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Original Contribution

Prognostic factors for primary septicemia and wound infection caused by *Vibrio vulnificus*

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Abstract

Objectives: The purpose of this study was to explore the predictive factors for mortality in primary septicemia or wound infections caused by *Vibrio vulnificus*.

Methods: A retrospective review of 90 patients 18 years and older who were hospitalized due to *V vulnificus* infection between January 2000 and December 2006 was performed. Clinical characteristics, laboratory studies, treatments, and outcomes retrieved from medical records were analyzed. Multiple logistic regression and receiver operating characteristic curve analyses were performed.

Results: Of 90 patients identified as *V vulnificus* infections, 39 had primary septicemia and 51 had wound infection. The mean age was 63.0 ± 11.9 years. The mean Acute Physiology and Chronic Health Evaluation (APACHE II) and Mortality in Emergency Department Sepsis (MEDS) scores on admission were 11.1 ± 4.9 and 5.5 ± 3.8, respectively. Fifteen patients died, yielding an in-hospital mortality rate of 17%. Multivariate analysis revealed that higher APACHE II (odds ratio, 1.5; 95% confidence interval [CI], 1.2-1.8; $P < .0001$) and MEDS (odds ratio, 1.3; 95% CI, 1.1-1.6; $P = .0201$) scores on admission were significantly associated with mortality. The area under the receiver operating characteristic curves values for APACHE II and MEDS in predicting in-hospital mortality were 0.928 (95% CI, 0.854-0.972) and 0.830 (95% CI, 0.736-0.901), respectively.

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Conclusions: The APACHE II and MEDS scores on admission are significant prognostic indicators in primary septicemia or wound infections caused by *V vulnificus*. A further prospective study to strengthen this point is required.

1. Introduction

Vibrio vulnificus infection is uncommon but potentially life-threatening with a reported case-fatality rate worldwide in the past 2 decades ranging from 10% to 54% [1-8]. *V vulnificus* bacteria, which thrive in warm marine waters, mainly induce the following 3 clinical manifestations in human beings: gastrointestinal illness, primary septicemia, and primary wound infections. Primary septicemia and wound infections, unlike self-limited gastroenteritis, can progress quickly and become severe [1-12]. A high index of suspicion for *V vulnificus* infection is considered when patients present with gastrointestinal symptoms, fever, skin or soft-tissue lesions, or shock after the ingestion of raw seafood, especially oysters, or with a wound infection after exposure to seawater [1-8,11-13]. However, the fatality from the infections can occur in as few as 1 to 3 days after arrival [2-4,6-12]. Besides early recognition of the disease, identifying the risk factors of mortality in patients with *V vulnificus* infection as early as possible seems to be important. Several authors have suggested that *V vulnificus* infection associated with hemorrhagic bullae, necrotizing fasciitis, or septic shock, particularly in immunocompromised persons, could be regarded as a severe infection [2-5,7-10]. Recently, Liu et al [6] used a severity of illness assessment for predicting mortality in patients with *V vulnificus* septicemia and found that a high Acute Physiology and Chronic Health Evaluation (APACHE) II score was statistically associated with mortality. However, these previous studies had not included patients with wound infections caused by *V vulnificus* or had deficiencies in their study design and/or statistical analyses such as inadequate multivariate analysis or the lack of estimation of discriminative power to evaluate the performance of the scoring system for prediction of mortality [2-10]. Therefore, this study was performed to explore the relationship between clinical factors on admission, including the severity of illness assessment, clinical manifestations, laboratory findings, and mortality in patients with *V vulnificus*. In addition, the performance of the severity of illness scoring systems in *V vulnificus* patients was also evaluated.

2. Methods

2.1. Study design

This was a retrospective study in an academic medical center. This study was approved by the hospital's institutional review board.

2.2. Setting and study subjects

Consecutive patients aged 18 years or more who were hospitalized at an academic medical center (Tainan, Taiwan) due to *V vulnificus* infection via emergency department (ED) were enrolled by reviewing all the ED visits based on the ED patient registration from January 2000 through December 2006. The academic medical center is a 2200-bed, primary- and tertiary-care teaching hospital with nearly 54 000 inpatient admissions and more than 168 000 ED visits per year.

2.3. Study protocol

The *V vulnificus*–infected patients with primary septicemia or wound infection were included in the study. The medical record for each identified patient was retrieved and reviewed. *V vulnificus* was isolated from blood, wound, and/or stool cultures. Each *V vulnificus* isolate was a halophilic, Gram-negative rod identified by test results as positive for cytochrome oxidase, glucose fermentation, citrate use, indole production, ornithine decarboxylase, and hydroxylase of ortho-nitrophenyl galactoside [14]. The *V vulnificus* isolates identified by conventional methods were further verified by the API-20E system (bioMe'rieux Vitek Inc, Hazelwood, MO). Presumed mode of the infection was based on the exposure history of the patient [1-5,10,11]. *V vulnificus*–infected patients who did not have an apparent focus of infection but had a history of recent consumption of raw or undercooked seafood were regarded as having primary septicemia. Patients having a history of preexisting wound exposure to seawater or marine creatures or a recent injury from handling seafood were considered to have primary wound infections. During the study period, 95 ED visits were identified as *V vulnificus* infections. Among the 95 *V vulnificus*–infected patients, 5 patients had gastroenteritis, and they only needed an outpatient follow-up. The remaining 90 patients, 39 having primary septicemia and 51 having wound infections, were hospitalized and included in the analysis.

2.4. Measurements

Demographic data, underlying medical conditions, symptoms/signs on admission, severity of illness on admission, laboratory and microbiological findings, treatment, and outcomes were retrieved, collected, and analyzed. The severity of illness on admission was evaluated with the APACHE II score system [15] and the

Mortality in Emergency Department Sepsis (MEDS) scoring system [16] in the first 24-hour period after arrival. The APACHE II scoring assessment was modified according to recommendation of Meakins et al [17] and Knaus et al [18] so that the unavailable measures of arterial pH and partial pressures of oxygen were assigned a score of zero in the scoring system because arterial blood sampling is not indicated for every patient at the time of admission. The definitions of MEDS score variables were based on the report by Shapiro et al [16]. The variables of MEDS scoring model included age more than 65 years (yes, 3 points; no, 0 point), nursing home resident (yes, 2 points; no, 0 point), rapid terminal comorbid illness (yes, 6 points; no, 0 point), lower respiratory tract infection (yes, 2 points; no, 0 point), bands greater than 5% of the white blood cell differential (yes, 3 points; no, 0 point), tachypnea or hypoxemia (yes, 3 points; no, 0 point), septic shock (yes, 3 points; no, 0 point), platelet count less than 150 000/mm^3 (yes, 3 points; no, 0 point), and altered mental status (yes, 2 points; no, 0 point). Antimicrobial susceptibility testing was performed using the Kirby-Bauer, broth dilution, and E-test methods. These results were evaluated according to the recommendations of the Clinical and Laboratory Standards Institute (formerly known as the National Committee for Clinical Laboratory Standards [19]). The initial empirical broad-spectrum antibiotics were administered parenterally after the blood, wound, or stool specimens had been obtained. Antibiotics were subsequently tailored to the patient, based on the identity of the organism(s) and its antibiotic susceptibility tests, as necessary. In-hospital mortality was defined as death during hospitalization.

2.5. Data analysis

Continuous variables were expressed as mean ± SD. Comparisons between groups for continuous variables were made using either the Student *t* test or Mann-Whitney *U* test, as appropriate. Categorical variables were described as the number or percentage of subjects with the characteristic of interest. Categorical variables were compared between groups using either the χ^2 test or Fisher exact test (if the expected value of at least 1 cell was <5). χ^2 test for trend was used to examine trends in proportions among groups. The relationship between (1) demographic, severity of illness, clinical manifestations, and laboratory factors and (2) mortality was assessed by univariate analysis. The significant factors obtained from univariate analysis were included in the logistic regression model with a forward selection method, which identified significant predictors of mortality. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated in the logistic regression model. The statistical analyses above were performed with SPSS for Windows, version 8.0 (SPSS Inc, Chicago, IL). The discriminative power of these scoring systems was evaluated using receiver operating characteristic (ROC) curve analysis generated using the MedCalc Statistical Software, version 9.5 (Broekstraat, Mariakerke, Belgium). The areas under the ROC curves (AUROCs) were used to compare the scoring models with each other. The discriminative power, defined as the ability of the model to discriminate between survivors and nonsurvivors, was assessed by calculating the AUROC, with estimates of standard error (SE) and 95% CI. In these curves, the closer the ROC curve is to the upper left-hand edge of the graph, the more "perfect" the result is considered because the true-positive rate is 1 and the false-positive rate is 0. An AUROC of 1 is considered perfect discrimination, whereas an AUROC of 0.5 is considered equal to chance (means no predictive ability) [20]. The statistic approach of comparing AUROCs was performed by estimating the correlation between AUROCs derived from the same sample of patients, which was developed by Hanley and McNeil [20,21]. The optimal cutoff point for predicting mortality was identified as the score giving the best Youden's index [maximum (sensitivity + specificity − 1)] for each scoring system [22,23]. Sensitivity, specificity, positive predictive values (PPV), negative predictive values (NPV), and likelihood ratios (LRs) were calculated at the optimal cutoff values for the scoring system assessments. A 2-tailed $P < .05$ was considered statistically significant.

3. Results

3.1. Demographics, clinical characteristics, treatment, and outcomes

The average age of the 90 patients was 63.0 ± 11.9 years (range, 31-89 years), and 57% of these patients were male. The mean APACHE II score on admission was 11.1 ± 4.9 (range, 2-27), whereas the mean MEDS score was 5.5 ± 3.8 (range, 0-14). The treatment for these patients included antibiotics alone (n = 32) and antibiotics plus surgical intervention (n = 58). Patients who eventually died had a higher proportion of initial antibiotic treatment with third-generation cephalosporins or quinolones compared with survivors, but the difference in the initial antibiotics administered between 2 patient groups did not reach statistical significance ($P = .056$). All patients subsequently received antibiotic therapy as directed by the results of the antibiotic susceptibility profiles. Patients with primary septicemia had a higher case-fatality rate than those with wound infections (28% [11/39] vs 7% [4/54]; $P = .010$). Fifteen patients died in the hospital, yielding an overall in-hospital mortality rate of 17%. Of the 15 deaths, 11 (73%) occurred in less than 72 hours after arrival. The demographic and clinical characteristics, treatment, and outcomes of these patients are shown in Tables 1 and 2.

Table 1 Demographic data, underlying diseases, and clinical features in 90 patients with primary septicemia or wound infection caused by *V vulnificus*

Variable	All patients (n = 90)	Survivors (n = 75)	Nonsurvivors (n = 15)	*P*
Age, mean ± SD (y)	63.0 ± 11.9	62.6 ± 11.5	64.9 ± 14.1	.495
Sex, male, n (%)	51 (57)	45 (60)	6 (40)	.154
Mode of infection				.010
Primary septicemia, n (%)	39 (43)	28 (37)	11 (73)	
Wound infection, n (%)	51 (57)	47 (63)	4 (27)	
APACHE II score, mean ± SD	11.1 ± 4.9	9.8 ± 4.0	17.5 ± 4.1	.0001
MEDS score, mean ± SD	5.5 ± 3.8	4.8 ± 3.6	8.7 ± 3.2	.0001
Duration of symptoms before admission, mean ± SD (d)	1.3 ± 0.8	1.3 ± 0.8	1.1 ± 0.5	.482
Coexisting medical conditions [a]				
Hepatic disorders [b]	29 (32)	21 (28)	8 (53)	.072
Diabetes mellitus	26 (29)	21 (28)	5 (33)	.757
Malignancy	14 (16)	11 (15)	3 (20)	.697
Immunosuppressive agents used	14 (16)	12 (16)	2 (13)	1.000
Chronic renal insufficiency	8 (9)	5 (7)	3 (20)	.126
Aplastic anemia	2 (2)	2 (3)	0	1.000
Substance abuse	1 (1)	0	1 (2)	1.000
HIV infection	1 (1)	1 (1)	0	1.000
Without comorbid disease	31 (34)	28 (37)	3 (20)	.197
Signs and symptoms on admission [a]				
Cellulitis without bullae	45 (50)	42 (56)	3 (20)	.011
Cellulitic or necrotic cutaneous lesions with hemorrhagic bullae or necrotizing fasciitis	30 (33)	21 (28)	9 (60)	.016
Fever	40 (44)	34 (45)	6 (40)	.704
Blood pressure <90/60 mm Hg	28 (31)	20 (27)	8 (53)	.042
Mental disturbance	1 (1)	0	1 (7)	.167

[a] When patients fit into multiple categories, they were counted in each category and expressed as number of patients (percentage).
[b] Hepatic disorders including chronic hepatitis B, chronic hepatitis C, alcoholic hepatitis, liver cirrhosis, and hepatocellular carcinoma.

3.2. Analysis of predictors related to mortality

When these significant variables obtained from univariate analysis in Tables 1 and 2 were subjected to multivariate analysis, only 2 variables, APACHE II (OR, 1.5; 95% CI, 1.2-1.8; $P < .0001$) and MEDS score on admission (OR, 1.3; 95% CI, 1.1-1.6; $P = .0201$), reached statistical significance (Table 3).

3.3. The ROC curve analysis of APACHE II and MEDS scores

Both the AUROC values for APACHE II and MEDS were significantly greater than the value of 0.5 (both $P = .0001$), and there was no significant difference between the 2 AUROC ($P = .163$) (Fig. 1). In addition, ROC curve analysis was also performed for the 2 scoring systems in patients with primary septicemia and in those with wound infection separately. In the 39 patients with primary septicemia, the AUROC for MEDS and APACHE II was 0.852 (SE, 0.078; 95% CI, 0.702-0.945) and 0.744 (SE, 0.095; 95% CI, 0.579-0.869), respectively. The values for the AUROC indicated that both scores provided independent, significant prognostic factors for mortality. The difference between the 2 AUROC in patients with primary septicemia was not statistically significant ($P = .310$). In the 51 patients with wound infection, the estimate of the AUROC for APACHE II was 0.992 (SE, 0.032; 95% CI, 0.915-1.000), whereas the AUROC for MEDS was 0.894 (SE, 0.108; 95% CI, 0.775-0.962). Both AUROCs showed good discriminative power for predicting mortality, and the areas under the 2 curves were not significantly different ($P = .278$).

3.4. The distributions of the APACHE II and MEDS scores relative to case fatality

A marked increase in case-fatality rate was observed when the APACHE II ≥15 or MEDS ≥4, whereas the APACHE II <10 or MEDS < 3, the case-fatality rate was zero (Fig. 2). Patients with APACHE II score on admission ≥15 points showed a significantly higher case-fatality rate than those with APACHE II scores <15 (87% [13/15] vs 11% [8/75]; $P < .0001$); patients with MEDS score at arrival of 4 points of more had a significantly higher case-fatality rate than patients with

Table 2 Laboratory and microbiological findings on admission, treatment, and outcomes in the 90 patients with *V vulnificus* infections

Variable [a]	All patients (n = 90)	Survivors (n = 75)	Nonsurvivors (n = 15)	*P*
WBC count >10^4 or <3×10^3 cells/mm^3	54 (60)	50 (67)	4 (27)	.004
Hemoglobin level <14 g/dL in male or <12 g/dL in female	43 (48)	35 (47)	8 (53)	.637
AST level >40 IU/L	54 (60)	42 (56)	12 (80)	.083
BUN >22 mg/dL	54 (60)	43 (57)	11 (73)	.248
Serum creatinine level >1.3 mg/dL	43 (48)	31 (41)	12 (80)	.006
Serum albumin level <3.5 mg/dL	28 (31)	21 (28)	7 (47)	.221
Bacteremia	56 (62)	44 (59)	12 (80)	.120
Therapeutic modality				.030
Surgical intervention [b] plus antibiotics	58 (64)	52 (69)	6 (40)	
Antibiotics alone	32 (36)	23 (31)	9 (60)	
Initial antibiotic treatment				.056
Penicillin group	24 (27)	23 (31)	1 (7)	
First- or second-generation cephalosporin with or without an aminoglycoside	32 (35)	28 (37)	4 (26)	
Third-generation cephalosporin with or without minocycline (or analogue)	26 (29)	19 (25)	7 (47)	
Quinolone group	8 (9)	5 (7)	3 (20)	
Subsequent antibiotic treatment [c]				.625
Penicillin group	5 (6)	5 (7)	0	
Second-generation cephalosporin with minocycline (or analogue)	14 (15)	13 (17)	1 (7)	
Third-generation cephalosporin with minocycline (or analogue)	62 (69)	49 (65)	13 (86)	
Quinolone group	9 (10)	8 (11)	1 (7)	
Time to surgical treatment after admission, mean ± SD (h) (n = 58)	12.5 ± 13.9	11.9 ± 13.6	15.6 ± 16.6	.991
Hospital stay, mean ± SD (d)	17.7 ± 15.6	20.5 ± 15.6	3.8 ± 4.1	<.0001

AST indicates aspartate aminotransferase; BUN, blood urea nitrogen; WBC, white blood cell.

[a] Listed as number of patients (percentage) except as noted.

[b] Surgical intervention: incision and drainage, debridement, fasciotomy, and/or limb amputation.

[c] The subsequent antibiotics administrated were modified according to the results of the microbiological studies and antimicrobial susceptibility tests.

MEDS scores less than 4 (93% [14/15] vs 48% [36/75]; $P = .001$) (Table 4).

4. Discussion

In the present study, most of the patients were male with an average age of 63 years, and hepatic disorders were the most prevalent among coexisting diseases, similar to previous reports of primary septicemia or wound infections caused by *V vulnificus* [1-12]. Our data revealed that *V vulnificus* mortality was related to a greater severity of illness on admission, a result similar to the finding of Liu et al [6]. Furthermore, the covariates of severity of illness assessment were the strongest predictors of mortality in *V vulnificus* patients in multivariate analysis. Several groups have previously reported that hemorrhagic bullae formation, necrotizing fasciitis, and/or septic shock were risk factors for mortality in *V vulnificus* patients [1,6,7,13]. Although these variables may be significant in a univariate fashion from either our study or previous reports [1,6,7,13], they do not appear to be required in the prediction model for mortality once the APACHE II and MEDS assessments were included. This finding implies that the 2 scoring models may be more representative and comprehensive than the aforementioned individual parameters for predicting mortality of *V vulnificus* patients.

Table 3 Predictors relative to mortality using multivariate analysis in the 90 patients with primary septicemia or wound infection caused by *V vulnificus*

Variable	Multivariate OR (95% CI)	*P*
APACHE II score on admission	1.5 (1.2-1.8)	<.0001
MEDS score on admission	1.3 (1.1-1.6)	.0201
Cutaneous lesions with hemorrhagic bullae or necrotizing fasciitis	3.0 (0.9-9.2)	.0515

Both the APACHE II and MEDS scoring systems, which assess severity of illness at time of ED admission, fit the

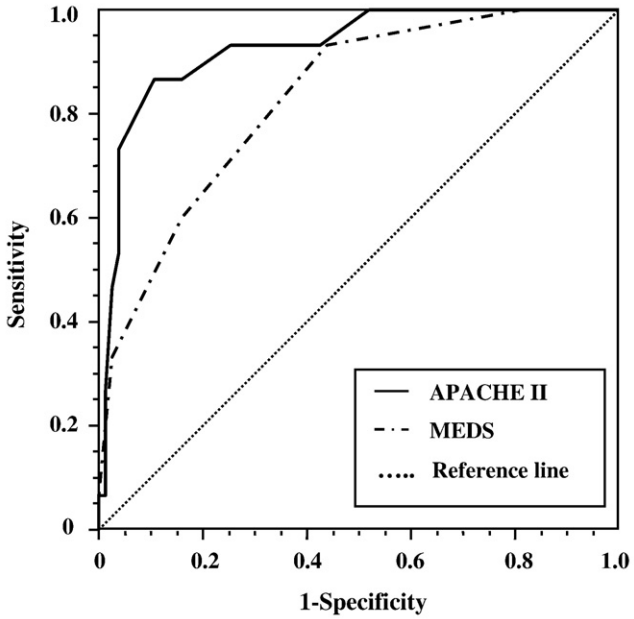

Fig. 1 Receiver operating characteristics curves of the APACHE II and MEDS scoring systems for prediction of mortality in the 90 patients with *V vulnificus* infection. The values of the AUROCs for the APACHE II and MEDS scoring models were 0.928 (95% CI, 0.854-0.972) and 0.830 (95% CI, 0.736-0.901), respectively. The reference line (diagonal line) indicates no discrimination.

prediction model and had good discriminative power for the prediction of in-hospital mortality in *V vulnificus* patients. Regardless of the severity of illness scoring system ultimately selected for predicting mortality, it is essential to estimate the discriminatory power other than goodness of fit in the application. Using ROC curve analysis, the values of AUROC for APACHE II and MEDS exceeded 0.8, demonstrating that both scoring systems have excellent discrimination for predicting in-hospital mortality. Which scoring system is better for prediction of mortality in *V vulnificus* patients? From our results, the discriminative power of APACHE II system was slightly higher than that of MED system, but the difference did not reach statistical significance. Although initially designed to measure the severity of disease for patients admitted to intensive care units, the APACHE II system has been extensively used to predict outcome in a variety of ill individuals [15,17,18]. The MEDS score has been developed specifically for patients with suspected infection at the time of ED to rapidly identify risk stratification of death for assigning appropriate therapy and using care resources [16,24,25]. The APACHE II scoring system requires more laboratory parameters and is a relatively complex tool, whereas the variables of the MEDS model are easily available on admission; so the MEDS system is simple, reliable, and feasible in determining the severity of illness evaluation at the time of admission [16,24,25]. This seems to suggest that MEDS could be an effective alternative tool for assessing severity of illness in *V vulnificus*–infected patients of primary septicemia or wound infections on admission.

In the present study, the nonsurvival group had a higher proportion of individuals receiving antibiotic treatment only than the survivors. More than 70% of patient in the nonsurvival group died within 72 hours of hospitalization. This result supports the finding of the previous studies in which individuals who have *V vulnificus* infection may rapidly progress and become fatal before receiving the most efficacious treatment [1-12]. Immediate antibiotics

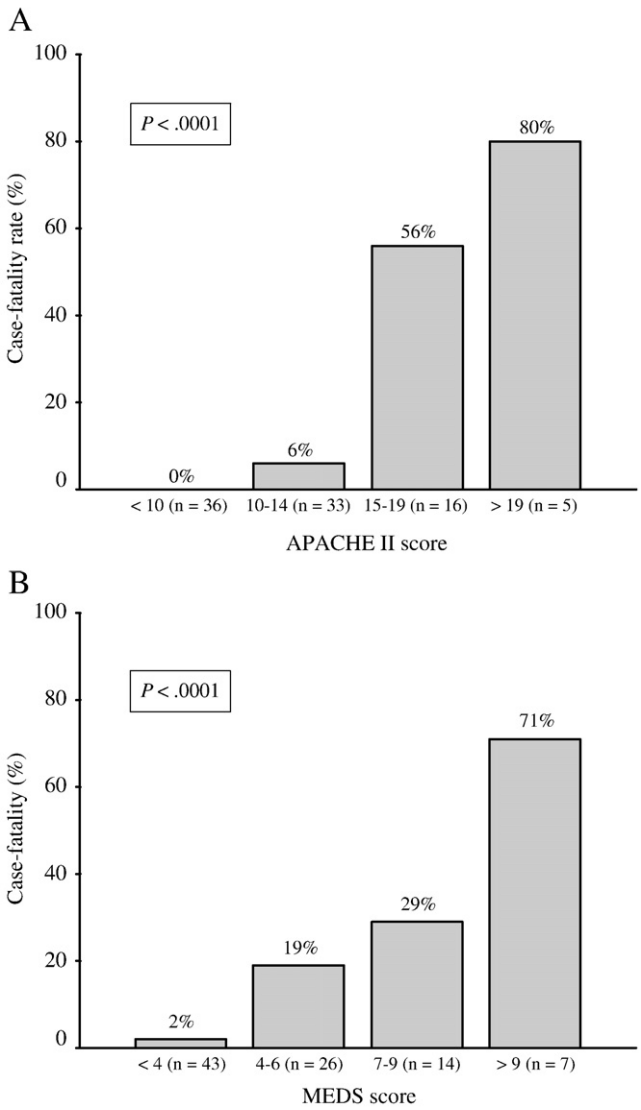

Fig. 2 The APACHE II score (A) and MEDS score (B) relative to case-fatality rate in the 90 patients with *V vulnificus* infection. The case-fatality rate increased significantly from zero in patients with APACHE II < 10 to 80% in patients with APACHE II >19 (panel A; $P < .0001$, using χ^2 for trend test). The case-fatality rate increased significantly from 2% in patients with MEDS <4 to 71% in patients with MEDS >9 (panel B; $P < .0001$, using χ^2 for trend test).

Table 4 Sensitivity, specificity, PPV, NPV, LR, and OR of the optimal cutoff values of APACHE II and MEDS scores for the prediction of mortality

Predictor	Sensitivity	Specificity	PPV	NPV	LR	OR
	95% CI (%)	95% CI (%)	95% CI (%)	95% CI (%)	95% CI	95% CI
APACHE II ≥15	87 (60-89)	89 (80-95)	62 (39-82)	97 (90-99)	8.1 (6.6-10.1)	54 (10-286)
MEDS ≥4	93 (68-99)	56 (44-68)	30 (17-45)	98 (88-99)	2.1 (1.7-2.7)	15 (1.9-121)

and supportive care should be administered in patients with suspected *V vulnificus* infection before laboratory confirmation. Although *V vulnificus* isolates were found to be susceptible to various classes of antibiotics in vivo studies [26-30], several authors [2,6,29,31] on the basis of human and laboratory studies have recommended that doxycycline or minocycline in conjunction with a third-generation cephalosporin are the choice of antibiotics for severe *V vulnificus* infection. Some investigators [30] found that certain advanced flouoroquinolones were as effective as these combined antibiotic therapy and may be an alternative choice for the severe cases. There is presently no objective measure or criterion to follow when attempting to determine the severity of infection. As mentioned earlier, APACHE II/MEDS could provide a more objective means for estimating severity of illness for *V vulnificus*–infected patients when compared with the previous indicators (such as hemorrhagic bullae, necrotizing fasciitis, or septic shock). Nevertheless, these risk factors derived from symptoms or signs, if present on admission, are more apparent, immediate, and convenient to clinicians for judging the illness severity of patients compared with any scoring method. The 2 scoring models seem to be alternatives in the real scenario. Halow et al [32] and other investigators reported that early surgical exploration, including incision and drainage, debridement, fasciotomy, and even limb amputation, for skin or soft-tissue infection caused by *V vulnificus* may play an important role in saving life [3,12,33]. *V vulnificus*–infected patients may rapidly progress to a more critical condition or potentially even die before clinicians had the opportunity to change the surgical strategy (eg, from debridement to fasciotomy or from debridement to fasciotomy to limb amputation) [2,3,5-7,11-13]. Clinicians should be highly alert to the disease progression and may use an aggressive approach as soon as possible for *V vulnificus* patients with skin and soft-tissue infection and a poor response to primary treatment.

It should be acknowledged that our results are limited by the retrospective nature in the present study; a further prospective study needs to be conducted. We could not assess the arterial blood parameters in APACHE II for all patients. In practice, arterial blood sampling is not routinely measured in every *V vulnificus* patient at the time of admission unless the situation of the patient is severe or critical. Meakins et al [17] and Knaus et al [18] have tested and verified that uncollected data can be assumed to have a weight of zero. Even with this modification, the APACHE II still significantly predicted *V vulnificus* patient mortality with an AUROC of 0.928. Moreover, this is a single-center study that may limit our reader's ability to generalize the results. As the literature reported [1-8,11-13], the prognosis of wound infection seemed to be better than that of primary septicemia among *V vulnificus* patients. In our subgroup analysis, high APACHE II or MEDS scores were significantly correlated with *V vulnificus* mortality for patients with either primary septicemia or wound infection. This seems to indicate that the severity of illness assessment using either APACHE II or MEDS scores at time of admission may predict mortality in *V vulnificus* patient populations caused by either primary septicemia or wound infection. In addition, the scoring systems are currently used for epidemiologic studies and interunit comparison, and their applicability to individuals is limited and controversial yet. Finally, we must draw the readers' attention to the wide CIs for some of the variables and remind that such intervals do not rule out the possibility that a variable will be significant. Nevertheless, the number of patients with *V vulnificus* infection in our study is comparable with patient numbers in previously published reports for a study period ranging from 3 to 13 years [1-8,11-13,32,33].

In conclusion, this study identifies that the APACHE II and MEDS scores on admission are significant prognostic indicators in primary septicemia or wound infections caused by *V vulnificus*, but their applicability in ED setting may be limited by their complexity. A further prospective study to strengthen our finding is required.

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