

## A Study to Assess the Patient Clinical Outcome Using Sofa Score among Patients Admitted to ICU of Tertiary Hospital of South India

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### ABSTRACT

Due to very less number of intensive care units in the health sector, there is global burden on ICUs. The SOFA (Sequential Organ Failure Assessment) scoring system is validated in present set up to make clinically, ethically and economically sound decision in critical care area. A descriptive survey study was conducted in ICUs of Kasturba Hospital, Manipal to assess the patient clinical outcome using SOFA score. The non-probability purposive sampling technique was used among 250 ICU. The study found that majority 177 (70.8%) of patients were male with the mean age of 53.14 years. The total of 105 (42%) patients died at the end of ICU stay; the average length of ICU stay was 7.48 days, and ventilators were used among 75.2 % of patients. SOFA score ranges from 0.5-17.5 (mean score=6.438). The result also referred that there was significant difference in the SOFA score among died and survived (t-value =8.747, p-value < 0.001). The value of SOFA score also differs among the patient using ventilator and not using ventilator (t-value=3.07, p-value <0.001). The calculation of area under the curve (AUROC) for SOFA score was 0.785 (p value <0.001) which concluded that SOFA scores actually does discriminate between died and survivor in ICU. SOFA score has 72.4% sensitivity and 69.7% specificity for the cut off score of 6 for predicting mortality. The fitness of the score was established by Hosmer Lemeshaw Chi Square test, SOFA with  $\chi^2= 10.74$ , *p value* = 0.15. Hence SOFA is having good calibration and fit for use.

**Key words:** Clinical outcome, ICU patient, SOFA score

### INTRODUCTION

According to the report given by University of California, in United States there are 4 million Intensive Care Unit (ICU) admissions per year out of which 8-19% die which accounts of 500,000 deaths annually. [1] The National Account for Statistics of India reported that there are about 70,000 ICU beds available in India that serves for ICU admission of 5 million critically ailing people per year. [2]

The clinical decision making in ICU is many times problematic clinically and ethically. Hence a predictive scoring system is required to provide a stable fundamental principle and clinical decision making in

ICU. Among those scoring system Sequential Organ Failure Assessment (SOFA) scores is the one that has been used globally for taxing ICU status and severity of disease illness. [3] This organ-specific scoring system is based on the assumption that sick is a patient more organ system is involved, range from organ function derangement to organ failure. [4]

The SOFA score is established to measure the function of six major organ systems (i.e., cardiovascular, respiratory, renal, hepatic, central nervous system, and coagulation) over time. As the name suggests it is calculated sequentially on the

first day of admission and each of the subsequent days of ICU stay.<sup>[5]</sup>

A study was conducted in Taiwan by Chen to predict patient outcome using SOFA and APACHE II scores among patient with *Acinetobacter baumannii* bacteremia. The study was done from 2004 to 2007 among 110 patients. The retrospective study was done by using the clinical and laboratory data. The findings of the study suggested that SOFA >8 were associated with significantly higher 14-day mortality similarly SOFA >7 was associated with higher in-hospital mortality rates. The area under receiver operating characteristics (AUROC) curve for predicting 14-day mortality was SOFA:  $0.83 \pm 0.06$ ; and for predicting in-hospital mortality it was SOFA:  $0.85 \pm 0.04$ . Thus the study concluded that SOFA scores is reliable and effective tools for risk identification in prediction of 14-day mortality and in-hospital mortality for bacteremic patients.<sup>[6]</sup>

Thus validating the score in our set up greatly contribute in appraising latest modalities, examining resources usages and improving quality assessment and predict the prognosis of critically ill patients including ICU mortality.

**Purpose of the study:** The purpose of the study was to determine SOFA scores that would help in predicting patient severity and various patient clinical outcomes. The findings of the study would help the health personnel to provide prompt intervention that would to be life saving for the patients.

**Aim:** The main aim of the study was to determine SOFA scores that would help in predicting patient severity and various patient clinical outcomes.

**Objectives:** The objectives of the study were to:

- Determine SOFA score for prediction of patient clinical outcome.
- Compare the patient clinical outcome using SOFA score.
- Find association of SOFA score with patient clinical outcome.

### Significance of the study

SOFA score will help to objectively assess the patient mortality and outcome.

The SOFA system in turn will be useful in appraising latest modalities, examining resources usages and improving quality assessment and predict the prognosis.

This system tend to be of more importance because of the sophisticated setup of ICUs where there is more critical and severe patient, high technical advancement, high cost and demanding work environment. Hence such predictive scoring system will be required to provide a stable fundamental principle and clinical decision making in ICU.

SOFA score will also act as an important early marker of daily nursing clinical workload, especially predicting the demands to be fulfilled in the area of clinical care, respiratory care, diagnostic methods and treatments.

### MATERIALS AND METHODS

**Research Design:** The descriptive survey design was used in the study.

**Research Setting and Population:** The study was conducted in Intensive Care Units (ICUs) of Kasturba Hospital, Manipal. The ICUs included were ICU-1, ICU-2, ICU-3, Casualty ICU and Neurosciences ICU. In this study, the population comprises of all the patients admitted in ICU of Kasturba Hospital, Manipal.

**Sampling:** Non-probability purposive sampling technique was used, sample size was calculated based on pilot study findings; the calculated sample size was 238. The final data was collected from 250 patients.

Inclusion criteria:

- Patients whose arterial blood gas analysis were done on the first and second day of admission.
- Patients whose required blood investigations are carried out.
- Intensive Care Unit stay is of minimum 24 hours.

**Instrument:**

Tool 1: Demographic and clinical proforma

Tool 2: Sequential Organ Failure Assessment (SOFA) scoring system: The functional variables that are components of SOFA and considered in the study as well are as follows:

- Respiratory system: PaO<sub>2</sub>/FiO<sub>2</sub> (mm Hg)
- Coagulation: Platelets count (10<sup>3</sup>/mm<sup>3</sup>)
- Liver: Bilirubin (mg/dL)
- Cardiovascular: Hypotension
- Central nervous system: Glasgow Coma Score
- Renal function: Creatinine (mg/dL) or urine output (mL/d)

The maximum score is 24 and minimum is 0. The SOFA score was recorded on first and second day of admission sequentially and mean value was taken as SOFA score.

**Data Collection Procedure:** Data was collected after getting necessary ethical approval. Data was collected from 8<sup>th</sup> January to 28<sup>th</sup> February 2014 among 250 patients admitted in Intensive Care Units (ICUs) of Kasturba Hospital, Manipal. All the data were recorded by researcher only. The SOFA score was calculated on within 24 hour of admission to the ICUs from the records available in paper and online computer. The most deranged value was recorded and graded as per tool. Further SOFA score was calculated from all those samples on second day of admission as well for getting mean SOFA score.

**Statistical Analysis:** Data was checked for completeness and organized, coded and entered in statistical package for social science (SPSS 16) version. Both Descriptive (mean, standard deviation) and inferential statistics (chi-square test, receiver operating characteristic (ROC) curve) was used to analyze the data.

**RESULT**

The data presented in the table 1 shows that majority of the patients 177 (70.8%) were male and the mean age of the patient was 53.14 years. Among the ICUs included in the study, the maximum number of patients 103 (41.2%) were taken from the

casualty ICU and surgical intervention was done only among 60 (24%) of patients for this admission or hospitalization. The study result also shows that 157 (62.8%) of the patients were admitted in the ICUs from the Emergency triage.

The component of demographic proforma also included patient clinical diagnosis. The detail of which is elicited in figure 1.

**Table 1: Frequency and Percentage distribution of sample demographic characteristics n=250**

Variables	Frequency (f)	Percentage (%)
<b>Age (in years)</b>		
<40	63	25.2
40-60	92	36.8
>60	95	38
<b>Gender</b>		
Male	177	70.8
Female	73	29.8
<b>ICUs</b>		
Casualty ICU	103	41.2
ICU -1	68	27.2
ICU-2	50	20
Neurosciences ICU	29	11.6
<b>Surgical intervention</b>		
Performed	60	24
Not performed	190	76
<b>Origin of admission to ICUs</b>		
Emergency casualty	34	13.6
Emergency triage	157	62.8
OPD	5	2
Ward	53	21.2

The data presented in figure 3 represented that among all the patients diagnosis neurological disorder accounts for 32% of ICUs admission, followed by gastrointestinal disorder which was about 16.8 % and then the respiratory disorder caters for 15.6% of total diagnosis for ICUs admission.

The description of patient clinical outcome is depicted in table 2.

**Table 2: Frequency and Percentage distribution of Patient Clinical Outcome n=250**

Variables	Frequency (f)	Percentage (%)
<b>Discharge status</b>		
Died	105	42
Survived	145	58
<b>Length of stay</b>		
≤7days	148	59.2
>7days	102	40.8
<b>Co-morbidity associated</b>		
Yes	111	44.44
No	139	56.66
<b>Use of ventilator</b>		
Yes	188	75.2
No	62	24.8

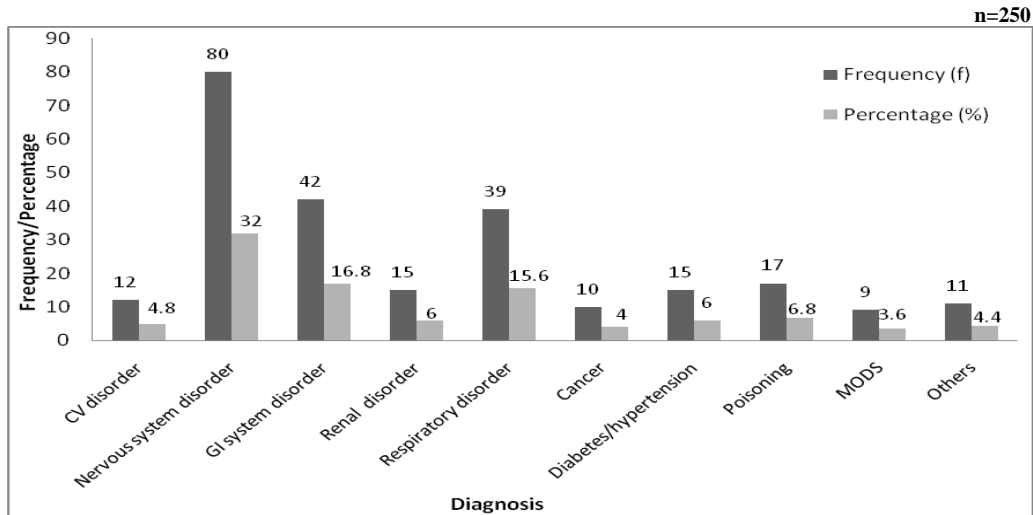


Figure 1: Bar diagram representing Patient Clinical Diagnosis

The data presented in table 2 shows that 105 (42%) of patients under study died at the end of ICU stay; with the average length of ICU stay of the patients were 7.48 days. The 44.4% patients admitted to ICU has associated one or more co-morbid condition like hypertension, diabetes, heart disease etc. Also ventilators were used among 75.2 % of patients being taken for study.

### Section 2: Description SOFA scores

This section describes the values of SOFA score findings among all the study patients. The range of maximum score and minimum score along with mean score was used to explain these findings.

Table 3: Description of SOFA score n=250

Variables	Minimum score	Maximum score	Mean score
SOFA	0.5	17.5	6.438

SOFA value ranges from 0 to 24 and the study findings shows that the average SOFA score ranges from 0.5-17.5 with the mean SOFA score of 6.438 in the present study.

### Section 3: Comparison of the patient clinical outcome by using SOFA score

This section describes the comparison of SOFA score with patient clinical outcome thus analysis shows the difference in these scores with discharge

status, length of stay, associated co-morbidity and use of ventilator.

Table 4: Comparison of patient clinical outcome using SOFA score n=250

Variables	Mean ± SD	t-value	CI	p value
<b>Discharge status</b>				
Died	8.49±3.51	8.74	2.74-4.33	<0.001**
Survived	4.95±2.59			
<b>Length of stay</b>				
≤7 days	6.58±3.64	0.78	-0.52-1.22	0.44
>7 days	6.24±3.23			
<b>Comorbidity</b>				
Yes	6.41±3.16	0.124	-0.95-0.84	0.904
No	6.47±3.85			
<b>Use of ventilator</b>				
Yes	6.87±3.48	3.704	0.85-2.69	<0.001**
No	5.12±3.14			

\*-significant; \*\*- highly significant

The table 6 shows that SOFA score of survivor was 4.95±2.59 and that of died was 8.49±3.51. Thus patient having mortality have higher SOFA than that of survivor. The table also shows that there is significant difference in the SOFA score among died and survived (t-value =8.747, p value < 0.001). Hence it inferred that there is significant difference in SOFA score among died and survived. The SOFA score significantly differs among patients on ventilator and not on ventilator (t-value=3.07, p value <0.001).

However, the result shows that there is no significant difference in scores of SOFA among patient having longer length of ICU stay.

### Other findings on performance of SOFA score

This section describes about the performance of SOFA score in predicting mortality among ICU patients. The Receiver Operating Characteristics (ROC) curve was used to analyze the performance of these scores. The area under each ROC curve was calculated to assess the discriminatory ability of the SOFA scores to distinguish whether a patient died or survived. For each ROC analysis, the cut-off values, sensitivity, specificity and overall correctness were calculated.

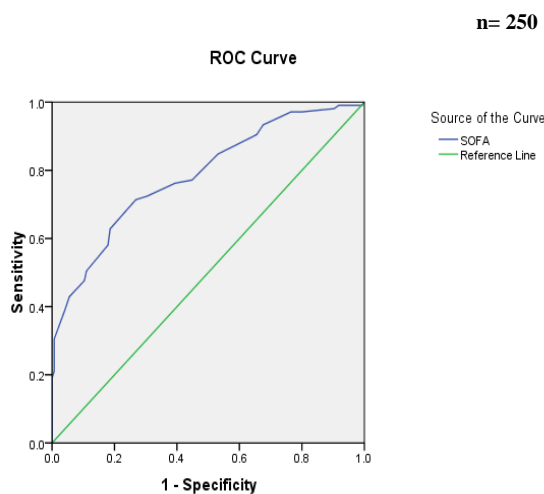


Figure 2: Receiver Operating Characteristics (ROC) Curve plot SOFA

Thus from the curve above the area under receiver operating characteristic curve (AUROC) was calculated and shown in table 5.

Table 5: Comparison of AUROCs for SOFA scores in ICU patients (values: mean  $\pm$  SD) n=250

	SOFA AUROC	p-value
Patient clinical outcome (ICU mortality)	0.785 $\pm$ 0.29 95 % CI: 0.728-0.843	<0.001**

\*\*-. highly significant

The calculation of area under the ROC curve (AUROC) for SOFA is 0.785. The higher the value of AUROC higher is the accuracy of model. Thus the calculation of the AUROC indicated there was good accuracy for SOFA scores for predicting mortality among ICU patients. The p value <0.001 concluded that both SOFA score

actually discriminate between ICU died and survivor.

### Calculation of cut-off values along with specificity and sensitivity

The coordinates of ROC curve was used to find out the cut off values for SOFA score which have maximum sensitivity and specificity. Thus among the score at which SOFA score was having maximum specificity and sensitivity was taken as cut off value for predicting ICU mortality. The detail is mentioned in table 6.

Table 6: Determine sensitivity and specificity SOFA score in predicting ICU mortality n=250

Score	Death	Survived
SOFA score >6	76 (72.4%)	44 (30.3%)
SOFA score $\leq$ 6	29 (27.6%)	101 (69.7%)

Thus from above table it is depicted that A SOFA has 72.4% sensitivity and 69.7% specificity for the score of 6 in predicting mortality of the ICU patient. Thus SOFA is both sensitive as well as specific in predicting ICU mortality. Hence SOFA score value greater than 6 was associated with higher mortality.

The data were further analyzed to find calibration of SOFA. The Hosmer Lemeshaw Chi Square test was used which reflect the goodness of fit to check the fitness of scoring system to predict ICU mortality. It calibrates the scoring system.

Table 7: Calibration of SOFA score n=250

Model	Chi square	df	p-value
SOFA	10.74	7	0.15

The table above shows that model fitness is acceptable for SOFA with  $\chi^2=10.74$ , *p value* = 0.15, which indicates that these models predict values not significantly different from what we observed. The calculated *p* value should be greater than established cutoff (*p* value=0.05) to indicate good fit. Hence the SOFA scores shown to have good calibration.

### Section-4: Association of SOFA score with patient clinical outcome

The table above explains that the ICU patients having SOFA scores greater



than 6 have 6.29 times higher likelihood of death than those having SOFA score less than 6 (p value <0.001). Hence we reject the null hypothesis and conclude that there is significant relationship between SOFA score and patient clinical outcome. There was significant relationship established between SOFA score with the patient on ventilator (OR=0.553; p value=0.04).

**Table 8: Association of SOFA score with patient clinical outcome n=250**

Variables	df	OR	CI	p value
<b>Status at discharge</b>				
Died	1	6.29	3.45-10.48	<0.001**
Survived				
<b>Length of stay</b>				
≤7 days	1	0.82	0.495-1.36	0.446
>7 days				
<b>Comorbidity</b>				
Yes	1	0.664	0.402-1.098	0.11
No				
<b>Use of ventilator</b>				
Yes				
No	1	0.553	0.307-0.997	0.04*

\*-significant; \*\*- highly significant

## DISCUSSION

In the present descriptive study the mean SOFA score was found to be 6.44. Also SOFA score among survivor was found to be 4.95±2.59 and among died was 8.49±3.51, which was again higher than that of survivor. The overall mortality of the patient was 42%. The above finding was supported by a study done in Greece from 2008 to 2011. This retrospective study was done among 105 lung cancer patient to find out the outcome when being admitted to ICU. The overall mortality was found to be 44.7%. The SOFA score among survivor and non-survivors was 6.5 and 7.6 respectively. The slight variation in the values of present study may be due to case mix study. [7]

The present also showed that SOFA was found to have significant association with co-morbidity and patient with use of ventilator where as no significant association was established with the length of ICU stay. Also findings suggested that SOFA have sensitivity of 72.4% and specificity of 69.7% under cut off value of 6. Also the calibration for SOFA ( $\chi^2=10.74, p\text{ value} = 0.15$ ) was done by using

Hosmer Lemeshow chi square test. Thus the study shows that SOFA have good calibration and fit to be used. The above mentioned values were supported by a study done in Taiwan by Tseng et al on determining the dependence on ventilator among 163 ICU patients. The study shows that the optimal cutoff value for SOFA score is 8.5. Also the study mentioned that the sensitivity and specificity of 83% and 67% for the SOFA score. The area under the ROC curve indicated for SOFA was 0.81 ( $P < 0.0001$ ) respectively. Hence the present study validates the use of SOFA scoring system as well. [8]

The study was further supported by another study done by Hwang et al with the aim of assessing the performance of Sequential Organ Failure Assessment (SOFA), Acute Physiology and Chronic Health Evaluation (APACHE) II scoring system, and Trauma and Injury Severity Score (TRISS) method to predict group mortality for intensive care unit (ICU) trauma patients. The retrospective study was done among 706 patients from 2006 to 2010. The result of the study showed that sensitivities and specificities were 74.1% and 97.1%, respectively, for the SOFA score. Also the area under the curve (AUC) was 0.953 for SOFA. The study assess goodness-of-fit by the Hosmer-Lemeshow  $\chi^2$  statistic for SOFA ( $\chi^2 = 8.006, df=8, p\text{-value} = 0.757$ ). Thus supporting literature with close values validate the findings of the study. [9]

## CONCLUSION

The study was done with the basic aim of checking the performance of prognostic scoring system SOFA score Hence the findings of the study concluded that: SOFA score posses good calibration to predict patient clinical outcome including status at discharge, associated co morbidity, use of ventilator and have excellent discriminatory ability to distinguish patient mortality at the end of ICU stay. However it is not a good prognostic measure to predict the length of ICU stay among the critically

ill patients. The study is limited to unicenter and also management protocol differed in each ICU and as per case. The study recommends the implementation of prognostic scores for prediction of clinical outcome and risk assessment of patient.

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How to cite this article: Mishra R, Chakrabarty J, Sequira L. A study to assess the patient clinical outcome using sofa score among patients admitted to ICU of tertiary hospital of South India. Int J Health Sci Res. 2018; 8(2):164-170.

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