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Clinical study of a new Modified Early Warning System scoring system for rapidly evaluating shock in adults

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ABSTRACT

Objective: Shock, the most common severe emergency syndrome, has a complicated etiopathogenesis, is difficult to identify, progresses quickly, and is dangerous. Early identification and intervention play determining roles in the final outcomes of shock patients, but no specific scoring system for shock has been established to date.
Methods: We collected 292 shock patients and analyzed the correlation between 28-day prognosis and the Acute Physiologic Assessment and Chronic Health Evaluation II (APACHE II), Modified Early Warning System (MEWS), and Sequential Organ Failure Assessment scoring systems. According to the previous result, we established a new MEWS scoring system based on the conventional MEWS, which also included age and transcutaneous oxygen saturation. Some of the items with a strong correlation with the 28-day prognosis were selected to establish the new MEWS scoring system. We then evaluated the predictive efficacy of the new MEWS scoring system on 28-day prognosis and the correlation with other scoring systems.
Results: Some indexes, including age, transcutaneous oxygen saturation, arterial blood pH and blood lactic acid, serum sodium, serum potassium, HCO_3, and red blood cells deposited, differed significantly between the nonsurviving and surviving groups ($P < .05$). The area under the curve (AUC) of the APACHE II, MEWS, shock index, and Sequential Organ Failure Assessment scoring systems for 28-day prognosis indicated a critical predictive efficacy. Receiver operating characteristic curves indicated that the MEWS AUC was 0.614, new MEWS AUC was 0.696, and APACHE II AUC was 0.785, suggesting superiority of the new MEWS to the conventional MEWS but inferiority to the APACHE II. Interestingly, the correlation efficient of the traditional MEWS and the new MEWS was 0.81. The correlation efficient of these scoring systems with other indexes, including lactic acid and hemoglobin, was less than 0.3.
Conclusions: The new MEWS scoring system could be an independent indicator to reflect shock severity. It has higher predictive efficacy in septic shock, especially for 28-day prognosis.

1. Introduction

Shock is one of the most common severe syndromes in emergency treatment. Acute myocardial infarction guidelines, the surviving sepsis campaign [1], and low blood volume resuscitation guidelines [2], indicate that we should prioritize the early identification of shock [3]. In the clinical setting, the classification of shock does not yet have uniform standards. According to the initiating link and clinical features, shock can be divided into cardiogenic, hypovolemic, and vasogenic shock, and vasogenic shock can be further divided by pathogenesis into infectious, irritability, and strong nerve stimulation. Shock is an important lethal factor in the emergency department and intensive care unit (ICU), and it is quite important that critical shock be identified as early as possible based on some basic clinical observation indexes.

Most emergency treatments identify shock patients using the nonspecific Acute Physiologic Assessment and Chronic Health Evaluation II (APACHE II) system or Modified Early Warning System (MEWS) because of the lack of a canonical specific scoring system that is used widely and globally. The APACHE II system is suitable for estimating shock severity and has higher predictive mortality accuracy for ICU patients [4]. However, more than 20 kinds of clinical data must be gathered, some of which are time-consuming. Therefore, it is difficult to achieve the goal of rapidly assessing emergency patients with severe shock because complete scoring should be finished within 24 hours after clinical reception. The Sequential Organ Failure Assessment (SOFA) scoring system, which is mainly used to identify patients with multiple-organ dysfunction, includes 12 kinds of worse-state inspections; therefore, the scoring system has higher accuracy and specificity. However, similar to the APACHE II, the SOFA is unusable for early rapid assessment and has poor timeliness. Collectively, it is quite important to identify a rapid scoring system for use in emergency assessments.

Among all of the scoring systems, the MEWS has been widely used in emergency situations because it is simple and easy to use [5,6]. Burch et al [7] indicated that the 5 basic indexes of the MEWS are practical tools that can be used to rapidly and effectively estimate hospital

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admission and clinical death risk. However, Subbe et al [8] reported that the MEWS has poor resolving ability for those patients in shock without any symptoms in accidental and emergency situations, whereas Naeem and Montenegro [9] showed that the MEWS has a limited ability to estimate sudden deterioration in patients with cardiac shock.

This study aimed to estimate a new MEWS scoring system using appropriate indexes by analyzing the correlation of each index with 28-day prognosis as well as the prediction efficiencies of the different scoring systems on 28-day prognosis using collected clinical data of shock patients. We then further analyzed the predictive efficiency of the new MEWS system on 28-day prognosis as well as the correlation of each system with the other scoring systems. The study aimed to provide a new method to early identify and estimate mortality risk in patients with severe shock in the clinical setting.

2. Materials and methods

2.1. Subjects

The data of patients in shock who were admitted to the ICU from the emergency department at West China Hospital of Sichuan University between January 2013 and January 2014 were collected. The time of data collection was begun with ICU admission, and the place of data collection was in ICU. This study was conducted in accordance with the declaration of Helsinki, and this study was approved by the Ethics Committee of West China Hospital of Sichuan University. Written informed consent was obtained from all patients.

2.2. Group standard

Patients diagnosed as having shock were further divided into the hypovolemic shock (hypovolemic), septic shock (infectious), cardiogenic shock (cardiogenic), and mixed shock (mixed) groups according to initiating link and clinical features. The diagnostic criteria of hypovolemic shock [2,10] included acute blood and fluid loss or medical history of seriously inadequate liquid (water) intake. The criterion of septic shock [1] was the detection of serious infection and sepsis; that of cardiogenic shock [11-13] was a medical history of acute myocardial infarction, primary or secondary cardiomyopathy, acute myocarditis, serious malignant arrhythmia, cardiac tamponade, myocardial toxicity of drug poisoning, or cardiac surgery. In cases of mixed shock, an initiating link and clinical features are not used to identify that the disease is derived from specific pathogenesis or factor, but the disease is caused by mixed factors such as severe acute pancreatitis.

2.3. Data collection and analysis

A retrospective analysis was performed to collect case histories of the patients in the study, including their relevant data and indexes. From the patients diagnosed as having shock in the emergency ICU, the clinical data were collected. Specifically, the data included basic information (age and sex), chief complaint and final diagnosis, vital signs (such as temperature and heart rate), blood routine index (such as hemoglobin and packed cell volume), arterial blood gas analysis index (pH of arterial blood and oxygen concentration), blood biochemical indexes (such as lactic acid and bilirubin), and conventional indicators of coagulation system (such as blood clotting time and D-dimer).

The end point of the observation time was 28 days after the patients were treated. If the patient died, that point was considered the end time. The observation methods included clinical observation and follow-up, and the evaluation indexes included whether mechanical ventilation or vasoactive drugs were used, the amount of liquid in 24 hours, and the survival prognosis at 28 days.

The shock index and mean arterial pressure of each scoring system were calculated as follows:

$$\text{Shock index} = \text{heart rate}/\text{systolic pressure}$$

$$\text{Mean arterial pressure} = (\text{systolic pressure} + 2 \times \text{diastolic pressure})/3$$

MEWS, SOFA, and APACHEII scores were estimated as described elsewhere [5,6,14]. The new MEWS scoring system was designed, and the scores of the features about the patients in Table 4 were estimated and provided.

2.4. Statistical analysis

Components in enumeration data were described using constituent ratio, whereas concentrate and dispersion degrees in measurement data were described using mean ± SD or median. Means were compared using *t* test, medians were compared using the rank sum test, and rate and correlation analyses of categorical data were compared using the chi-square test. All of the statistical analyses were performed using SPSS 22.0 software, and values of $P < .05$ were considered statistically significant. The receiver operating characteristic (ROC) curve was used to estimate the efficiency of each scoring system for 28-day prognosis. Spearman correlation analysis was used to estimate the correlation of the new scoring system with each of the other systems and indexes.

3. Results

3.1. General patient characteristics

From the collected data from hospitalizations in West China Hospital of Sichuan University between January 2013 and January 2014, a total of 299 patients were identified based on inclusion and exclusion criteria. Of them, seven (2.3%) were lost to follow-up or had incomplete data, while 292 had complete data, including 192 male patients (65.75%) and 100 female patients (34.25%). A total of 134 patients died within 28 days (45.89%). No statistical difference in 28-day prognosis was detected between male and female patients using the χ^2 test ($P > .05$), nor was any significant difference in 28-day prognosis detected among the different groups ($P > .05$).

3.2. Effect of clinical indexes on 28-day prognosis

The statistical analysis indicated that age had an effect on 28-day prognosis, and the average age of nonsurviving patients was higher than that of surviving patients according to a *t* test ($P < .0001$). The mortality rate increased with increased age, and a statistically significant difference was seen among the different groups using the χ^2 test ($P < .05$).

Significant differences in some indexes were detected between the nonsurviving group and the surviving group ($P < .05$), including pulse oxygen saturation, pH of arterial blood, serum sodium concentration, lactic acid level, serum potassium concentration, plasma HCO_3 concentration, and packed cell volume. Of these indicators, mean pulse oxygen

Table 1
The clinical data of the patients in the study

	No surviving group	Surviving group	*P*
Mean pulse oxygen saturation	92 (33, 100)	95 (60, 100)	.000*
pH of arterial blood	7.27 ± 0.19	7.37 ± 0.14	.000*
Serum sodium concentration	118.47 ± 43.65	134.30 ± 7.62	.000*
Lactic acid level	5.3 (1, 20)	2.65 (1.00, 29.00)	.000*
Serum potassium concentration	25.26 ± 49.12	3.86 ± 0.97	.000*
Plasma HCO_3 concentration	25.94 ± 37.63	18.91 ± 12.94	.049*
Packed cell volume	4.97 ± 12.47	0.31 ± 0.09	.000*

* $P < .05$ indicates statistical significance.