



Brief Report

Usefulness of the Mortality in Severe Sepsis in the Emergency Department score in an urban tertiary care hospital^{☆,☆☆}Denise McCormack, MD, MPH^{a,*}, Avi Ruderman, MD^{a,1}, William Menges, MS^{b,1}, Miriam Kulkarni, MD^{a,1}, Tiffany Murano, MD^{a,1}, Steven E. Keller, PhD^{c,2}^a Department of Emergency Medicine, Rutgers University–New Jersey Medical School, Newark, NJ 07103^b Rutgers University–School of Biomedical Sciences, Newark, NJ 07103^c Rutgers University–New Jersey Medical School, 183 South Orange Avenue Room E 1536, Newark, NJ 07103

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ABSTRACT

Background: The Mortality in Severe Sepsis in the Emergency Department (MISSED) score is a newly proposed scoring system. The goal of this study is to determine if the MISSED score is generalizable to an urban tertiary care hospital.

Methods: This is a retrospective chart review conducted from July 2012 to June 2014. Inclusion criteria consisted of adult emergency department (ED) patients with severe sepsis, defined as lactate level 4 mmol/L or greater. Demographics, lactate, international normalized ratio (INR), albumin, intensive care unit admission, and ED intubation were analyzed using χ^2 test, *t* test, and logistic regression. The MISSED score was calculated using the variables albumin 27 g/L or less, INR 1.3 or greater, and age 65 years or older and analyzed using the area under the curve. The primary outcome was inhospital mortality.

Results: A total of 182 patients met inclusion criteria, and mortality was 32%. Patients in the mortality group had older age (58.1 ± 17.2 vs 62.7 ± 14.7 ; $P = .07$), higher lactate (5.9 ± 2.7 vs 7.3 ± 3.1 ; $P < .01$), lower albumin (34.3 ± 8.3 vs 25.6 ± 7.1 ; $P < .0001$), higher INR (1.4 ± 0.6 vs 2.4 ± 1.9 ; $P < .0001$), ED intubation (21% vs 56%; $P < .0001$), and intensive care unit admission (41% vs 78%; $P < .0001$). The regression model found that albumin of 27 g/L or less (odds ratio [OR], 1.8; 95% confidence interval [CI], 1.05–3.36), INR 1.3 or greater (OR, 8.3; 95% CI, 3.35–20.51), and ED intubation (OR, 5.6; 95% CI, 2.56–12.35) predicted mortality. The area under the curve for the MISSED score was 0.78 (95% CI, 0.73–0.85).

Conclusion: The MISSED score is useful for predicting mortality in ED patients with severe sepsis.

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1. Introduction

Sepsis is a major health care issue and confers a significant mortality risk [1]. It accounts for approximately 500 000 emergency department (ED) visits annually. The annual incidence of severe sepsis is estimated to be 300 cases per 100 000 patients with mortality rates that range from 20% to 50% [1–4]. Such alarming mortality rates makes early identification of high-risk ED patients imperative.

One solution has been the creation of mortality scoring systems that are specific to the ED. Although multiple scoring systems exist, there are few that were specifically designed for use in ED patients. The Mortality in Emergency Department Sepsis (MEDS) score is one of these systems [5–9]; however, there have been several studies that have challenge its generalizability [10–15]. In a recent study done in the United Kingdom, Sivoyoham et al [16,17] proposed the Mortality in Severe Sepsis in the Emergency Department (MISSED) score to predict mortality risk in sepsis.

The MISSED score is composed of 3 variables, albumin 27 g/L or less, international normalized ratio (INR) 1.3 or greater, and age 65 years or older [16,17]. Sivoyoham et al [16,17] reported that the MISSED score was equivalent to the Acute Physiology and Chronic Health Evaluation II score in predicting sepsis mortality. Ryoo et al [18] reported that higher MISSED scores predicted mortality but the variables albumin 27 g/L or less, INR 1.3 or greater, and age 65 years or older were not shown to be predictors of mortality. The goal of this study is to determine if albumin 27 g/L or less, INR 1.3 or greater, and age 65 years or older are independent predictors of sepsis mortality and to evaluate whether the MISSED score is generalizable to a tertiary care

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* Corresponding author. Tel.: +1 973 972 9261; fax: +1 973 972 9268.

E-mail addresses: Mccormde@njms.rutgers.edu (D. McCormack),Ruderman@njms.rutgers.edu (A. Ruderman), wmm49@gsbs.rutgers.edu (W. Menges),Kulkarni@njms.rutgers.edu (M. Kulkarni), Muranote@njms.rutgers.edu (T. Murano),skeller@njms.rutgers.edu (S.E. Keller).¹ Tel.: +1 973 972 9261; fax: +1 973 972 9268.² Tel.: +1 908 770 3314; fax: +1 973 772 7997.

hospital in the United States. We hypothesize that the MISSED score is a reliable tool to predict inhospital mortality in ED patients with severe sepsis.

2. Methods

2.1. Design and setting

This study is a retrospective chart review that was conducted from July 2012 to June 2014 at an urban tertiary care teaching hospital ED that has an emergency medicine (EM) residency program. The ED has approximately 92 000 visits annually. The ED does not have a specific protocol for severe sepsis, and thereby, resuscitation of the septic patient is determined by the clinical judgment of the ED physician according to the Surviving Sepsis Campaign Guidelines [19]. Data were collected retrospectively according to the criteria published by Worster et al and Kaji et al [20,21]. This study was approved by the university institutional review board.

2.2. Patient selection

Patients were selected based on the following inclusion criteria: patients' age 18 years and older with a diagnosis of severe sepsis. The diagnosis of severe sepsis was determined based on the presence of the systemic inflammatory response syndrome, blood lactate level greater than or equal to 4 mmol/L, and a suspected source of infection. Exclusion criteria included pregnancy, drug overdose, end-stage cancer, burn injury, trauma, epilepsy seizure, cardiac arrest, gastrointestinal bleed, acute coronary syndrome, cardiac dysrhythmia, acute stroke, acute congestive heart failure exacerbation, immunosuppression due to organ transplant, active steroid use or chemotherapy, AIDS with CD4 count less than 50 cells/mm³ or unknown CD4 count, and hospice status. Patients prescribed warfarin were excluded from this study. Patients who had missing data for albumin or INR were also excluded from the study.

Two EM residents including 1 senior and 1 junior resident conducted chart reviews for patients with lactate greater than or equal to 4 mmol/L over the 2-year period and selected patients who met inclusion criteria. A student in the Master of Biomedical Sciences program was trained to record laboratory results from the electronic medical record (EMR) of each patient. The senior EM resident conducted retrospective chart reviews of the EMR, laboratory results, and documentation from the entire hospital course and was responsible for accuracy of all the information obtained by the junior resident and master's student.

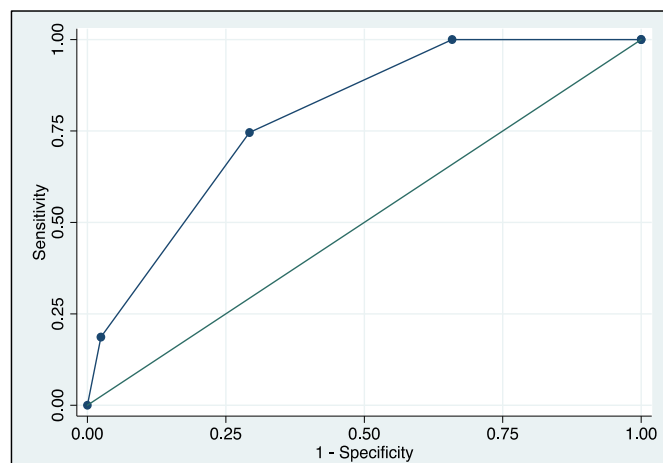


Figure. MISSED score. The ROC curve for the MISSED score. The AUC is 0.78 (95% CI, 0.73–0.85).

2.3. Data analysis

The calculated sample size necessary to obtain a power of 80% was 192. The variables that were recorded were age, sex, race, lactate, albumin, INR, glucose, intensive care unit (ICU) admission, and endotracheal intubation. The ED physicians ordered all of the laboratory tests and results obtained during the ED course. The source of sepsis was documented based on the EMR and confirmed if necessary with results from the hospital course. The primary outcome of interest was inhospital mortality, and the secondary outcome was ICU admission. χ^2 Test was used for analysis of categorical variables, and the Student *t* test was used for analysis of continuous variables. A hierarchical forward stepwise logistic regression analysis was performed to identify predictors of inhospital mortality, as measured by the odds ratio (OR) and 95% confidence interval (CI). Statistical significance was defined as $P < .05$.

2.4. MISSED score

The MISSED score was calculated using the variables albumin 27 g/L or less, INR 1.3 or greater, and age 65 years or older, and each variable received a score point of 1. The sum of the variables for each patient was used to calculate the MISSED score, which was analyzed by the receiver operating characteristic (ROC) curve and the area under the curve (AUC) in Figure. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were reported for MISSED scores greater than or equal to 1, greater than or equal to 2, and greater than or equal to 3. Logistic regression analysis was used to determine the OR for ICU admission and mortality for MISSED scores 1, 2, and 3. The software program StataCorp 2013 (College Station, TX) was used to conduct all statistical analyses.

3. Results

A total of 915 charts were reviewed, and 182 patients met inclusion criteria which generated a study power of 73%. Of the 182 patients included in the study, the inhospital mortality rate was 32% (59/182). Of the 59 patients who died, 1 patient had a non-ST-segment elevation myocardial infarction during the hospital course and died shortly after cardiac catheterization, 55% (32/59) of patients had progression of multiple-organ dysfunction syndrome from sepsis leading to cardiac arrest with unsuccessful resuscitation, and 43% (25/59) were placed on comfort care after physician-facilitated family discussions (Table 1). The mean age was 59.6 ± 16.4 years, and pneumonia was the most common source of infection (39%). Patient characteristics of age 65 years or older ($P = .93$) and male sex ($P = .69$) were not associated with mortality (Table 2). We found that 22% (40/182) of patients were hyperglycemic, defined as glucose greater than or equal to 200 mg/dL; however, there was no association between hyperglycemia and mortality (24% vs 19%; $P = .45$). Patients in the mortality group had older age (58.1 ± 17.2 vs 62.7 ± 14.7 ; $P = .07$), higher lactate (5.9 ± 2.7 vs 7.3 ± 3.1 ; $P < .01$), lower albumin (34.3 ± 8.3 vs 25.6 ± 7.1 ; $P < .0001$), higher INR (1.4 ± 0.6 vs 2.4 ± 1.9 ; $P < .0001$), ED intubation (21% vs 56%; $P < .0001$), and ICU admission (41% vs 78%; $P < .0001$) as shown in Table 2.

The logistic regression model (Table 3) found that albumin of 27 g/L or less (OR, 1.8; 95% CI, 1.05–3.36), INR 1.3 or greater (OR, 8.3; 95% CI, 3.35–20.51), and ED intubation (OR, 5.6; 95% CI, 2.56–12.35) were independent predictors of mortality. Age older than 65 years (OR, 1.0; 95% CI, 0.44–2.29) and lactate 7.5 mmol/L or greater (OR, 1.7; 95% CI, 0.75–4.04) were not shown to be independent predictors of mortality. The logistic regression model to predict mortality based on the MISSED score found an OR of 3.0 (95% CI, 1.41–6.40) for a score of 2 and OR of 11.0 (95% CI, 2.70–44.79) for a score of 3. The ORs for ICU admission for MISSED scores 1, 2, and 3 were determined to be 0.9 (95% CI, 0.39–1.92), 2.2 (95% CI, 1.01–4.84), and 4.6 (95% CI, 1.12–18.99), respectively (Table 4).

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