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Predictive Value of New Sequential Organ Failure Assessment (SOFA) Score of Mortality in Critically Ill Patients in Emergency Department in Suez Canal University Hospital

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ABSTRACT
Background: One of the scoring methods used to assess organ failure is the Sequential Organ Failure Assessment (SOFA) score, which can forecast the severity and course of the illness. It is currently utilised as a crucial indicator for determining if a patient has sepsis syndrome. **Objective:** This study aimed to assess the prognostic predictive performance of a new indicator, SOFAComb calculated by SOFAΔ + absolute SOFA score in critically ill patients in the Emergency Department at Suez Canal University Hospital. **Patients and Methods:** This was a descriptive cross-sectional study conducted on 124 patients aged 18 years and above who attended the Emergency Department (ED) at Suez Canal University Hospital, Ismailia, Egypt diagnosed with sepsis. **Results:** The patients' ages varied from 86 to 104 years, with a mean age of 62.6 years. Male participants made up 46% of the study and female participants made up 54%. In terms of predicting mortality in sepsis patients, the SOFAComb outperformed SOFA in terms of sensitivity, specificity, and positive predictive value (PPV). While SOFAΔ outperformed both in terms of PPV and specificity.
Conclusion: The SOFAComb presented a good predictive tool for patient outcome.
Keywords: Sepsis, SOFA, SOFAΔ, SOFAComb.

INTRODUCTION

One of the grading methods used to evaluate organ failure is the Sequential Organ Failure Assessment (SOFA) score, which can forecast the course and severity of the illness [1,2]. The recognition of sepsis syndrome on a distinct patient level now uses it as a crucial premise [3]. Organ dysfunction scores are being used more frequently to evaluate the efficacy of novel therapy medications in phase II trials after being adopted as an endpoint in exploratory studies for sepsis by the European Medicines Agency (EMA) and others [4]. Despite certain jargon differences, the SOFA score has proved useful in a variety of applications. Several words are often used and connected to the meanings given below [5]:

Admission SOFA: Based on the highest value for each subscore in the 24 hours before to entrance to the ICU, the admission SOFA score is determined.

Daily Extreme SOFA Score: Calculated for each 24-hour assessment, the daily extreme SOFA score is similar to the daily SOFA score; the SOFA score should be assessed using the maximum value of each subscore for that time period. Maximum SOFA score: During the course of the research, the maximum SOFA score is the greatest daily SOFA score.

Delta SOFA score: The delta SOFA is the difference between the beginning point value and the total SOFA score (or that of a different subscore). The SOFA for admission or a certain study day might serve as the beginning point value. Mean SOFA: Based on the sum of the SOFA scores for each research day, the mean SOFA score is computed for a single patient throughout the course of a specified study period [4].

A new indication, SOFAComb derived by SOFAΔ + absolute SOFA score, was seen in a recent research based on this idea [6]. However, there were restrictions because the data was a retrospective analysis; the objective of this study is to conduct a prospective study to corroborate the findings.

The study's objectives are to demonstrate the clinical picture and demographic data of critically ill patients and to assess prognostic factors (like comorbidities) that affected morbidity and mortality rate of critically ill patients. **Hypothesis**: SOFAComb is a high predictive value than SOFAΔ and absolute SOFA score for predicting mortality in critically ill patients in the emergency departments.

PATIENTS AND METHODS

This was a descriptive cross-sectional study conducted on 124 patients aged 18 years and above who attended the Emergency Department (ED) at Suez Canal University Hospital, Ismailia, Egypt including patients that were critically ill and had severe respiratory, cardiovascular, or neurological derangement, or combination: Respiratory failure type 1 or type 2, hypotension or heart failure, disturbed level of consciousness, of both sexes. The SOFA score was determined on Day 1 (baseline), Day 2, Day 4, Day 7, and consisted of six components: respiratory, coagulation, hepatic, circulatory, nervous system, and renal scores. On day 28, the results for the patients were also noted.

Ethical approval:

All data of the patients included in this study had been collected after having informed written consent from the patients or patients' first-degree relatives. After receiving approval from the Ethics Council of the Faculty of Medicine at Suez Canal University, the researcher collected data on a pre-organized data sheet. The conduct of this study adhered to the Declaration of Helsinki for Humans, the international medical association's rule of ethics.

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The patients who were excluded: were trauma patients. Data were collected included age, gender, special habits of medical importance, complaint of the patient, comorbid diseases{hypertension (blood pressure > 140/90 as defined by Joint National Committee (JNC) 8)[7], diabetes mellitus (random blood sugar (RBS) > 200 mg/dl) [8] or history if the patient on insulin or oral hypoglycemic drugs or both), ischemic heart disease (by history, ECG, echocardiography or previous history of cardiology care unit admission), heart failure (by history or echocardiography or previous history of cardiology care unit admission, patients on diuretics or digitalis or both)}, family history of sudden cardiac death, medications, and allergy, and presenting complaint and associated symptoms, cause of presentation at emergency room (ER).The appropriate laboratory and radiological investigations were done to know the etiology of sepsis. The outcome of the patients was determined as survival or death and the mortality rate was calculated.

Statistical analysis: The acquired data were coded, processed, and analysed using the Statistical Package for the Social Sciences (SPSS) version 24 for Windows (IBM SPSS Inc, Chicago, IL, USA). To represent qualitative data, frequencies and relative percentages were used.

Chi square (X^2) test was used to identify differences between two or more sets of qualitative variables. Mean±SD were used to present quantitative data. The independent samples t-test was used to compare two independent groups of normally distributed variables (parametric data). ROC curve (Receiver operator characteristic curve): It is a graphic presentation of sensitivity against 1- specificity. It is done by comparing values of cases to detect a cutoff of certain outcome. AUC (Area under the curve) = Area under the curve, the greater the area, the more accurate is the curve. Total area is 1.0, the yellow line is the reference line, it divides the area into 2 halves. P value of 0.05 or less was considered significant.

RESULTS

The patients' ages varied from 86 to 104 years, with a mean age of 62.6 years. According to Table (1), male participants made up 46% of the study and female participants made up 54% (Table 1).

Table (1): Demographic distribution of the study group

Demographic data		Total	Died (n=76)	Not died (n=48)	p-value
Age (year)	Mean ± SD	62.6±18.7	67.7±15.9	54.5±20	<0.05*
	Range	18 (86-104)	39 (65-104)	18 (67-85)	
Male	N (%)	57 (46%)	35 (46.1%)	22 (45.8%)	0.98
Female	N (%)	67 (54%)	41 (53.9%)	26 (54.2%)	

Our study showed that diabetes and hypertension were the most common chronic illnesses in the studied population. Chronic illnesses (Hypertension, diabetes mellitus, asthma, cardiovascular disease, COPD, cancer, epilepsy) were significantly present in patients who died with sepsis than those who survived (**Table 2).**

Table (2): Chronic illnesses of the studied patients

Chronic illnesses		Total	Died (n=76)	Not died (n=48)	p-value
HTN	Yes	28(22.6%)	24 (31.6%)	4(8.3%)	0.002*
	No	96(77.4%)	52 (68.4%)	44(91.7%)	
DM	Yes	35(28.2%)	29(38.2%)	6(12.5%)	<0.05*
	No	89(71.8%)	47(61.8%)	42(87.5%)	
Asthma	Yes	4(3.2%)	0 (0%)	4(8.3%)	0.02*
	No	120(96.8%)	76(100%)	44(91.7%)	
COPD	Yes	4(3.2%)	0 (0%)	4(8.3%)	0.02*
	No	120(96.8%)	76(100%)	44(91.7%)	
CKD	Yes	3(2.4%)	2(2.6%)	1(2.1%)	0.6
	No	121(97.6%)	74(97.4%)	47(97.9%)	
Cancer	Yes	20(16.1%)	16(21.1%)	4(8.3%)	0.04*
	No	104(83.9%)	60(78.9%)	44(91.7%)	
CLD	Yes	12(9.7%)	8(10.5%)	4(8.3%)	0.4
	No	112(90.3%)	68(89.5%)	44(91.7%)	
Covid	Yes	16(12.9%)	8(10.5%)	8(16.7%)	0.2
	No	108(87.1%)	68(89.5%)	40(83.3%)	
Epilepsy	Yes	4(3.2%)	0(0%)	4(8.3%)	0.02*
	No	120(96.8%)	76(100%)	44(91.7%)	
CVS	Yes	20(16.1%)	16(21.1%)	4(8.3%)	0.04*
	No	104(83.9%)	60(78.9%)	44(91.7%)	

HTN=hypertension, DM=diabetes mellitus, CKD=chronic kidney disease, CLD=chronic liver disease, CVS= cerebrovascular stroke.

The SOFAComb had a better sensitivity, specificity, and PPV than SOFA in predicting mortality in patients with sepsis. While, SOFAΔ had better specificity and PPV than both as shown in **Table (3)** and **Figure (1).**

Table (3): Area under the curve for SOFAComb, SOFA, SOFAΔ at the base, 2, 4 and 7 days as a predictor of mortality

SOFA scores	Sensitivity	Specificity	PPV	NPV	Accuracy	Area under the curve	Cut off point
SOFA base	94.7	25	66.6	75	67.7	0.2	2.5
SOFA 2 days	100	33.3	70.3	100	74.2	0.2	2
SOFA 4 days	100	16.7	65.6	100	67.8	0.15	1
SOFA 7days	100	33.4	70.3	100	74.2	0.11	1
SOFA Δ 2	36.9	84	77.8	45.5	54.9	0.27	1
SOFA Δ 4	100	66.7	82.6	100	87	0.18	-3
SOFA Δ 7	88	84	89	81.6	86.2	0.12	-2.5
SOFA 2comb	100	41.7	73	100	77.4	0.18	1
SOFA 4 comb	100	41.7	73	100	77.4	0.14	-1
SOFA 7 comb	100	50	76	100	76	0.08	-2

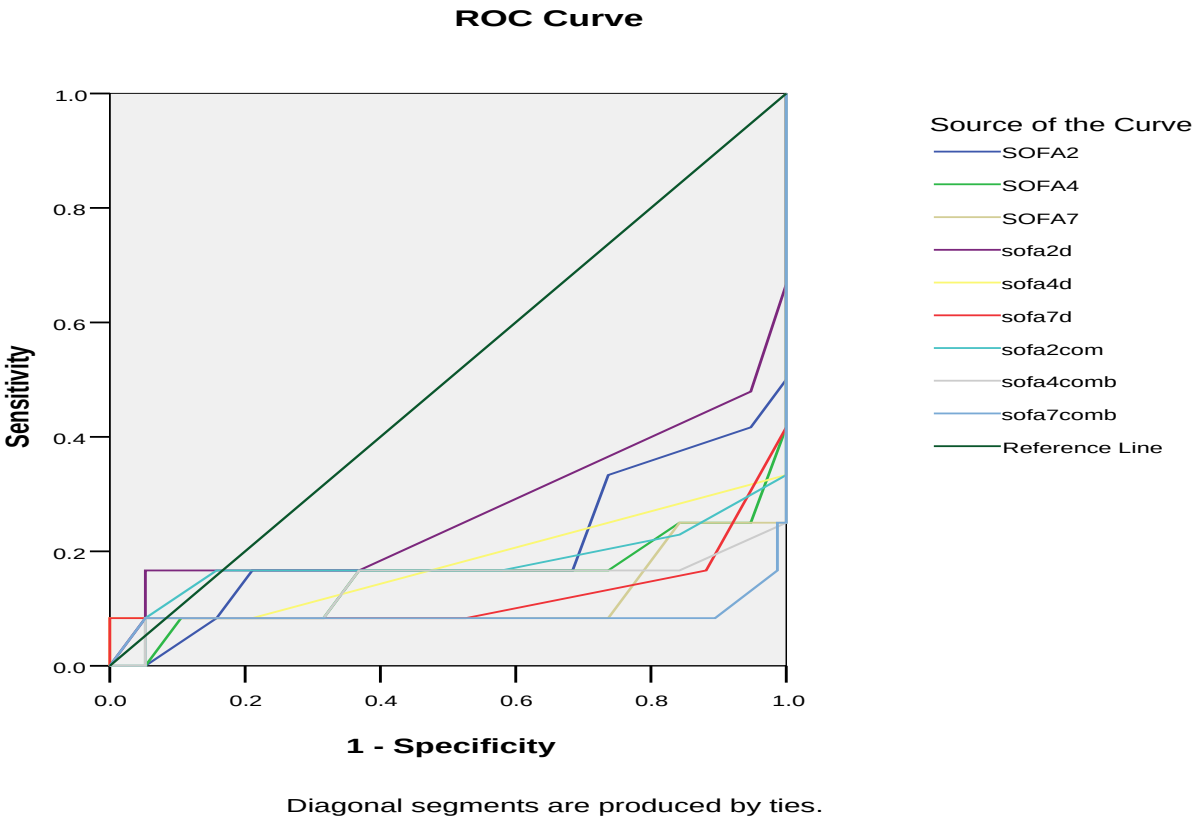

Figure (1): ROC curve of SOFAComb, SOFA, SOFAΔ at base, 2, 4 and 7 days as a predictor of mortality.

Table (4): shows the SOFAComb score of the patients who died and who survived. SOFAComb at 7 days was higher between died patients than those who survived.

Table (4): Comparison of the SOFAComb score between the died and survived patients

SOFA scores		Total	Died (n=76)	Not died (n=48)	p-value
SOFA base	Mean ± SD	6.5 ± 2.6	7.4 ± 2.6	5.11± 2	<0.05*
	Range	12(2-14)	11(3-14)	6(2-8)	
SOFA 2 days	Mean ± SD	7.6 ± 3.3	8.8 ± 2.9	5.6± 3	<0.05*
	Range	15 (3-18)	13 (5-18)	9 (3-12)	
SOFA 4 days	Mean ± SD	8.5± 3.7	10.2± 2.9	5.9± 3.4	<0.05*
	Range	17(2-19)	13(6-19)	12(2-14)	
SOFA 7days	Mean ± SD	9.5± 4.5	11.8± 3.1	5.9 ± 4	<0.05*
	Range	18(2-20)	13(7-20)	15(2-17)	
SOFA Δ 2	Mean ± SD	1± 1.2	1.4± 0.8	0.5± 1.6	<0.05*
	Range	5(-1-4)	4 (0 - 4)	5(-1-4)	
SOFA Δ 4	Mean ± SD	2± 1.8	2.7± 1	0.8 ± 2.2	<0.05*
	Range	8(-2-6)	3(2-5)	8(-2-6)	
SOFA Δ 7	Mean ± SD	3± 2.9	4.4± 1.7	0.8± 3.1	<0.05*
	Range	13(-4-9)	5(2-7)	13(-4-9)	
SOFA 2comb	Mean ± SD	8.5± 4.3	10.2± 3.5	6.2 ± 4.3	<0.05*
	Range	20(2-22)	15(7-22)	14(2-16)	
SOFA 4 comb	Mean ± SD	10.6± 5.2	13.05± 3.5	6.8± 5.2	<0.05*
	Range	24(0-24)	15(9-24)	20(0-20)	
SOFA 7 comb	Mean ± SD	12.6± 7.1	16.2± 4.4	6.9 ± 6.8	<0.05*
	Range	27(-1-26)	17(9-26)	27(-1-26)	

DISCUSSION

It is advised that a delta-SOFA, which is the trajectory of the SOFA score, be used as an endpoint in exploratory clinical studies and as a more accurate indication of mortality. The usage of SOFA is, however, not without certain concerns. For instance, SOFA merely represents changes in the score; its potential worth as an absolute score has not been taken into account [(8)]. So, the goal of this study was to assess the prognostic predictive performance of a new indicator, SOFAComb calculated by SOFAΔ + absolute SOFA score in critically ill patients in the Emergency Department at Suez Canal University Hospital

In current study, the patients' ages varied from 86 to 104 years, with a mean age of 62.6 years. According to Table (1), male participants made up 46% of the study and female participants made up 54%.

These results were not the same as the study's findings by **Lukoko *et al.*** [(9)], which showed that most of the studied patients were males (61.4%), with a median age of 53 years. This study showed that diabetes and hypertension were the predominant chronic illnesses in the studied population. Chronic illnesses (Hypertension, diabetes mellitus, asthma, cardiovascular disease, COPD, cancer, epilepsy) were significantly present more in patients who died (76 patients with sepsis) than those who survived (48 patients).

Lukoko *et al.* [(9)] reported that the most frequent comorbid conditions were hypertension (27.5%) and diabetes mellitus (11.4%). However, there was no difference in the history of chronic illness between survivors and non-survivors contradicting our results. This would be explained by their recruitment of patients with respiratory failure, acute renal injury, sepsis, or septic shock.

The SOFAComb had a better sensitivity, specificity, and PPV than SOFA in determining death in sepsis patients. While, SOFAΔ had better specificity and PPV than both. This agreed with the results of a previous study where the accuracy of SOFAΔ exceeded 80%. However, this study evaluated SOFAΔ among patients with disseminated intravascular coagulopathy (DIC) and 28 days and the performance of SOFAΔ was not evaluated at an earlier time [(10)].

Another study contradicted our results where the SOFAComb showed better accuracies than SOFAΔ on days 2, 4, and 7[(11)]. This would be explained by their recruitment of patients with sepsis- associated DIC and introduction of antithrombin supplementation as a treatment. This makes it uncertain whether the results would be applied to patients with sepsis with or without DIC treated with other medications. Additionally, there were missing data in their analysis impairing data validation due to selection bias. Also, this study was a retrospective study [(11)].

Another study reported a SOFA point ≥ 2 was associated with increased odds of mortality. The median SOFAΔ was 0 and it performed poorly [(10)]. Also, the

current study reported poor performance of SOFAΔ at 48 hours while higher performance was reported on days 4 and 7. This would be rendered to elevated SOFA scores at 48 hours as it has been reported that increased SOFA scores between days 1 and 2 were associated with increased short-term mortality [(12)].

A recent study agreed with the results of the current one with SOFA scores reporting good discrimination (AUC 0.788) for prognostication of surgical patients admitted to the ICU [(13)]. Another one reported a direct positive and significant association between SOFAΔ score and in-hospital mortality. However, this study performed a modification in the respiratory component of the SOFA score, the calculations were not performed in real-time and recruited certain patients with sepsis (those with cardiovascular or metabolic hypoperfusion) [(1)]. Variable results regarding the performance accuracy of SOFAΔ were related to the fact that SOFAΔ represents the change in SOFA only with no integration of the absolute SOFA [(14)]. Few studies reported on the accuracy of the SOFAComb in the prediction of mortality in critically ill patients with conflicting results. An earlier study was in favor of the SOFAΔ rather than the absolute SOFA score. This would be rendered to the fact that SOFAΔ is a fast and easy measure that reflects the effect of antiseptic measures [(14)]. However, SOFAΔ can't reflect the effect of treatment as a prolonged time would be needed. This drawback would be solved with the use of the absolute SOFA score giving priority to SOFAComb in patient's prognostication [(11)].

STRENGTH AND LIMITATIONS

This was a single-center study, with a small sample size. This was the first prospective cohort study to evaluate the role of SOFAComb in the prediction of mortality in sepsis patients. These results couldn't be generalized due to different resources between hospitals as well as ICU admission criteria. Organ subscores were not evaluated. We conducted follow-up for a short period of time.

CONCLUSION

The SOFAComb presented a good predictive tool for critically ill patients.

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- **Competing interests:** Nil.
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- **Take-home messages:** The SOFAComb presented a good predictive tool for patient outcomes in critically ill patients.

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