacteraemia score ($P = 0.024$; OR = 1.33, 95% CI 1.04–1.69) were significant risk factors for mortality. The association of metastatic infection with mortality was of borderline significance ($P = 0.057$; OR = 4.47, 95% CI 0.96–20.88). Empirical glycopeptide therapy was not associated with decreased mortality.

All MRSA isolates were susceptible to vancomycin, teicoplanin, linezolid and daptomycin (Table 3). The MICs of vancomycin for all MRSA isolates were between 1 μg/mL and 2 μg/mL. A detrimental effect of increased vancomycin MICs on patient outcome could not be demonstrated despite separate analyses using the different definitions of outcome. Intravenous linezolid was used in six patients later in the course of hospitalisation (four due to treatment failure with glycopeptides and two due to cytopenia using glycopeptides) and oral linezolid was prescribed for three patients following glycopeptide therapy (oral switch).

4. Discussion

Most studies of MRSA bacteraemia have included nosocomially acquired cases and compared the difference between MRSA and meticillin-susceptible *S. aureus* (MSSA). How-

Table 2
Mortality analysis of 141 patients with meticillin-resistant *Staphylococcus aureus* (MRSA) bacteraemia (36 patients with mortality within 3 days ($n = 24$), McCabe rapidly fatal disease ($n = 9$) or mortality not related to MRSA bacteraemia ($n = 3$) were excluded)[a]

Characteristic	Patient group		OR	95% CI	*P*-value
	Total ($n = 141$)	In-hospital mortality ($n = 25$)			
Age (years) (mean ± S.D.)	62.6 ± 16.5	72.3 ± 10.7	1.04	1.01–1.08	0.010[b]
Sex (M/F) (*n*)	83/58	14/11	0.87	0.36–2.07	0.748
Source of patients					
Community	18 (12.8)	1 (4.0)	0.24	0.03–1.91	0.197
Healthcare-associated	106 (75.2)	18 (72.0)	0.82	0.31–2.16	0.685
Nosocomial	17 (12.1)	6 (24.0)	3.01	1.00–9.13	0.082
Persistent bacteraemia > 5 days	34 (24.1)	17 (68.0)	12.4	4.62–33.2	<0.001[b]
Polymicrobial bacteraemia	14 (9.9)	3 (12.0)	1.30	0.34–5.06	0.703
Foreign body	60 (42.6)	12 (48.0)	1.31	0.55–3.11	0.544
Debridement	65 (46.1)	10 (40.0)	0.74	0.31–1.78	0.500
Severity of illness (McCabe classification)					
Ultimately fatal disease	80 (56.7)	22 (88.0)	7.33	2.08–25.9	0.001[b]
Non-fatal disease	61 (43.3)	3 (12.0)	0.14	0.04–0.48	0.001[b]
Pitt bacteraemia score (mean ± S.D.)	2.77 ± 2.4	4.60 ± 2.8	1.40	1.17–1.68	<0.001[b]
Septic shock	58 (41.1)	20 (80.0)	8.21	2.86–23.55	<0.001[b]
Empirical vancomycin	26 (18.4)	7 (28.0)	1.99	0.73–5.41	0.174
Type of infection					
Catheter-related	34 (24.1)	7 (28.0)	1.28	0.48–3.39	0.616
Soft tissue	31 (22.0)	2 (8.0)	0.26	0.06–1.18	0.068
Primary bacteraemia	18 (12.8)	2 (8.0)	0.54	0.12–2.53	0.741
Orthopaedic	16 (11.3)	1 (4.0)	0.28	0.04–2.23	0.305
Lower respiratory tract	14 (9.9)	6 (24.0)	4.26	1.33–13.7	0.009[b]
Infective endocarditis (IE)	11 (7.8)	4 (16.0)	2.97	0.90–11.0	0.106
Endovascular infection other than IE	9 (6.4)	3 (12.0)	2.50	0.58–10.8	0.198
Urinary tract	7 (5.0)	0	–	–	0.353
Biliary tract	1 (0.7)	0	–	–	1.000
Underlying illness/condition					
Diabetes mellitus	54 (38.3)	12 (48.0)	1.63	0.68–3.89	0.271
End-stage renal disease	41 (29.1)	10 (40.0)	1.83	0.74–4.49	0.185
Heart disease	31 (22.0)	8 (32.0)	1.90	0.73–4.95	0.183
Stroke	30 (21.3)	6 (24.0)	1.21	0.44–3.36	0.714
Active malignancy	18 (12.8)	3 (12.0)	0.92	0.25–3.45	1.000
Liver cirrhosis	13 (9.2)	4 (16.0)	2.27	0.64–8.04	0.247
Intravenous drug user	4 (2.8)	0	–	–	1.000
Intravenous catheter use	44 (31.2)	10 (40.0)	1.61	0.66–3.93	0.295
Foley catheter use	11 (7.8)	3 (12.0)	1.84	0.45–7.50	0.412
Mortality					
Day 7	3 (2.1)	3 (12.0)	–	–	–
Day 14	9 (6.4)	9 (36.0)	–	–	–
In-hospital mortality	25 (17.7)	25 (100.0)	–	–	–
Metastatic infection	22 (15.6)	11 (44.0)	7.50	2.75–20.5	<0.001[b]
Vancomycin MIC 2 μg/mL	33 (23.4)	7 (28.0)	1.35	0.51–3.57	0.550
Vancomycin MIC 1 μg/mL	108 (76.6)	18 (72.0)	0.74	0.28–1.97	0.550

OR, odds ratio; CI, confidence interval; S.D., standard deviation; MIC, minimum inhibitory concentration.
[a] All data are *n* (%) unless otherwise stated.
[b] Significantly associated with mortality ($P < 0.05$).

ever, the antimicrobial agents used for MSSA and MRSA are different [10]. In this study, we focused on patients with MRSA bacteraemia recovered at the ED and demonstrated the characteristics and outcome of these patients. The outcome of our patients was more closely associated with the severity of underlying illness and bacteraemia, age and persistent bacteraemia. Despite recent studies suggesting that increased MICs of MRSA isolates have a detrimental effect on patient outcome [13,14], this is not supported in the current study. The in-hospital mortality was 33.6% and 32.5% amongst patients with MRSA isolates with a vancomycin MIC of 1 μg/mL and 2 μg/mL, respectively.

Many factors complicate the evaluation of treatment response in patients with MRSA bacteraemia. One of the

Table 3
Minimum inhibitory concentrations (MICs) of 177 meticillin-resistant *Staphylococcus aureus* (MRSA) isolates associated with bacteraemia

Antimicrobial agent	MIC (μg/mL)			No. (%) of susceptible isolates
	Range	MIC_{50}	MIC_{90}	
Vancomycin	1.0–2.0	1.0	2.0	100
Linezolid	0.5–1.0	1.0	1.0	100
Teicoplanin	0.25–8.0	1.0	2.0	100
Daptomycin	0.25–1.0	0.5	1.0	100

$MIC_{50/90}$, MIC for 50% and 90% of the organisms, respectively.

most important factors is the wide variation in the severity of underlying illness. Patients with rapidly fatal disease carry the highest mortality rates from bacteraemia episodes, which reached 84.6% in this study and 76.2% in a previous one [17]. Inclusion of these patients in survival analyses will confound the search for important prognostic factors. A recent study also found that underlying illness was the most important predictor of 7-day mortality in patients with *S. aureus* bacteraemia [27].

The type of infection is also clearly correlated with treatment response. Differences in the type of infection determine the feasibility of source infection control. Pneumonia has been long considered the most difficult type of MRSA infection to treat [28,29]. Difficulty in achieving high concentrations of glycopeptides in the lung and in removing the infected tissue might represent equally important obstacles to effective management [29]. In this study, the mortality rate in patients with orthopaedic infection (6.3%) was substantially lower than in pneumonic patients (66.7%), probably due to relatively lower co-morbidity in these patients and ease of surgical intervention. The spectrum of MRSA bacteraemia can vary from mild to life-threatening disease; however, determining the type of infection is sometimes difficult, especially for patients with early mortality.

Without novel molecular methods, patients with MRSA bacteraemia have to survive several days waiting for a positive blood culture, traditional identification of isolates and determination of antimicrobial susceptibility in order to confirm the existence of MRSA. It also takes days for vancomycin to take effect. Some patients in this study died before the culture results were known, as shown by the 3-day mortality rate of 13.6%. Recent studies showed that empirical glycopeptides might improve the outcome of patients with MRSA infection [30,31]. However, amongst the 24 patients who died within 3 days in this study, 6 had rapidly fatal disease and the average Pitt bacteraemia score was 8.46, implying that these patients had advanced disease and the outcome might not be altered by early antimicrobial therapy.

During the study period, linezolid was the only available alternative agent for MRSA infection. Quinupristin/dalfopristin is not marketed in Taiwan [32]. In this study, linezolid was used in only nine patients, four of whom died despite linezolid use. As for the role of combination therapy, a high rate of gentamicin resistance was also found amongst MRSA isolates in Taiwan [32]; despite occasional use of gentamicin amongst our patients, this is not routine in clinical practice. Previous reports showed that adding rifampicin is effective as combination therapy for MRSA infection [33], and resistance of MRSA to rifampicin in Taiwan was not high [32]. However, this agent is not used in the initial treatment of most patients in our hospital.

The increasing rate of MRSA isolates with high vancomycin MICs is a serious and important issue. An increase in the vancomycin MICs of isolates has been correlated with the rate of treatment failure, although the vancomycin MICs were within the susceptible range [13]. However, in this study, despite several endpoints being applied, no correlation of increased vancomycin MICs and poor patient outcome was found.

A recent study of Soriano et al. [34] showed that an elevated MIC itself did not alter patient mortality, but a vancomycin MIC of 2 μg/mL did carry a higher risk of death only in patients receiving empirical therapy. There may be some explanations for this discrepancy. First, the patients studied by Sakoulas et al. were identified because of poor response to vancomycin therapy, whereas this study included all patients with clinically significant MRSA bacteraemia presenting to an ED. Second, the distribution of vancomycin MICs of MRSA isolates was relatively homogeneously high in the present study (1–2 μg/mL), which might have limited its ability to demonstrate the probable beneficial effect of lower MICs. Third, the percentage of empirical therapy was low in this study and, owing to the limited numbers, we could not reproduce the findings of Soriano et al. [34].

In summary, this study of patients with MRSA bacteraemia treated at an ED found no effect of increased vancomycin MICs of isolates on patient outcome. In patients who had MRSA isolates with relatively high vancomycin MICs, the outcome was more closely associated with the severity of underlying illness and bacteraemia, age and persistent bacteraemia. Whether empirical vancomycin therapy or new anti-MRSA agents will improve the outcome of these patients deserves further research.

Funding: No funding sources.

Competing interests: None declared.

Ethical approval: Institutional Review Board, National Taiwan University Hospital, Taipei, Taiwan.

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