Original Article

Sepsis patient evaluation emergency department (SPEED) score & mortality in emergency department sepsis (MEDS) score in predicting 28-day mortality of emergency sepsis patients

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ARTICLE INFO

ABSTRACT

Purpose: Sepsis is a common acute life-threatening condition that emergency physicians routinely face. Diagnostic options within the Emergency Department (ED) are limited due to lack of infrastructure, consequently limiting the use of invasive hemodynamic monitoring or imaging tests. The mortality rate due to sepsis can be assessed via multiple scoring systems, for example, mortality in emergency department sepsis (MEDS) score and sepsis patient evaluation in the emergency department (SPEED) score, both of which quantify the variation of mortality rates according to clinical findings, laboratory data, or therapeutic interventions. This study aims to improve the management processes of sepsis patients by comparing SPEED score and MEDS score for predicting the 28-day mortality in cases of emergency sepsis.
Methods: The study is a cross-sectional, prospective study including 61 sepsis patients in ED in Suez Canal University Hospital, Egypt, from August 2017 to June 2018. Patients were selected by two steps: (1) suspected septic patients presenting with at least one of the following abnormal clinical findings: (a) body temperature higher than 38°C or lower than 36°C, (b) heart rate higher than 90 beats/min, (c) hyperventilation evidenced by respiratory rate higher than 20 breaths/min or $PaCO_2$ lower than 32 mmHg, and (d) white blood cell count higher than 12,000/μL or lower than 4000/μL; (2) confirmed septic patients with at least a 2-point increase from the baseline total sequential organ failure assessment (SOFA) score following infection. Other inclusion criteria included adult patients with an age ≥ 18 years regardless of gender and those who had either systemic inflammatory response syndrome or suspected/confirmed infection. Patients were shortly follow-up for the 28-day mortality. Each patient was subject to SPEED score and MEDS score and then the results were compared to detect which of them was more effective in predicting outcome. The receiver operating characteristic curves were also done for MEDS and SPEED scores.
Results: Among the 61 patients, 41 died with the mortality rate of 67.2%. The mortality rate increased with a higher SPEED and MEDS scores. Both SPEED and MEDS scores revealed significant difference between the survivors and nonsurvivors ($p = 0.004$ and $p < 0.001$, respectively), indicating that both the two systems are effective in predicting the 28-day mortality of sepsis patients. Thereafter, the receiver operating characteristic curves were plotted, which showed that SPEED was better than the MEDS score when applied to the complete study population with an area under the curve being 0.87 (0.788—0.963) as compared with 0.75 (0.634—0.876) for MEDS. Logistic regression analysis revealed that the best fitting predictor of 28-day mortality for sepsis patients was the SPEED scoring system. For every one unit increase in SPEED score, the odds of 28-day mortality increased by 37%.

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  Peer review under responsibility of Chinese Medical Association.

Conclusion: SPEED score is more useful and accurate than MEDS score in predicting the 28-day mortality among sepsis patients. Therefore SPEED rather than MEDS should be more widely used in the ED for sepsis patients.

Introduction

Sepsis is a syndrome of physiologic, pathologic, and biochemical abnormalities induced by infection. In developed health care systems, sepsis management takes place in the Intensive Care Unit (ICU) but initially most of patients with sepsis are managed in the Emergency Department (ED), underlining the fact that the length stay in ED should be 6 h or less.[1] It is a highly prevalent condition which accounts for 10% of admissions to the ICU and is associated with an in-hospital mortality rate of 10%–20%.[2] The most common primary sources of infection resulting in sepsis are the lungs, the abdomen, and the urinary tract. Typically, 50% of sepsis cases start as an infection in the lungs. No source can be found in one third of cases.[3]

Severe sepsis is defined as sepsis associated with organ dysfunction, hypoperfusion or hypotension. Septic shock in adults refers to a state of acute circulatory failure characterized by persistent arterial hypotension despite adequate volume resuscitation, in the absence of other cause of hypotension.[4] In 2016, sepsis was defined as a life-threatening organ dysfunction caused by a deregulated host response to infection. This new definition emphasizes the primacy of the non-homeostatic host response to infection, the potential lethality that is considerably in excess of a straightforward infection, and the need for urgent recognition. For clinical operationalization, organ dysfunction represented by an increase in the sequential organ failure assessment (SOFA) score of 2 points or more, associated with an in-hospital mortality >10%.[5] Sepsis patients with a serum lactate level of >20 mmol/L (180 mg/L), despite adequate volume resuscitation, were still subject to a hospital mortality rate exceeding 40%.[6]

Sepsis patients may not necessarily appear seriously ill at presentation in ED but their condition may deteriorate rapidly; therefore, early recognition of sepsis and systemic inflammatory response syndrome (SIRS) in the critically ill patient and early initiation of antibiotic and goal-directed therapies have demonstrated a reduction in mortality, morbidity and multiple organ failure which increase length of stay.[7]

Mortality due to sepsis can be assessed via multiple scoring systems like SOFA, quick SOFA (qSOFA), mortality emergency department (MEDS) score, sepsis patient evaluation emergency department (SPEED) score, etc. All the systems quantify abnormalities according to clinical findings, laboratory data or therapeutic interventions. The predominant score in current use in ICU is SOFA.[8]

MEDS score is the most frequently used scoring system to predict mortality for patients diagnosed with sepsis in the ED, which has been validated widely. MEDS score is based on assessment of whether the patient has terminal illness (<30 day expected survivor), tachypnea or hypoxia, septic shock, platelets <150,000/mm³, age > 65 years, lower respiratory infection, nursing home resident, altered mental state.[9]

Another scoring system called SPEED evaluates the presence of an immunosuppressive state: presence of HIV/AIDS, malignancy, organ transplant recipient, or current use of immunosuppressive drugs, hypotension (systolic pressure<90 mmHg), hypothermia (body temperature<36.0°C), low hematocrit (hematocrit<0.38), hypoxemia (pulse oxymetry<90%), elevated blood lactate>2.4 mmol/L, acidosis (blood PH < 7.35), and pneumonia. It is even considered simpler than the MEDS score as it relies only on the most fundamental and readily available diagnostic tools.[10]

Diagnostic options within the ED are limited by budget constraints for invasive hemodynamic monitoring or imaging. Covariates like differential blood cell counts, including platelet and banded neutrophils, are utilized by some scoring systems and might not be readily available to test in EDs in developing countries. While the covariates collected and analyzed in SPEED score are the ones that can be easily and quite universally obtained in an ED setting: patient's characteristics, vital signs, and laboratory values.[11]

For a better understanding and management of sepsis patients, this study aims to:

1. To determine the outcome of septic patients in the ED;
2. To estimate the predictive value of SPEED score for 28-day mortality and morbidity in septic patients compared to the standard scoring systems in ED (MEDS score);
3. To prove the hypothesis that SPEED score is more simple and effective than MEDS score in predicting mortality in septic patients.

Methods

The current study cohort was a prospective follow-up study conducted at the ED in Suez Canal University Hospital, Egypt from August 2017 to June 2018. All the patients with an age ≥18 years regardless of gender who had either SIRS or suspected/confirmed infection were selected. In additions, they need to met the following criteria:

1. Suspected septic patients presenting with at least one of the clinical findings:(a) body temperature higher than 38°C or lower than 36°C, (b) heart rate higher than 90 beats/min, (c) hyperventilation evidenced by respiratory rate higher than 20 breaths/min or $PaCO_2$ lower than 32 mmHg, and (d) white blood cell count higher than 12,000/μL or lower than 4000/μL.
2. Confirmed septic patients with at least a 2 points increase from the baseline total SOFA score following infection (which is assumed zero in patients with no preceding organ dysfunction). Patients were selected according to their SOFA score due to the fact that the third international consensus defines sepsis as "a life-threatening organ dysfunction caused by a deregulated host response to infection". Organ dysfunction can be identified through acute increase in total SOFA score following infection by at least 2 points from the base lines.[9,19] However, all patients were followed up shortly for 28 days for the results of mortality.

Moreover, patients who arrested on arrival and pregnancy were excluded. Data were collected in the ED in Suez Canal University Hospital 5 days per week until sample size was collected.

Full medical history (from relatives)

Data collected include demographic data like age and sex, complaint and history of present illness, drug history, number of days with antibiotics, co-morbid conditions and risk factors, review of other systems, and history of chronic disease. The presence of the following chronic illness was also recorded: chronic obstructive airway disease, diabetes, any malignancy, HIV/AIDS, cerebrovascular accident, chronic cardiac failure, chronic or end-stage renal failure, hepatitis B or C, hypertension, organ transplant recipient, immunosuppressed state, nursing home residency and history of chronic kidney disease.

Complete clinical examination

General examinations included vital signs (pulse, blood pressure, temperature and respiratory rate) and complete cardiovascular, chest, and abdominal examination. Laboratory measurements covers complete blood cell count, arterial blood gas, liver function tests of alanine aminotransferase (ALT), aspartate aminotransferase (AST), renal function tests, serum creatinine and serum lactate. All the laboratory data were done in Suez Canal University lab.

Fates of the patients were divided into discharged, died, or admitted to the ICU or inpatient department.

The sample size was calculated according to Dawson et al.'s[12] formula, which is equal to 54 subjects. Adding 10% as a dropout proportion gives rise to 61 patients as a sample size number.

This study was conducted using non-probability convenience sampling. In addition, every patient was subject to two scoring systems SPEED score and MEDS score. Then a comparison was made between fates of patients in each scoring system to detect which of them is more effective in predicting outcome.

Follow-up of patients was established via collection from hospital records or via telephone contacting their relatives if the patient was discharged home or transferred to another hospital.

Data analysis

Statistical analysis was done using SPSS 10.0. Continuous variables were handled with student t-test and presented as median while discrete variables with Chi-square test and expressed as frequencies and percentage. The level of significance was set at $p < 0.05$.

Ethical consideration

An informed consent has been taken from all caregivers of participants before taking any data. Moreover the data are considered confidential and not used outside this study without the patient's approval.

Results

Our study included 61 sepsis patients. Until the end of 28 days, 16 (26.2%) were admitted to the inpatient department, 4 (6.6%) to

the ICU, and 41 (67.2%) died either in the ER or ICU. It was revealed that patients who died either at the ER, ICU, or inpatient department had a statistically significant difference from those who survived and admitted to the ICU or inpatient department or discharged after recovery in regards to both SPEED score ($p = 0.004$) and MEDS score ($p < 0.01$) (Table 1).

Patients were then divided into survivor and nonsurvivor groups. The nonsurvivors had a significantly higher median age (years) than the survivors [65.00 (59.00–76.50) *vs.* 53.50 (38.25–63.75)] ($p = 0.004$), while gender distribution revealed no significant difference ($p = 0.160$).

As for the vital signs, only Glasgow coma scale (GCS) score showed a significant difference between two groups: the survivor group had a much higher median score than the nonsurvivor group (15 *vs.* 11, $p = 0.022$, Table 2). Chronic diseases revealed no significant difference between two groups (Tables 2 and 3).

The 28-day mortality rate for MEDS score and SPEED score quintiles is listed in Table 4, which showed that the mortality rates rose with increased MEDS scores and SPEED scores.

Comparison between survived and died patients by Mann-Whitney U test showed a statistically significant difference in terms of AST ($p = 0.011$), prothrombin time (PT) ($p = 0.035$), international normalized ratio (INR) ($p = 0.023$) and PCO_2 ($p = 0.01$), while other laboratory parameters including random blood glucose, total leucocytic count, hemoglobin, platelets count, ALT, AST, total bilirubin, serum creatinine, serum Na^+, serum k^+ showed no significant difference. Arterial blood gas of PH, PCO_2, HCO_3 and lactate showed no significant difference either (Appendix A.).

Focusing on the SPEED score parameters, the survived patient had a significantly lower rates of hypotension ($p = 0.048$) and hypoxemia ($p = 0.050$). Other SPEED parameters showed no significant difference (Table 5).

Regarding MEDS score parameters, presence of terminal illness ($p = 0.005$), septic shock ($p < 0.01$) and altered mental status ($p = 0.013$) were significantly higher in nonsurvivors. There was no significant difference between both groups regarding other MEDS parameters (Table 6).

Mann-Whitney U test revealed that the median SPEED score ($p = 0.001$) and MEDS score ($p = 0.01$) showed significant difference between survived and died patients (Table 7).

Logistic regression analysis was used to assess the predictive effect of SPEED score and MEDS score regarding 28-day mortality among sepsis patients. SPEED score was revealed to be the best fitting predictor of 28-day mortality for sepsis patients; for every 1-unit increase in SPEED score, the odds of 28-day mortality increased by 37% (Table 8).

The receiver operating characteristic curves for MEDS score and SPEED score are plotted in Fig. 1 and Table 9. The SPEED score performed better than the MEDS score when applied to the complete study population with an area under the curve of 0.87 (0.788–0.963) as compared with 0.75 (0.634–0.876).

Discussion

This study aims to assess the efficacy of SPEED scoring system as an outcome predictor in cases of emergency sepsis patients after

Table 1
Group comparison between sepsis scores and fate of septic patients ($n = 61$).

Scoring system	Survived and admitted to		Died at			p value
	Inpatient department	ICU	ER	ICU	Inpatient department	
MEDS	5 (3–8)	9 (7–10)	11 (8–13)	10.5 (8–15)	9 (4–11)	0.004
SPEED	5 (3–8)	9 (8–12)	13 (12–18)	11.5 (8–18.5)	15 (10.75–19)	<0.001

Table 2
Group comparison between survived and died septic patients regarding vital signs ($n = 61$).

Group	Vital signs	SBP (mmHg)	DBP (mmHg)	GCS score
	Temperature (°C)			
Survivors ($n = 20$)	38.25 (36.00—39.13)	100 (80.0—110.0)	60 (50.0—70.0)	15 (12.5—15.0)
Nonsurvivors ($n = 41$)	36 (36.00—38.55)	80 (70.0—108.0)	50 (40.0—70.0)	11 (9.0—13.0)
p value	0.197	0.089	0.172	0.022[a]

Data are analyzed by Mann-Whitney U test and presented as median (25th quartile-75th quartile).
[a] Statistical significance.
SBP: systolic blood pressure; DBP: diastolic blood pressure; GCS: Glasgow coma scale.

Table 3
Group comparison between survived and died septic patients regarding chronic diseases ($n = 61$).

Group	Chronic diseases				
	Diabetes	Hypertension	Cardiovascular event	Ischemic heart diseases	Chronic kidney disease
Survivors ($n = 20$)	11 (55.0)	18 (90.0)	1 (5.0)	3[15]	1 (5.0)
Nonsurvivors ($n = 41$)	16 (39.0)	7 (17.1)	9 (22.0)	9 (22.0)	5 (12.2)
p value	0.230[a]	0.510[a]	0.093[a]	0.520[a]	0.653[b]

[a]Data are analyzed by Chi-square test; [b]Data are analyzed by Fisher's Exact test.
All data are presented as n (%).

Table 4
The 28-day mortality rate for MEDS score and SPEED score quintiles ($n = 61$).

Variables	Survivors	Nonsurvivors	Total	Mortality rate (%)
MEDS score				
0-4	7	0	7	0
5-7	2	3	5	60.0
8-11	9	12	21	57.1
12-14	2	11	13	84.6
≥15	0	15	15	100.0
SPEED score				
<3	7	3	10	30.0
4-6	2	8	10	80.0
7-9	7	6	13	46.2
>10	4	24	28	85.7

Table 5
Group comparison between survived and died septic patients regarding SPEED score parameters.

SPEED parameters	Survivors ($n = 20$)	Nonsurvivors ($n = 41$)	p value
Immunosuppressed state	3 (15.0)	14 (34.1)	0.141
Hypotension (systolic blood pressure<90 mmHg)	9 (45.0)	29 (70.7)	0.048
Hypothermia (body temperature <36.0°C)	7 (35.0)	23 (56.1)	0.122
Hypoxemia (pulse oximetry<90%)	5 (25.0)	21 (51.2)	0.050
Low hematocrit (hematocrit<0.38)	10 (50.0)	21 (51.2)	0.900
Elevated lactate (blood lactate>2.4 mmol/L)	11 (55.0)	29 (70.7)	0.260
Pneumonia	5 (25.0)	19 (46.3)	0.160
Acidosis (blood pH < 7.35)	11 (55.0)	24 (58.5)	0.700

Data are analyzed by chi-square test and expressed as n (%).
[a]: Statistical significance.

Table 6
Group comparison between survived and died septic patients regarding MEDS score parameters.

MEDS parameters	Survivors ($n = 20$)	Nonsurvivors ($n = 41$)	p value
Terminal illness	1 (5.0)	16 (39.0)	0.005[a]
Tachypnea or hypoxia	5 (25.0)	21 (51.2)	0.060
Septic shock	2 (10.0)	28 (68.3)	<0.01[a]
Platelet < 150.000/mm^2	4 (20.0)	13 (31.7)	0.338
Bands > 5%	16 (80.0)	34 (82.9)	0.900
Age > 65 years	6 (30.0)	22 (53.7)	0.110
Lower respiratory infection	5 (25.0)	19 (46.3)	0.160
Nursing home resident	5 (25.0)	16 (39.0)	0.390
Altered mental status	5 (25.0)	25 (61.0)	0.013[a]

Data are analyzed by Chi-square test and expressed as n (%).
[a] Statistical significance.

Table 7
Group comparison between survived and died septic patients regarding different sepsis score.

Variables	Survived ($n = 20$)	Died ($n = 41$)	p value
MEDS score	8 (3—8.75)	13[10—18]	0.010[a]
SPEED score	7.5[3—9]	11 (6—12.5)	0.001[a]

Data are analyzed by Mann-Whitney U test and expressed as median (IQR).
[a] Statistical significance.

"8—11", "12—14", and "≥15", respectively (Table 4). These findings are consistent with the results of previous studies. For instance, in the study of Hermans et al,[9] the mortality increased per subsequent MEDS category. The mortality was 3.1% in the category ≤4 points,

Table 8
Logistic regression analysis of SPEED score and MEDS score in predicting 28-day mortality among sepsis patients.

Variables	β (SE)	OR (95% CI)	p value
Constant	9.86 (3.91)	—	0.012
Age	0.047 (0.028)	1.048 (0.992—1.107)	0.095
INR	- 3.369 (2.39)	0.034 (0—3.73)	0.159
SPEED score	0.37 (0.138)	1.44 (1.106—1.898)	0.007[a]
MEDS score	0.038 (0.152)	1.039 (0.77—1.41)	0.804

β: beta-coefficient; SE: standard error; OR: odds ratio; CI: confidence interval, INR: international normalized ratio.
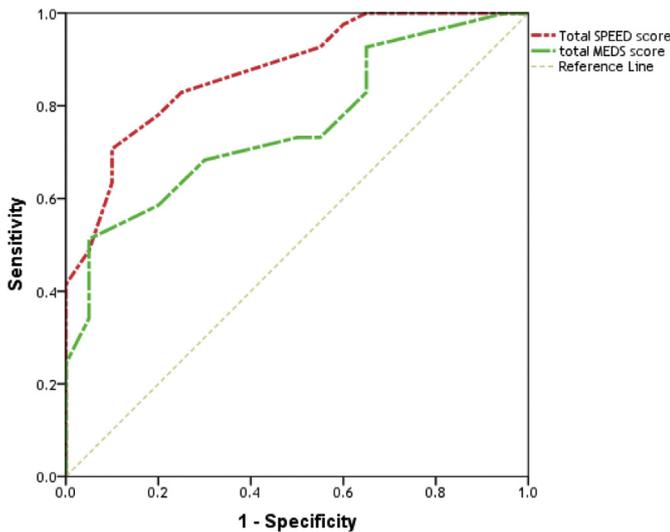[a] Statistical significance.

deriving and validating it as a risk stratification tool by Bewersdorf et al.'s study,[10] which included 440 patients from August 2011 to January 2012 at University of Malaya Medical Center, a tertiary hospital in an urban setting which treats about 125,000 ED patients annually.

In this study, we observed a higher mortality rate associated with higher scores of both MEDS and SPEED. Mortality rates were 0%, 60%, 57%, 85%, and 100% for MEDS scores of "0—4", "5—7",

Fig. 1. Receiver operator characteristic curves for MEDS and SPEED scores for 28-day mortality.

Table 9
Area under the curve for MEDS and SPEED score.

Variable	Area	Stand. error	*p* value	95% *CI*
SPEED score	0.876	0.045	0.001*	0.788—0.963
MEDS score	0.755	0.062	0.001*	0.634—0.876

5.3% for 5—7 points, 17.3% for 8—12 points, 40.0% for 13—15 points and 77.8% for >15 points. Similarly, the prospective, observational study of Gunes-Ozaydin[18] and colleagues demonstrated higher figures of mortality associated with higher scores of MEDS. Mortality rates were 8.5%, 26%, 50%, and 57% associated with MEDS scores of "0—7", "8—12", "13—15", and ">15", respectively. Thus, MEDS represent a good predictive tool for mortality with higher mortality risk associated with the higher MEDS score.[9]

There was no specific scoring system to predict mortality in sepsis patients presenting to the ED until Shapiro et al.[11] published the MEDS score in 2003. However, it failed to become a part of the routine clinical practice despite originally being developed for the ED. This may be because MEDS requires a certain diagnostic workup that might be difficult to obtain in the settings of limited resources. For example, MEDS requires the acquisition of the number of thrombocytes and bands in differential cell count. Additionally, MEDS score is complex to be calculated and interpreted. In light of these limitations, another prospective observational study validated the SPEED score, which can accurately predict mortality in sepsis patients and is simple to calculate.[10] Since then, there were no other studies that have assessed the efficacy of this score.

In this study, the predictive ability of both SPEED score and MEDS score for 28-days mortality of sepsis patients in ED was investigated. Altogether 61 patients were included and till the end of follow-up, 20 patients survived and the remaining 41 patients died. Comparison between the survivors and nonsurvivors revealed that the former is younger in age (median 65.0 *vs.* 53.5, *p* = 0.004). In line with this findings, the study of Ghanem-Zoubi and colleagues,[13] which included 1072 consecutive patients also demonstrated a statistically significant difference of the mean age between survived (81.50 ± 10.02) and died patients (70.83 ± 17.611) (*p* < 0.0001). Similarly, in another study including inpatients at a Brazilian teaching hospital which assessed the impact of duration of organ dysfunction on the outcome of patients with severe sepsis and septic shock, age was found to be significantly associated with

mortality by univariate analysis (*p* = 0.015). In their study, the mean ages (years) was (47.9 ± 18.5) for survivors and (61.3 ± 20.8) for non-survivors.[14] Furthermore, many earlier studies have well established that older age contributes to a greater sepsis risk.[9] In fact, sepsis encountered in infancy is followed by a declined incidence during childhood and then shows another peak during adulthood.[12] Adults aging over 65 years represent half or more of the cases with severe sepsis.[13] Consequently, age is one of the most important risk factors associated with sepsis.

In our study, there was no association between the 28-day mortality and the gender (*p* = 0.16) as well as concurrent presence of underlying diseases as diabetes (*p* = 0.230), hypertension (*p* = 0.510), cardiovascular events (*p* = 0.093), and chronic kidney disease (*p* = 0.653). Similarly, in a study to identify a reliable tool for the early prognostic stratification of sepsis patients admitted to the ED, Freitas and colleagues retrospectively reported no significant relationship between mortality in sepsis patients and ischemic heart disease, chronic obstructive pulmonary disease, heart failure, chronic kidney disease, and diabetes mellitus.[14]

Laboratory investigation showed that there was a statistically significant difference in median INR (*p* = 0.023) and PT levels (*p* = 0.035) between survived and died patients. These findings are consistent with the findings reported by McCormack et al.[15] They investigate 182 patients and found that patients in mortality group had a higher INR level (1.4 ± 0.6 *vs.* 2.4 ± 1.9, *p* < 0.0001); additionally, logistic regression model found that INR ≥1.3 was an independent predictor of mortality (*OR* = 8.3; 95% *CI*, 3.35—20.51). Thus, complete laboratory workup, including coagulation profile, is essential in the process of assessment and risk stratification of sepsis patients.

In the current study, the median MEDS score (8 *vs.* 13, *p* = 0.01) and SPEED score (7.5 *vs.* 11, *p* = 0.001) showed statistically significant difference between survived patients and died patients. Ghanem-Zoubi and colleagues[13] also reported a great difference in MEDS score between survived and died patients (mean ± SD, 4.9 ± 3.0 *vs.* 7.7 ± 3.0, *p* < 0.0001). Another retrospective study conducted at the EDs of four training and research hospitals by Hung et al.[16] showed a statistically significant difference between survivors and nonsurvivors regarding the mean MEDS score (0.07 *vs.* 0.29, *p* < 0.0001).

However, in our study, the SPEED score was the best-fitting independent predictor of the 28-day mortality after performing logistic regression analysis. We found that in sepsis patients, for every 1 unit increase in SPEED score, the odds of 28-day mortality increased by 37% (*OR* = 1.44, 95% *CI* = 1.106—1.898, *p* = 0.007). Additionally, ROC analysis of both SPEED and MEDS scores was done to evaluate the predictive ability of 28-day mortality. The SPEED score performed better than the MEDS score when applied to the complete study population with AUC being 0.876 and 0.755, respectively (*p* = 0.001); while the 95% *CI* for SPEED and MEDS scores were 0.788—0.963 and 0.634—0.876, respectively. These results are consistent with the prospective study of Bewersdorf et al.[10] which validated the SPEED score and demonstrated a better performance of SPEED score than the MEDS score (*p* = 0.02) when applied to the complete study population of 440 patients with an AUC of 0.81 (0.76—0.85) for the SPEED score and 0.74 (0.70—0.79) for the MEDS.[19]

Another prospective observational clinical study held in the ED of Beijing Chao-Yang Hospital, a teaching hospital of Capital Medical University with approximately 250,000 ED visits per year, compared between the MEDS, APACHE II, and PIRO scores regarding their predictive ability of 28-day mortality and reported an AUC of 0.736 for the MEDS score (*p* = 0.000, 95% *CI* = 0.693—0.779).[16] Similar AUC for MEDS score were also observed in other studies with a range of 0.6—0.75.[9] Consequently,

In contrast, a historical cohort study by Shapiro et al[11] in a secondary and tertiary care university hospital in the Netherlands, Maastricht University Medical Center to assess the value of MEDS, C-reactive protein, and lactate to predict 28-day mortality. The ED charts of everyone who attended the ED were reviewed. ROC analysis showed that the MEDS score predicted 28-day mortality better than CRP (AUC = 0.81, 95% *CI* = 0.73−0.88 *vs.* 0.68, 95% *CI* = 0.58−0.78). The higher AUC (0.81) of MEDS in this study compared to the current study can be perfectly explained by the huge difference in sample size. We only included 61 patients but they included 331 patients. Additionally, they selected all patients seen by an internist, whose blood was cultured regardless of the sepsis criteria because the MEDS score was originally developed in a group of patients selected based on the criterion of having blood cultures taken in the ED.[11]

Regarding parameters of MEDS score, we found a statistically significant association between mortality and presence of terminal illness ($p = 0.005$), septic shock ($p < 0.01$) and altered mental status ($p = 0.013$) (Table 5). These findings were similar to those of the study Shapiro et al[11], a prospective study conducted with septic patients at the ED resuscitation room, which demonstrated significant associations between mortality and presence of terminal illness, septic shock, and altered mental status (p < 0.001). No significant difference was found between both groups regarding other MEDS parameters. This was inconsistent with Shapiro et al.'s[11] study which demonstrated a significant association of mortality with all the MEDS score parameters except for "bands >5%" and "nursing home resident".

Regarding the SPEED score parameters, we found a significant association between hypotension and mortality ($p = 0.048$). This was similar to the study by Wang and colleagues[17] which assessed the predictive performance of qSOFA for mortality and ICU admission in patients with infection at the ED. Their study showed that systolic blood pressure, diastolic blood pressure, and mean arterial pressure were statistically significantly lower among non-survivors (113 ± 37, 65 ± 21, and 81 ± 25, respectively) and patients admitted to the ICU (112 ± 38, 63 ± 22, and 79 ± 26, respectively) than survivors (129 ± 28, 73 ± 17, and 91 ± 19, respectively) and non-ICU admissions (128 ± 29, 73 ± 16, and 91 ± 19, respectively) ($p < 0.001$). Thus, the SPEED score parameters provide a reliable and quick tool to predict mortality among sepsis patient.

Regarding SPEED scores, there was also higher mortality risk associated with higher SPEED scores: 30%, 80%, 46%, and 86% risk of mortality were associated with SPEED scores of "0−3", "4−6", "7−9", and ">10", respectively. Similar results observed in the prospective study of Bewersdorf et al.[10] to derive and validate the SPEED score. The data set utilized to identify multivariate predictors of mortality and to develop the sepsis score and the validation set used after development of SPEED to test the quality of the score. Both the validation and derivation sets demonstrated higher mortality figures associated with higher SPEED scores. In the derivation set, mortality rates were 10%, 30%, 55%, and 95% associated with SPEED scores of "0−3", "4−6", "7−9", and ">10", respectively. In the validation set, mortality rates were 5%, 25%, 50%, and 75% associated with SPEED scores of "0−3", "4−6", "7−9", and ">10", respectively.[19]

To the best of our knowledge, this study is the first to compare the performance of SPEED and MEDS scoring systems. Additionally, our study has the strength of being prospective, and adhering to the widely used and accepted definition of sepsis.

In addition, the SPEED score is useful and accurate in prediction of 28-day mortality among sepsis patients with a discrimination power higher than the widely used MEDS score. There was a statistically significant difference of SPEED scores between survivors and non-survivors. By logistic regression analysis, the best-fitting predictor of 28-day mortality was the SPEED score. Additionally,

the SPEED score performed better than the MEDS score when applied to the complete study population with a higher AUC. Thus, it is a simpler and quicker predictive tool, which can perfectly use to assure proper allocation of the limited resources of the ED for the high-risk patients.

Our recommendation is to increase the level of awareness of emergency physicians about the importance of adherence to the SPEED score and their full comprehension of the predictive scores and their effectiveness as predictors of mortality and reliability as risk stratification tools. Implementation of the SPEED score in the ED is highly advisable and will lead to proper assessment, accurate resource allocation, and effective treatment guidance while dealing with septic patients.

Our study faced some limitations. Firstly, it is a single-center study whose results could not efficiently be generalized. Larger multi-centric studies are suggested to furthermore accurately assess the efficacy of the score. Secondly, although we used a larger sample size than that used in Elbaih et al.,[19] the sample size was still rather small. Thirdly the study was not blinded which might have introduced some bias into the results. In addition to these limitations, we depended on the notes of the attending doctor for obtaining all the necessary information, which could have led to information bias because some relevant information may not have been properly recorded. Moreover, data regarding the treatment of patients was not collected, whose variations might have affected the primary outcome of 28-day mortality.

Ethical statement

All patients gave consent to participate in the study without affecting their course of treatment accordingly to Institutional approvals of the Research Ethics Committee of the Faculty of Medicine, Suez Canal University.

1) Approval of Research ethics committee.
2) Administrative of SCUH was informed consent.
3) An informed consent taken from each patient or relatives.
4) Confidentiality of data.

Conflicts of interest

There are not any potential conflicts of interest, real or perceived.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cjtee.2019.10.004.

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