Accuracy of SOFA Score in Predicting Outcome in Medical Patients with Various Diagnosis in Intensive Care Unit in a Tertiary Care Hospital in Northern India

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ABSTRACT

Introduction: The objective was to assess the accuracy of sequential organ failure assessment (SOFA) score in predicting outcome of patients in Intensive Care Unit (ICU) with various admitting diagnosis.

Material and Methods: One hundred ninety consecutive patients between 16 and 90 years admitted to ICU over one year were studied prospectively. Ten patients with incomplete records were excluded. SOFA score was determined on admission to ICU. The mean SOFA scores for each admitting diagnosis was calculated and correlated with mortality in ICU.

Results: The mortality rate was 45.3% and the mean duration of stay in the ICU was 9 days. Our study patient cohort was sicker as these were medical patients and evidenced by significantly higher mean SOFA score of 5.50 ± 1.89 in survivors and 11.67 ± 2.87 in non-survivors. The average duration of ICU stay in survivors was 12.14 ± 2.52 days and in non-survivors 5.709 ± 6.16 days. The initial SOFA score had a strong statistical correlation with mortality (P value <0.05) in patients admitted with sepsis, COPD, Community acquired pneumonia and cardiac causes. In patients with AIDP (Acute Inflammatory Demyelinating Polyneuropathy) and ARDS (Acute Respiratory Distress Syndrome), SOFA ≤6 was associated with better outcome. However, in patients admitted with GTCS (Generalised Tonic Clonic seizures) and strokes, SOFA score could not be used to predict outcome (P value >0.05). SOFA score of 0-6 had 0% mortality, 6-9 had 25%, 9-15 had 85% and >15 had 100% mortality.

Conclusion: In resource restricted ICUs especially with staff shortage, SOFA score is a simple and effective tool in predicting outcome in patients admitted with medical causes. However, it should always be used in conjunction with clinical judgement especially in patients admitted with stroke and seizures. With increasing number of elderly population, SOFA score may be used in explaining prognosis and counselling relatives in deciding escalation of treatment and do not attempt resuscitation (DNAR). More research is required in assessing the role of SOFA score in various admitting diagnosis.

Keywords: Multiple Organ Failure, Critically Ill, Sequential Organ Failure Assessment Score, Mortality, Severity of Illness Index, Intensive Care Unit.

INTRODUCTION

An Intensive Care Unit (ICU) in a hospital deals with patients that require critical care. The beds in ICU are often limited and resource constrained in middle income countries. Critical care predictive scoring systems derive a severity score from various measurable clinical variables and these serve as a helpful tool at admission in predicting the course of the patient in the ICU. The main goal is prognostication of patient's status however, they also help in the assessment of various interventions and quality of care in ICU. The most common critical care predictive scoring systems are the Acute Physiologic and Chronic Health Evaluation (APACHE)[1], Simplified Acute Physiologic Score (SAPS)[2], Mortality Prediction Model (MPM)[3] and Sequential Organ Failure Assessment (SOFA)[4]. However, most of these scores use numerous variables which is inconvenient in a setting where evaluation needs to be prompt in rapidly changing medical condition of the patients. SOFA uses simple variables of major organ function, derived from routine investigations to calculate a severity score and for faster evaluation. This scoring system has been validated in both medical and surgical ICU's where mortality is directly proportional to the SOFA scores in the ICU.[4] The objective of our study was to assess the accuracy of sequential organ failure assessment (SOFA) score in predicting outcome of patients in Medical Intensive Care Unit (MICU) with various medical admitting diagnosis in a tertiary care hospital in North India.

MATERIAL AND METHODS

We first obtained approval from the hospital ethics committee, then a prospective observational study was conducted in a medical ICU (MICU) of a tertiary care hospital in Northern India. Case notes of a total of 200 consecutive patient admitted to medical ICU from December 2015 to December 2016 were assessed. The criteria for admission in MICU is decided by the admitting intensivist based on the clinical condition and functional status of the patient. Primarily patients are admitted from Medicine. Patients are not refused admission to the ICU based on age and treatment options are not restricted to a specific group of patients during the ICU stay. 10 patients with incomplete records were excluded. Data collected included age, sex, admitting diagnosis, SOFA (Sequential Organ Failure Assessment) scores at the time of ICU admission, average length of stay and the patient outcome. The average length of stay (ALOS) was calculated from the time of admission in ICU to discharge from ICU or death.

STATISTICAL ANALYSIS

Statistics Data was expressed as mean ± standard deviation

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and percentages. Continuous variables were evaluated using Student's t-test and categorical variables using Chi-square test. Patient characteristics and confidence intervals (CI) were calculated by logistic regression analysis to identify independent risk factors and control confusion effects. Significant variables in univariate analysis were submitted to logistic regression. Significance probabilities (P values) of <0.05 were considered statistically significant. Statistical analysis was performed using the IBM SPSS statistics version 19.0.

	Shifted to ward (%)	Died (%)	Total (%)	P value
Female	49	45	94	0.687
Male	55	41	96	
Total	104	86	190	

Table-1: Relationship of gender with mortality

		N (%)	Mean SOFA score	p-value
Outcome	Died	86 (45.26)	11.67	0.004
	Survived	104 (54.73)	5.50	

Table-2: Relationship of SOFA score with mortality

Admitting Diagnosis in MICU	Outcome		Frequency (%)
	Died	Survived	
Stroke	22 (91.7%)	2 (8.3%)	24 (12.63)
Sepsis	34 (68.0%)	16 (32.0%)	50 (26.31)
COPD	4 (13.3%)	26 (86.7%)	30 (15.78)
Poisoning	14 (36.8%)	24 (63.2%)	38 (20.00)
CAP	2 (16.7%)	10 (83.3%)	12 (6.31)
AIDP	0	12 (100.0%)	12 (6.31)
GTCS	4 (50.0%)	4 (50.0%)	8 (4.21)
Cardiac	6 (42.9%)	8 (57.1%)	14 (7.36)
ARDS	0	2 (100.0%)	2 (1.05)
Total	86 (45.3%)	104 (54.7%)	190 (100.0%)

Table-3: Relationship of admitting diagnosis with ICU outcome.

RESULTS

During the study period, a total of 200 consecutive patients records were assessed. The medical records of 10 patients were found to be incomplete, and these patients were excluded from the study. Of the 190 patients, average age was 53 years with lowest age 16 years and highest age of 90 years. Male to female ratio 1:1.04.

The overall observed ICU mortality was 45.3%. On statistical analysis, no association was found between mortality and sex ratio (P > 0.05) (Table 1)

The average age of the patients is 53 years, mean SOFA score is 9 and average period of stay is 9 days. In our study, patient was sicker as these were medical patients and evidenced by significantly higher SOFA score of 5.50 ± 1.89 in survivors and 11.67 ± 2.87 in non-survivors (Table 2). The average duration of ICU stay in survivors was 12.14 ± 2.52 days and in non-survivors 5.709 ± 6.16 days.

The admitting diagnosis of patients is as shown in Table 3. The maximum admissions were secondary to sepsis followed by poisoning.

In our study, SOFA score on admission was a good predictor of mortality (*P* value <0.05) in patients admitted with sepsis, COPD, CAP and cardiac causes (Table 4). None of our patients with AIDP and ARDS died, so calculating P value is not possible but in these patients also SOFA ≤6 was associated with better outcome. However, in patients admitted with neurological diagnosis (GTCS and strokes) SOFA score could not be used to predict outcome.

12.6% (N 24) of our patients in this study were admitted with stroke. 16 were admitted with haemorrhagic stroke and 8 with ischaemic stoke. Mean average score in non-survivors was 10.91 ± 2.87 and in survivors 7.0 (*P* value .073, 95% CI -.396 to 8.214). SOFA score was not statistically significant in predicting outcome.

26.3% (N 50) patients were admitted with sepsis with MODS. Mean SOFA score in non-survivors was 12.82 ± 2.70 and in

Admitting Diagnosis in MICU	N		Mean SOFA score	*P* value	95% Confidence Interval	
					Upper	Lower
Stroke	Died	22	10.91 ± 2.87	.073	-.396	8.214
	Survived	2	7.00			
Sepsis MODS	Died	34	12.82 ± 2.70	<.001	1.904	5.243
	Survived	16	6.25 ± 1.82			
COPD	Died	4	10.50 ± 0.57	<.001	3.441	7.405
	Survived	26	5.08 ± 1.89			
Poisoning	Died	14	12.14 ± 2.68	<.001	4.966	8.653
	Survived	24	5.33 ± 1.12			
CAP	Died	2	10.00 ± 2.42	.007	3.265	7.234
	Survived	10	4.60			
AIDP	Died	0				
	Survived	12	2.33 ± 1.43			
GTCS	Died	4	7.50 ± 1.73	.134	-.619	3.619
	Survived	4	6.00			
Cardiac causes	Died	6	12.00 ± 0.89	<.001	4.665	9.335
	Survived	8	5.00 ± 2.72			
ARDS	Died	0				
	Survived	2	6.00			

Table-4: Admitting diagnosis vs SOFA score

survivors was 6.25 ± 1.82 which was statistically significant in predicting outcome (*P* value< 0.001, 95% CI 1.904-5.243).

15.78% (N 30) patients were admitted with acute COPD exacerbation with type 2 respiratory failure with CO2 narcosis (respiratory acidosis). Mean SOFA score in non-survivors and survivors was 10.50 ± 0.57 and 5.08 ± 1.89 respectively. SOFA score was statistically significant in predicting outcome (*P* value < 0.001, 95% CI 3.441-7.405).

20% (N 38) patients were admitted with poisoning. 31 patients were admitted with organo-phosphorous compound poisoning, 4 with rodenticide poisoning, 2 with hydrocarbon poisoning and 1 with accidental corrosive poisoning. Mean SOFA score in non-survivors was 12.14 ± 2.68 and in survivors was 5.33 ± 1.12 which was statistically significant in predicting outcome (*P* value <0.001, 95% CI 4.966-8.653).

6.31% (N 12) patients were admitted with CAP (Community Acquired pneumonia) with Type 1 respiratory failure. Mean SOFA score in non-survivors was 10.00 ± 2.42 and in survivors was 4.60 which was statistically significant in predicting outcome (*P* value .007, 95% CI 3.265-7.234).

6.31% (N 12) patients were admitted with AIDP (Acute Inflammatory Demyelinating Polyneuropathy). None of the AIDP patients died. Mean SOFA score in survivors was 2.33 ± 1.43.

4.21% (N 8) patients were admitted with GTCS (Generalised Tonic Clonic seizures). Mean SOFA score in non-survivors and survivors was 7.50 ± 1.73 and 6.00 respectively. SOFA score was not statistically significant in predicting outcome (*P*- value 0.134, 95% CI -.619 to 3.619).

7.36% (N 14) patients were admitted with cardiac causes. 12 patients admitted post-MI (Myocardial infarct) cardiac arrest and 2 admitted with cardiogenic shock secondary to complete heart block (CHB). Mean SOFA score in non-survivors was 12.00 ± 0.89 and in survivors was 5.00 ± 2.72 which was statistically significant in predicting outcome (*P*- value <.001, 95% CI 4.665-9.335).

1% (N 2) patients were admitted with ARDS. Both the patients survived and mean SOFA score was 6.

Among 190 patients 86 died and 104 patients were shifted to the wards. Out of 190 patients, 52 patients had SOFA score of 0-6 and mortality was 0%. In SOFA score of 6 to 9, 54 patients were admitted out of which 40 were shifted to the wards and 14 died (mortality rate 25%). In the group of SOFA score 9 to 15, a total of 66 patients were admitted in the ICU, 56 died and 10 were shifted to the wards (mortality rate 85 %). In the group with SOFA score 15 to 18, a total of 18 patients were admitted and all of them died (mortality rate 100%).

It is observed from the above that there is very high correlation between the SOFA score and the outcome of the patient, both the mean and the highest SOFA score are good indicators of the mortality rate of the patient.

DISCUSSION

The most common critical care predictive scoring systems include Acute Physiologic and Chronic Health Evaluation (APACHE) (1), Simplified Acute Physiologic Score (SAPS) (2), Mortality Prediction Model (MPM)(3) which are primarily prognostic models. The newer scoring systems, SOFA and multi-organ dysfunction scores (MODS) are the organ dysfunction scores which unlike the prognostic models can capture the clinical condition of the patient as these can be measured repeatedly at fixed time intervals. The APACHE system[1] developed in 1980s was the first illness severity model widely used by ICUs and it had a good correlation with mortality. However, the score was difficult to administer as it involves a complex measure of 34 physiologic variables and chronic health evaluation. APACHE II was as a simplified version of the first and used 12 physiologic variables and chronic health evaluation.[5] APACHE III variables are for ICU readmission, patient location, and hospital length of stay (LOS) before ICU admission.[6] The variables used in SAPS are readily available, and the calculations are simple. However, similar to APACHE, there is no correction for the patient's admitting diagnosis.[7] The MPM II, is less physiologically based than APACHE or SAPS.[8] Unlike the MODS score[9] in which the first value of each day is used, for the SOFA score, the worst value on each day is recorded.

Vincent et al[10] introduced the SOFA score in 1996 on behalf of the working group on sepsis of the European Society of Intensive Care Medicine. It was initially developed as a sepsis-related organ failure assessment in 1994, the SOFA score was renamed when it was found to be applicable for both septic as well as nonseptic patients.[10] The relationship between SOFA score on admission to ICU and mortality was studied retrospectively in 1643 patients with sepsis. Vincent et al[4] then conducted a prospective multicentric study of 1449 medical/ surgical patients in which a maximum total SOFA score greater than 15 correlated with a mortality rate of 90%. The score includes variables from six major organ systems (pulmonary, hematologic, hepatic, cardiovascular, central nervous, and renal) and records the most deranged value on each day. The scores range from 0 (normal) to 4 (most deranged). SOFA scores can be taken daily or on a 48 h basis. Serial evaluation of the SOFA score predicts outcome in critically ill patients.[11] Initial and highest scores of more than 11 or mean scores of more than 5 corresponded to mortality of more than 80%.[11] The predictive value of the mean score was independent of the length of ICU stay. The best correlation of scores with the outcome in terms of morbidity and mortality is seen with maximum SOFA score and mean SOFA score.[12]

A systemic review of the SOFA, SAPS II, APACHE II, and APACHE III scoring systems found that the APACHE systems were slightly superior to the SAPS II and SOFA systems in predicting ICU mortality.[13] The accuracy of both the SAPS II and APACHE instruments improved when combined with the assessment of sequential SOFA scores. However, APACHE III predictive scoring system tends to be the most costly because it requires specific computer technology and extensive data collection. MPM, SAPS and SOFA scoring systems are simple and inexpensive as these require less data collection and no computer investment.[14]

In a prospective observational study of 1,340 patients with multiple organ dysfunction syndrome, Cabre and colleagues[15] reported 100% mortality for patients with age over 60 years with a total maximum SOFA greater than 13 on any of the first 5 days of ICU admission. In our study those with SOFA score of >15 had 100% mortality.

SOFA score has been validated in severe sepsis.[16] In our study, 26.3% were admitted with sepsis MODS. Mean SOFA score in non-survivors was 12.82 ± 2.70 and in survivors was 6.25 ±

1.82 which was statistically significant in predicting outcome (*P* value < 0.001, 95% CI 1.904-5.243). Vincent et al[4] have shown that mortality rates are lower in patients with organ dysfunction associated with respiratory failure than with combined organ failure (mortality 65-74%). There is a significant association of initial SOFA score in analysing organ dysfunction in infectious diseases.[17] In our study, 6.31% patients were admitted with CAP with Type 1 respiratory failure. Mean SOFA score in non-survivors was 10.00 ± 2.42 and in survivors was 4.60 which was statistically significant in predicting outcome (*P* value .007, 95% CI 3.265-7.234).

Cour et al[18] conducted a study on 304 patients admitted for post-CA (cardiac arrest) management. At day 1, SOFA remained significantly ($p < 0.001$) higher in non-survivors (9.8 ± 3.8) when compared to survivors (6.5 ± 4.1). This is similar to our study of 7.36% patients admitted with cardiac causes. 12 patients were admitted with post-MI (Myocardial infarct) cardiac arrest and 2 admitted with cardiogenic shock secondary to complete heart block (CHB). Mean SOFA score in non-survivors was 12.00 ± 0.89 and in survivors was 5.00 ± 2.72 which was statistically significant in predicting outcome (*P* value < .001, 95% CI 4.665-9.335). Hence, SOFA score may help clinicians to objectively evaluate the severity of the post-CA syndrome.[18] Jansenns et al[19] have shown in 303 consecutive medical cardiovascular patients, SOFA score on Day 1 in non-survivors 5.9 ± 3.7 vs 1.9 ± 2.3 in survivors (*P* <0.001). This study supports SOFA as an excellent tool for assessing extent of organ dysfunction in medical cardiovascular patients.

Korean study[20] assessed performance of the SOFA scoring system in intensive care unit organophosphate poisoned patients. In a sample of 131 patients, the sensitivities, specificities, and accuracies were 86.2%, 82.4%, and 83.2% for the SOFA score, respectively. The SOFA score was more useful in predicting mortality, and easier and simpler than the APACHE II and SAPS II.[20] In our study 31 patients were admitted with organophosphate poisoning. Mean SOFA score in non-survivors was 12.14 ± 2.68 and in survivors was 5.33 ± 1.12 which was statistically significant in predicting outcome (*P* value< 0.001, 95% CI 4.966-8.653).

The mean SOFA score in survivors was 3.48 ± 2.238 and in non-survivors was 8.9 ± 3.45 and the difference was statistically significant.[21] This study depicts strong correlation of mortality with

SOFA scores on day 1. In Baradari et al[22] study; the admission, mean and highest SOFA scores were 11.72, 16.38 and 16.45 in deceased patients, and 6.52, 5.82 and 6.5 in survived patients, respectively. All three models were able to predict the outcome of patients significantly (*P* <0.001).

CONCLUSION

In resource restricted ICUs especially with staff shortage, SOFA score on admission is a simple and effective tool in predicting outcome in patients admitted with medical causes. It can be used to triage patients into risk categories for further management and resource planning. However, it should always be used in conjunction with clinical judgement especially in patients admitted with stroke and seizures. With increasing number of elderly population, SOFA score may be used in explaining prognosis and counselling relatives in deciding escalation of treatment and do not attempt resuscitation (DNAR). More research is required in assessing the role of SOFA score in various admitting diagnosis.

Limitations

A few limitations of our study need to be acknowledged. Our analysis focused only on SOFA score (initial score) on admission and not the subsequent scores. We did not include information on the baseline functional status, cognitive status and physiological parameters in our study as we specifically wanted to study the association of the initial SOFA score and the admitting diagnosis.

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