International Journal of Medical Arts

Volume 5, Issue 10, October 2023

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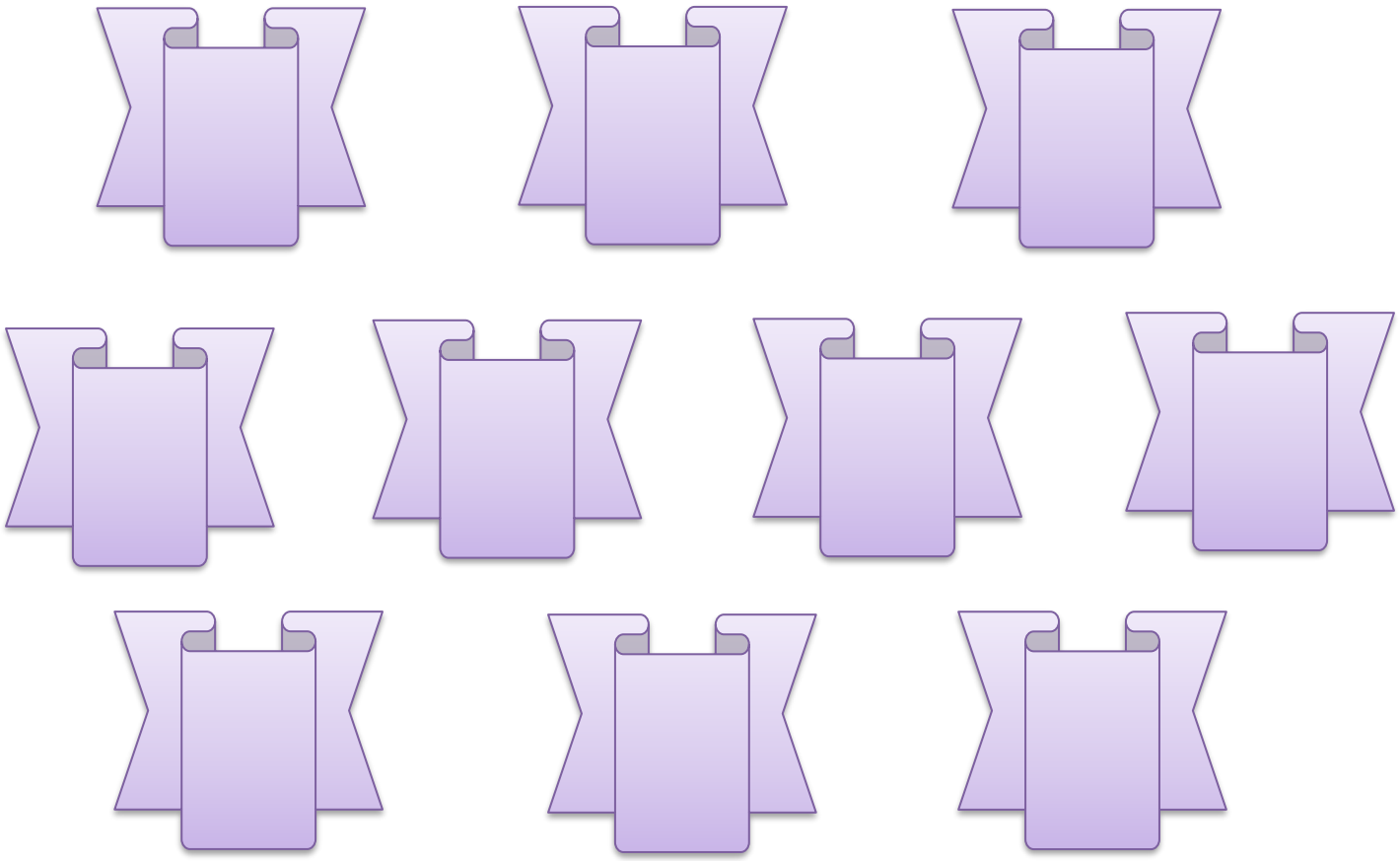

Print ISSN: 2636-4174

Online ISSN: 2682-3780

Available online at Journal Website
https://ijma.journals.ekb.eg/
Main Subject [Emergency Medicine]

Original Article

Impact of SOFA Score on The Outcomes of Traumatic Patient in Intensive Care Unit

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Article information

Received: 06-11-2023

Accepted: 03-12-2023

DOI: 10.21608/IJMA.2023.246932.1858.

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Citation: Gomaa MG, Aboelenin MA, Abdelsalam Y. Impact of SOFA Score on The Outcomes of Traumatic Patient in Intensive Care Unit. IJMA 2023 October; 5 [10]: 3776-3784. doi: 10.21608/IJMA.2023.246932.1858.

ABSTRACT

Background: When a patient is admitted to the intensive care unit [ICU], organ dysfunction is thought to be the primary cause of death and complications. Since its development in the 1990s, the sequential organ failure assessment [SOFA] score has been used in critical care to assess and forecast acute morbidities and related patient outcomes.

The Aim of the work: For assessment SOFA score ability as a diagnostic indicator in predicting traumatic patients' outcome in the ICU.

Patients and Methods: This was a prospective cross-sectional study conducted on all trauma patients who admitted to ICU at Damietta Al-Azhar University Hospital. After approval of ethical committee 70 patients of them ranged from 18 to 69 years were selected.

Results: Regarding the cause of admission in the studied population, 24% was abdominal trauma followed by ICH in 20%, multiple fracture in 17.1%, subdural hematoma and pneumothorax in 14.29% for each then Brain contusion in 10% of included patients. The duration of hospital stay ranged between 4-20 days with mean duration of 9.600 ± 4.095 days. SOFA score has sensitivity of 91.7% and specificity of 100% for predicting mortality, at cutoff point 5.5. There was statistical significance positive correlation between SOFA score and the duration of hospital stay.

Conclusion: There is statistically significant positive correlation between SOFA score and the duration of hospital stay so It is suggested that SOFA score be used as a suitable tool to predict patients' outcomes.

Keywords: SOFA Score; Intensive care unit; Traumatic Patient.

INTRODUCTION

Three types of scoring systems are available for evaluating trauma patients in the ICU: 1] Physiological markers include the Acute Physiology and Chronic Health Evaluation, the Revised Trauma Score [RTS], and the Simplified Acute Physiology Score, 2] In line with the localization of the trauma and the definition of the entity: [Injury Severity Score [ISS]], and 3] Considering either anatomical lesions or physiological abnormalities: Trauma Injury Severity Score and A Severity Characterization of Trauma [1].

Mortality from ICUs is closely associated with the severity and incidence of organ failure. The SOFA score's usefulness as a diagnostic tool is assessed. A statistical analysis is conducted on the SOFA score distributions in the days leading up to patient death and patient discharge [2]. Although the SOFA score is seen to be a useful tool for anticipating when patients will leave the ICU, it is not a very good indicator of when patients will pass away. The distribution of the total SOFA score did not appear to vary in the days leading up to the patient's death. However, the distribution of SOFA scores showed a tendency towards lower scores in the days preceding patient discharge [2]. Finally, dissecting the different components of the total SOFA score revealed that the cardiovascular and coagulation scores had the most link with mortality, making them the most valuable subsets to utilize as diagnostic markers [2].

The sickest patients are treated and cared for by the most highly qualified nurses and medical specialists in the ICU, a specialized facility [3]. Poor patient care can result in more costly problems, extended hospital stays [LOS], disability, and even death. Based largely on the severity of the illness and the patient's deteriorating health, figures from around the world show that the death rate in ICUs ranges from 6 to 40% [4].

Given the aforementioned issues, a critical component in estimating the mortality and morbidity outlook for ICU patients is the clinical assessment of illness severity. This makes it possible to allocate the restricted number of ICU beds among patients who are waiting to be admitted to ICUs in a fair and equitable manner [5].

Predictive scoring algorithms seem to be useful in this regard to some extent. For around thirty years, these methods have been developed and recommended in order to evaluate a patient's prognosis and determine the extent of their disease at the time of admission to an ICU. The medical team might use this number to assess a patient's chances of making a full recovery. When patients are admitted to ICU, it also shows how unstable their bodies are physiologically [6].

With the use of these technologies, the likelihood of survival can be more accurately assessed in addition to the clinical evaluation. Support for clinical judgement and decision-making, standardization of research on critical care, definition of work pressure, effective utilization of technological and human resources, and comparison of care quality across different ICUs are additional benefits of implementing these systems [7].

This study aimed to assess the ability of the SOFA score as a diagnostic indicator in predicting the outcome in traumatic patients in the ICU.

PATIENTS AND METHODS

This study, which included all trauma patients admitted to the intensive care unit at Damietta Al-Azhar University Hospital, was prospective and cross-sectional. After approval of ethical committee 70 patients of them ranged from 18 to 69 years were selected.

Inclusion criteria: 70 patients of trauma cases aging from 18 to 69 years.

Exclusion criteria: Cases with sepsis at time of admission in ICU.

Data collection

Primary examination and CPR: A = Airway opening and maintenance: If the patient is responsive, able to talk intelligibly, and has an open airway. If an airway obstruction is found, do a jaw push or chin raise. B = Breathing and ventilation: More oxygen should be given to trauma victims in general. C = Circulation: The degree of reactivity, visible bleeding, skin tone, and pulse [presence, quality, and rate] are all used to evaluate this. If there is any visible bleeding, it should ideally be stopped with direct pressure. D = Disability: The Glasgow Coma Scale [GCS], pupil size and response, and lateralizing signals are used to evaluate this.

Secondary survey: After the ABCDEs of the first survey, a number of adjuncts assist in the assessment of further potentially fatal processes. Heart tamponade, pulseless electrical activity [PEA], ST-elevation myocardial infarction

[STEMI], and dysrhythmias are all evaluated with the ECG. An effective tool for determining fluid balance is a urinary catheter. Caution must be taken if there are any contraindications, such as bleeding at the meatus, perineal ecchymosis, or a high-riding prostate. By decompressing the stomach, a Ryle insertion can lessen the chance of aspiration and the pressure that a distended stomach may put on the chest. When there is a risk of a basilar skull fracture or face trauma, caution must be used to prevent nasal insertion. To guarantee a thorough assessment and care of the patient's injuries, a secondary survey is conducted following the completion of the initial survey by the time the initial survey was over, the trauma patient needs to have had a systematic resuscitation and any immediately life-threatening problems ought to have been identified and addressed. When the primary and secondary surveys are finished, a decision should be taken about the patient's next course of care. This could involve sending them for additional testing, admitting them to the OR ICU, or, in extreme cases, discharging them.

For each patient, complete history taking included AMPLE History. Personal history [age, gender, place of residence, type of work, and any unique medically significant behaviors, such as smoking]. Previous medical records and past surgical history were obtained. Routine laboratory investigations included CBC, RBG, INR, PT, ABO grouping, serum creatinine, liver enzymes, ABG and total, direct and indirect bilirubin. X-ray on suspected parts of the body [e.g. chest, abdomen, pelvis, upper limb, lower limb]. Focused assessment sonography for trauma patient [FAST]. CT Brain if needed.

SOFA score

Traditionally, the SOFA score is determined upon admission to ICU and then every 24 hours thereafter. The instrument uses six criteria—respiratory, cardiovascular, renal, neurological, hepatic, and hematological—that represent the function of an organ system and assigns a score between 0 and 4.

Table [1]: Sequential Organ Failure Assessment [SOFA] score [8]

Parameter	Findings	SOFA score
Respiratory system: PaO_2/FiO_2 [mmHg]	> 400	0
	< 400	1
	< 300	2
	< 200 with respiratory support	3
	< 100 with respiratory support	4
Nervous system: Glasgow Coma Scale	15	0
	13–14	1
	10–12	2
	6–9	3
	< 6	4
Cardiovascular system: Mean arterial pressure [MAP] [OR] administration of vasopressors required	MAP > 70 mmHg	0
	MAP < 70 mm/Hg	1
	Dopamine ≤ 5 µg/kg/min or dobutamine [any dose]	2
	Dopamine > 5 µg/kg/min OR epinephrine ≤ 0.1 µg/kg/min OR norepinephrine ≤ 0.1 µg/kg/min	3
	Dopamine > 15 µg/kg/min OR epinephrine > 0.1 µg/kg/min OR norepinephrine > 0.1 µg/kg/min	4
Liver: Bilirubin [mg/dl] [µmol/L]	< 1.2 [< 20]	0
	1.2–1.9 [20–32]	1
	2.0–5.9 [33–101]	2
	6.0–11.9 [102–204]	3
	> 12.0 [> 204]	4
Coagulation: Platelets $\times 10^3$/ml	> 150	0
	< 150	1
	< 100	2
	< 50	3
	< 20	4
Kidneys: Creatinine [mg/dl] [µmol/L]; urine output	< 1.2 [< 110]	0
	1.2–1.9 [110–170]	1
	2.0–3.4 [171–299]	2
	3.5–4.9 [300–440] [or urine output < 500 ml/day]	3
	> 5.0 [> 440]; urine output < 200 ml/day	4

Ethical consideration: The study design was submitted to the ethics committee for approval. approval from the hospital management where the study was conducted. At every stage of the investigation, personal privacy and confidentiality were protected. There was no alternative use for the collected data. Subjects' ethics, values, cultures, and beliefs were all respected.

Statistical analysis: Following collection, the data were examined and manually coded. These numerical codes were entered into a computer, and SPSS 22 for Windows was used to execute the statistical analysis. For quantitative data, the mean ± SD were shown. To illustrate the qualitative data, percentages and figures were utilized. The Chi square-test [X^2] can be used to compare qualitative data. The student's "t" test is used to compare the quantitative data from two independent, normally distributed samples. The sensitivity, specificity, and ideal cut-off values of the SOFA score for mortality prediction were ascertained through the application of ROC analysis. The sensitivity formula is true positive / [true positive + false negative]. Specificity is equal to true negative / [true negative + false positive].

RESULTS

The current study included 70 patients; their age ranged between 18 – 69 years with mean value of 44.243 ± 16.053. 52.9% were females and 47.1% were males. Regarding the cause of admission in the studied population, 24.29% was abdominal trauma followed by ICH in 20%, multiple fracture in 17.14%, subdural hematoma and pneumothorax in 14.29% for each then Brain contusion in 10% of included patients [Table 2].

The duration of hospital stay ranged between 4-20 days with mean duration of 9.600 ± 4.095 days. Regarding the development of organ dysfunction, 51.4% developed organ dysfunction while the remaining 48.6% did not develop organ dysfunction [Table 3].

Regarding the organ dysfunction, 32.9% have respiratory dysfunction, followed by 20% have neurological dysfunction, 15.7% have cardiac dysfunction, while renal and hepatic dysfunction were detected in 14.3% for each and lastly 12.9% have hematological dysfunction. Many patients have more than 1 organ dysfunction [Table 4].

SOFA score in the studied population ranged between 0-12 days with mean duration of 2.442 ± 3.278. Follow up of clinical outcome revealed that 82.9% were survived while 17.1% were died [Table 5].

Table [7] and Figure [1] demonstrated that the SOFA scores cutoff point of 5.5 has a 91.7% sensitivity and a 100% specificity in predicting death.

The length of hospital stay and the SOFA score had a statistically significant positive link [Table 8 and image 2].

Table [2]: Information on the study population demographics and reason for admittance

Variables		No.= 70
Gender	Men	33 [47.1%]
	Women	37 [52.9%]
Age [years]	Range	18 – 69
	Median [IQR]	51 [29.5]
	Mean ± SD	44.243 ± 16.053
Cause of admission [No., %]	Subdural hematoma	10 [14.29%]
	ICH	14 [20.00%]
	Abdominal trauma	17 [24.29%]
	Brain contusion	7 [10.00%]
	Pneumothorax	10 [14.29%]
	Multiple fracture	12 [17.14%]

Table [3]: Hospital stay duration and development of dysfunction in the studied population organs

Variables		No.= 70
Duration of hospital stay [days]	Range	4 – 20
	Median [IQR]	10 [6]
	Mean ± SD	9.600 ± 4.095
Organ dysfunction [No., %]	No	34 [48.6%]
	Yes	36 [51.4%]

Table [4]: Organ dysfunction characteristics of the studied population

		No.= 70	
		No.	Percentage
Respiratory dysfunction	No	47	67.1%
	Yes	23	32.9%
Cardiac dysfunction	No	59	84.3%
	Yes	11	15.7%
Renal dysfunction	No	60	85.7%
	Yes	10	14.3%
Hematological dysfunction	No	61	87.1%
	Yes	9	12.9%
Neurological dysfunction	No	56	80%
	Yes	14	20%
Hepatic dysfunction	No	60	85.7%
	Yes	10	14.3%

NB: some patients have more than 1 organ dysfunction

Table [5]: SOFA score and outcome in the studied population

		No.= 70
SOFA score	Range	0 –12
	Median [IQR]	2 [4]
	Mean ± SD	2.442 ± 3.278
Outcome [No., %]	Survived	58 [82.9%]
	Not survived	12 [17.1%]

Table [6]: The relation between SOFA score and outcome

		Outcome		Independent student t test	
		Survived	Died		
		No.=48	No.=12	t	p-value
SOFA score	Range	0 – 6	6 - 12	14.021	**<0.0001**
	Mean ± SD	1.207 ± 1.673	8.917 ± 2.020		

Table [7]: Sensitivity, specificity of SOFA for prediction of outcome

Cutoff point	Area under curve	Std. Error	Sensitivity %	Specificity %	Asymptotic 95% Confidence Interval	
					Lower Bound	Upper Bound
≥ 5.5	0.999	0.002	91.7%	100%	0.994	1.000

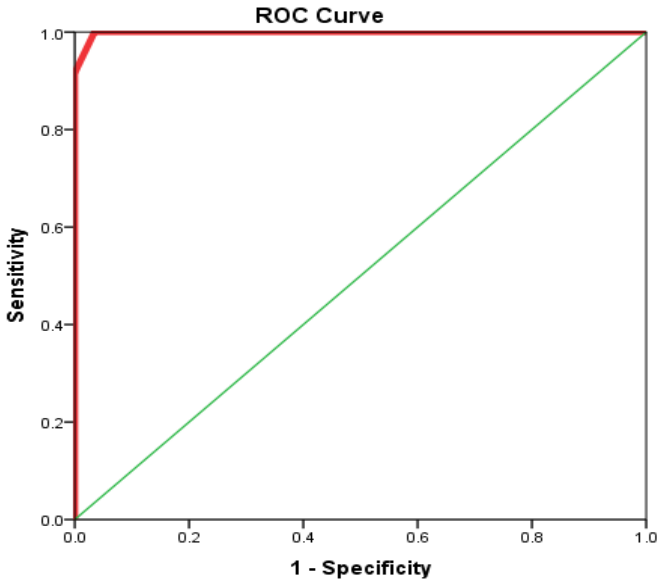

Figure [1]: ROC curve for SOFA for prediction of outcome

Table [8]: SOFA score and the hospital stay duration Pearson's correlation coefficients [r]

	SOFA score	
	r	P-value
Duration of hospital stay	0.951	<0.0001

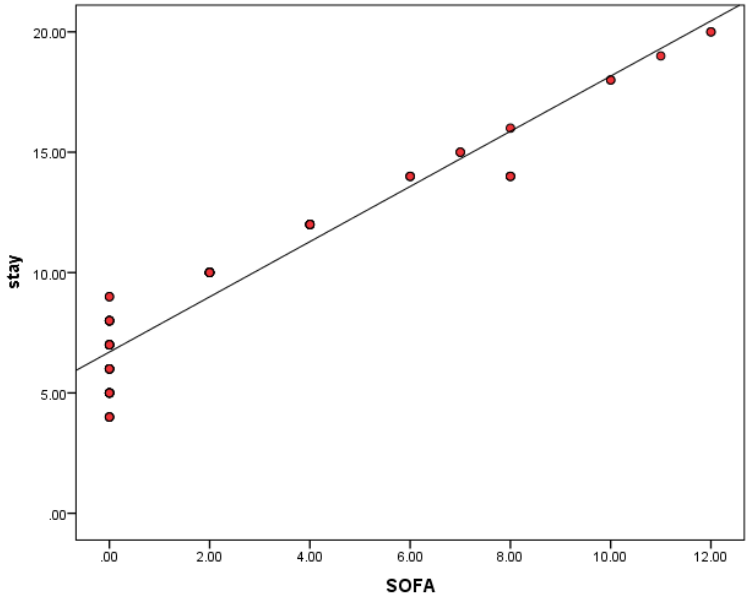

Figure [2]: SOFA score and the hospital stay duration Pearson's correlation coefficients

DISCUSSION

When a patient is admitted to the critical care unit, it is presumed that organ malfunction is the primary cause of mortality and complications. For patients in the emergency room and critical care unit, prompt diagnosis and treatment planning depend on assessing the risk of fatality and disability. Through the use of patient evaluation systems, patients with more serious conditions are given priority upon admission to the ICU, resulting in a more effective use of human, financial, and medical resources. The high expense and dearth of intensive care beds are to blame for this [9].

In this study, 70 individuals with a mean age of 44.243 ± 16.053 years ranging from 18 to 69 were included. There were 47.1% men and 52.9% women. However, in the study by **Fröhlich *et al.*** [10], 176 severely injured trauma patients were included in the study. In the final group, patients had a mean age of 53 ± 21 years and were predominantly male [67%]. In contrast, **Emadi *et al.*** [11] showed that the patients' ages ranged from 20 to 83 years old, with a mean of 36.84 years. Males made up 82% of the patients, while females made up 18%. The male patients' mean age was 37.7 years, while the female patients' mean age was 32.3 years.

According to the current study, subdural hematoma and pneumothorax accounted for 14.29% of all admissions in the population under study, while abdominal trauma accounted for 24.29%. Intracranial hemorrhage [ICH], multiple fractures, and multiple sclerosis each accounted for 20%, 17.1%, and 10% of included patients, respectively. 10% of included patients had brain contusions. In contrast, almost 90% of the sample group in the **McCarthy *et al.*** [12] investigation received penetrating wounds, with blast damage accounting for 79% of all injuries. Improvised explosive devices were the source of 84% of explosion injuries.

According to the current study, hospital stays lasted an average of 9.600 ± 4.095 days, with stays ranging from 4 to 20 days. On the other hand, in the **Emadi *et al.*** [11] study, subarachnoid and epidural hemorrhage was diagnosed in 50% of individuals who stayed longer than three days in the hospital, and penetrating abdominal trauma was evident in 75% of individuals who spent two days in the hospital. Furthermore, according to a study by **Vasconcelos *et al.*** [13], 1101 patients were admitted to three ICUs of a tertiary hospital between January 1 and December 31, 2020. The SOFA scores, which are the results of measurements taken 48 hours after ICU admission, were used to identify three patient

groups: patients with admission SOFA scores less than 2 [n = 348], patients with admission SOFA scores more than 2 whose 48-hour delta SOFA showed improvement [SOFA after < 48 hours admission SOFA] [n = 415], and patients with admission SOFA scores more than 2 who had either increased or stayed the same after 48 hours [SOFA after ≥ 48 hours admission SOFA] [n = 338]. The ICU stays of patients in group 1 were also generally shorter than those of patients in groups 2 and 3.

According to the findings of this study, 51.4% of participants experienced organ malfunction, while 48.6% did not have any organ dysfunction. In terms of organ dysfunction, respiratory dysfunction accounted for 32.9% of cases, neurological dysfunction for 20%, cardiac dysfunction for 15.7%, renal and hepatic dysfunction for 14.3% of cases, and hematological dysfunction for 12.9% of cases. Many individuals experienced impairment in many organs. Clinical outcome follow-up showed that 82.9% of patients survived and 17.1% died.

The present study findings are corroborated by a study by **Fröhlich *et al.*** [10], which found that, of the final group, 32 patients [18.2%] passed away an average of 10.2 ± 11.7 days [range: 4–29] following injury. In the last batch, 32 people [18.2%] passed away. The leading causes of death were sepsis [12%], respiratory failure [22%], loss of cerebral functions [22%], and failure of multiple organs [28%]. The cause of death was not recorded in 16% of instances. In contrast, 7% of patients in the **Emadi *et al.*** [11] study recovered after two days in the ICU, while 100% of patients who died did so.

Additionally, **Sayed *et al.*** [14] reported that although the overall mortality rate was 28%, **Jentzer *et al.*** [15] found that it was 6.8%, **Khwannimit *et al.*** [16] found that it was 16.6%, and **Lee *et al.*** [17] found that it was 44.5%. These variations could be explained by variations in the severity of illness and standard of care provided across ICUs.

The current study findings indicated that the population under investigation had a mean duration of 2.442 ± 3.278 days and a SOFA score that ranged from 0 to 12. When predicting death using the ROC curve, the SOFA score at cutoff point 5.5 has a 91.7% sensitivity and a 100% specificity. The length of hospital stay is positively correlated with SOFA score in a statistically meaningful way.

The study by **Jain *et al.*** [18] revealed a correlation between survival and the overall SOFA scores for each day, corroborating the findings of the current investigation. Day 1 through Day 5 total SOFA scores showed a strong correlation with survival, while Day 7 and Day 9 scores did not. There was a substantial correlation between each subject's mean SOFA score and death. Additionally, there was a strong association between each subject's maximum SOFA score and survival. There was no discernible relationship between the length of stay in the ICU and the outcome. 9.32 days was the average length of stay [range: 1-63 days]. In the **Emadi *et al.*** [11] trial, patients who passed away had an average SOFA score of 8, while the adjusted SOFA score was 6.

The SOFA score performed better in predicting mortality [area under the curve/AUC: 0.83 vs. 0.67 vs. 0.72 in the study by **Fröhlich *et al.*** [10] than in predicting duration of stay [AUC 0.71 vs. 0.80 vs. 0.82] or length of time on mechanical ventilation. In all analyses, the Denver score was more specific and the MODS and SOFA scores were relatively sensitive.

According to research by **Kumar and Chandan** [19], there were independent risk factors for mortality in the SOFA scores for cardiovascular, neurological, respiratory, renal, hematological, and hepatic dysfunctions. From the first to the last day of their study, a thorough analysis of the SOFA score was conducted. On day 1, both survivors and non-survivors had high SOFA scores, which showed statistical significance [9.33 vs 6.62, $p<0.001$].

According to the **Matsuda *et al.*** [20], patients who lived [5.0 vs. 10.0, $p < 0.001$] and those who had a favorable neurological outcome [5.0 vs. 8.0, $p < 0.001$] had lower SOFA scores than their counterparts. At 30 days, the SOFA score at admission was an independent predictor of both favorable neurological function and survival. Additionally, a favorable 30-day neurological outcome was predicted by a change in SOFA score [48–0 h].

An area under the ROC curve [AUC] of 0.847 vs 0.772 and 0.742, respectively, showed that the maximum SOFA had a stronger discriminative ability than the entrance SOFA or the Delta SOFA. **Moreno *et al.*** [21] comprised 1449 patients from 40 ICUs across 4 continents. A suggestion by **Moreno *et al.*** [21] was to compare SOFA ratings not just with ICU

outcomes but also with longer-term outcomes such as 30-day or hospital mortality.

According to **Holder *et al.*** [22], early serial organ failure ratings up to five days can enhance the prediction of ICU mortality. Nevertheless, coronary care units were included in the exceptionally low hospital and ICU death rates [6.4% and 11.2%, respectively].

The **McCarthy *et al.*** [12] study found that the median SOFA score at admission to Landstuhl Regional Medical Centre [LRMC] for patients with infections was 7 [interquartile range [IQR]: 4–9], while the score for patients without infections was 4 [IQR: 2–6] [p <0.001]. In both groups, the 30-day mortality rate was 2%. The LRMC SOFA score was found to be independently correlated with the development of infection by multivariate regression [odds ratio: 1.2; 95% confidence interval: 1.1–1.3]. An area under the curve of 0.69 for infection prediction and 0.80 for death prediction was found by the ROC curve analysis.

There are several limitations to this study. The current study is based on a small sample size and does not reveal long-term results. Furthermore, several comorbidities that could affect these results are not considered in this study. Further investigation on comorbidities, types of emergencies, and triage procedures is recommended in this field.

Conclusion: Early detection, treatment, and failure prevention are the best ways to regulate organ dysfunction; SOFA and other monitoring measures can lower mortality. Given its ease of use, the SOFA score is recommended as a good tool for patient prediction. The length of hospital stay is positively correlated with SOFA score in a statistically meaningful way.

Financial and non-financial relations and activities of interest: None

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International Journal of Medical Arts

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Print ISSN: 2636-4174
Online ISSN: 2682-3780