

Sequential organ failure assessment scoring and prediction of patient's outcome in Intensive Care Unit of a tertiary care hospital

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Abstract

Background and Aims: The objective was to determine the accuracy of sequential organ failure assessment (SOFA) score in predicting outcome of patients in Intensive Care Unit (ICU).

Material and Methods: Forty-four consecutive patients between 15 and 80 years admitted to ICU over 8 weeks period were studied prospectively. Three patients were excluded. SOFA score was determined 24 h postadmission to ICU and subsequently every 48 h for the first 10 days. Patients were followed till discharge/death/transfer from the ICU. Initial SOFA score, highest and mean SOFA scores were calculated and correlated with mortality and duration of stay in ICU.

Results: The mortality rate was 39% and the mean duration of stay in the ICU was 9 days. The maximum score in survivors (3.92 ± 2.17) was significantly lower than nonsurvivors (8.9 ± 3.45). The initial SOFA score had a strong statistical correlation with mortality. Cardiovascular score on day 1 and 3, respiratory score on day 7, and coagulation profile on day 3 correlated significantly with the outcome. Duration of the stay did not correlate with the survival ($P = 0.461$).

Conclusion: SOFA score is a simple, but effective prognostic indicator and evaluator for patient progress in ICU. Day 1 SOFA can triage the patients into risk categories. For further management, mean and maximum score help determine the severity of illness and can act as a guide for the intensity of therapy required for each patient.

Key words: Intensive Care Unit, mortality, sequential organ failure assessment score

Introduction

The Intensive Care Unit (ICU) of any hospital deals with patients requiring critical care and involves resuscitation of patients at extremes of physiological deterioration. Hence, evaluation of patient's status before admitting into ICU is essential for ensuring correct interventions and proper management of hospital resources.

Critical care predictive scoring systems derive a numerical value or severity score, from a variety of measurable clinical

variables and serve as a helpful tool at admission in predicting the course of the patient in the ICU. Though their main goal is prognostication of patient's status, they also help in the assessment of various interventions and quality of care. They are useful tools for research and administrative purposes and have been used to manage hospital resources, assigning patients with lower severity scores to lesser expensive settings. Their use can also be extrapolated to clinical trial settings where an investigator can use the scores to ensure that different groups involved in that trial are similar in their severity of illness. Among the available predictive scoring systems, most commonly

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employed include 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 may prove both tedious and inconvenient in a setting where evaluation needs to be fast paced to match the rapidly changing medical condition of patients.

SOFA uses simple measurements of major organ function derived from routine investigations to calculate a severity score. It requires only 6 variables and thus offers fast evaluation. The scores are calculated at 24 h after admission to the ICU and every 48 h thereafter. This scoring system has been validated in both medical and surgical ICU's where it has been depicted that the survival rate is directly proportional to the SOFA scores in the ICU.^[5]

The accuracy of predictive models is dynamic and should be periodically retested, revised, and updated in different clinical settings or they may fail to capture the effects of new technology, practice patterns, or standards of care. Thus, the present study was planned to assess the ability of SOFA scoring to predict mortality in the ICU setting of a tertiary care hospital in North India.

Material and Methods

The present study was designed as a prospective cohort study in the ICU of a tertiary care hospital. It included consecutive patients of either sex between the age of 15 and 80 years admitted to ICU over a period of 8 weeks. There were no exclusion criteria except the age bar.

After approval from the ethics committee, an informed consent was obtained from the relatives of the subjects prior to recruitment in the study. The patient underwent detailed clinical examination and laboratory investigations.

SOFA score was determined 24 h postadmission to ICU and subsequently every 48 h for the first 10 days. The diagnostic and therapeutic intervention was solely determined by the surgeon/clinician and the management of the patient carried out as per the standard policy of the department. Patients were followed till discharge/death/transfer from the ICU to other ward after stabilization. The outcomes studied included mortality and the duration of ICU stay.

Statistical analysis

Data are presented in a descriptive fashion as number (percentage) or mean (standard deviation). The categorical and continuous variables were analyzed using

Chi-square test and Mann–Whitney U-test, respectively. A *P* value < 0.05 was considered significant. Multivariate analysis of factors predicting the mortality was done with regression analysis. SPSS package IBM SPSS Statistics for windows, version 19.0. IBM Corp., Armonk, NY, USA, released 2010 was used for the same. Apriori sample size was not calculated as it was a short term ICMR project for 8 weeks and all the patients admitted in this period were included as per the admission criteria.

Initial SOFA score, highest and mean SOFA scores were correlated with the outcome measures.

Results

Forty-four subjects admitted to the ICU of a tertiary care hospital were recruited for the study. Three subjects were excluded as some of the investigation reports were not available. The clinical and laboratory data of 41 subjects were analyzed. Sixteen of the subjects died, resulting in 39% mortality.

Tables 1 and 2 shows the gender and age distribution of the subjects. The mean age was 40 ± 16 years. More than 80% of subjects were <55 years of age.

About three fourth of the patients had surgical reasons for ICU admission. These included peritonitis, tumors, trauma, etc. Septicemia, pancreatitis, lung disease constituted the medical conditions. One patient was admitted after caesarean section [Table 3].

The relation of individual system scores on day 1, 3, 5, 7, and 9 with mortality was studied [Table 4]. Poor cardiovascular score on day 1 and 3, coagulation profile on day 3, and respiratory score on day 7 correlated significantly with mortality.

The total SOFA scores on each day were correlated with survival [Table 5]. Total SOFA scores of day 1, 3, and 5 correlated significantly with survival, but those of day 7 and 9 did not.

The mean SOFA score for each subject correlated significantly with mortality. The maximum SOFA score for each subject also showed significant correlation with survival. The duration of stay in the ICU did not have a significant correlation with the outcome [Table 6]. The mean duration of stay was 9.32 days (range: 1-63 days).

Discussion

Among the scoring systems available, the most widely accepted and used in clinical practice are the APACHE, SAPS

and the MPM which are primarily prognostic models.^[6] The newer scoring systems include SOFA and multi-organ dysfunction scores (MODS) and are the organ dysfunction scores which may be measured repeatedly at fixed time intervals. They have an ability to capture the dynamic nature of clinical condition of the patient unlike the prognostic models.

The APACHE system was the first illness severity model widely used by ICUs. It was developed in the early 1980s and involved a complex measure of 34 physiologic variables and chronic health evaluation.^[7] The score had a good correlation with mortality, but it was difficult to administer and complex to score. APACHE II was developed as a simplified version of the first and used 12 physiologic variables, patient age, and chronic health evaluation.^[8] APACHE III was developed in 1991 and gives score for ICU readmission, patient location, and hospital length of stay (LOS) before ICU admission.^[9]

Table 1: Sex distribution and survival

Sex	Survivors	Nonsurvivors	Total
Male	10	6	16
Female	15	10	25

Table 2: Age distribution

Age (years)	Female	Male
15-25	6	4
26-35	4	5
36-45	9	1
46-55	3	2
56-65	1	3
66-75	1	0
75+	1	1
Total	25	16

Table 3: Indications for admission to ICU

Indication	Survivors	Nonsurvivors	Total
Surgical	20	10	30
Medical	6	4	10
Obstetric	0	1	1

ICU = Intensive Care Unit

Table 4: SOFA scores for various systems

System	Mean ±SD (P)				
	Day 1	Day 3	Day 5	Day 7	Day 9
Respiration	1.98±1.03 (0.42)	1.82±0.79 (0.13)	2.24±0.76 (0.25)	2.08±0.64 (0.03)	1.89±0.60 (0.55)
Coagulation	0.34±0.76 (0.41)	0.36±0.86 (0.00)	0.38±0.92 (0.10)	0.00±0.00 (1.000)	0.11±0.333 (0.371)
Liver	0.28±0.60 (0.62)	0.18±0.52 (0.75)	0.14±0.35 (0.11)	0.31±0.75 (0.17)	0.10±0.31 (0.31)
CVS	1.20±1.28 (0.00)	1.24±1.43 (0.00)	1.71±1.52 (0.06)	1.85±1.62 (0.10)	1.70±1.56 (0.38)
CNS	0.92±1.42 (0.00)	1.08±1.50 (0.01)	1.47±1.66 (0.16)	2.00±1.80 (0.14)	2.2±1.71 (0.58)
Renal	0.44±0.77 (0.22)	0.32±0.63 (0.10)	0.45±0.80 (0.22)	0.50±1.16 (0.42)	0.40±0.99 (0.88)

SOFA = Sequential organ failure assessment, SD = Standard deviation, CNS = Central nervous system, CVS = Cardiovascular system

Initially reported in 1984, the variables collected for SAPS represented the most deranged values in the first 24-h in the ICU. Unlike APACHE, 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.^[10]

The most recently designed scoring system, MPM II, is less physiologically based than APACHE or SAPS. The scoring system was developed to estimate mortality risk at 24 and 48 h after ICU admission, so it gives a revised risk based on the patient’s response to resuscitation and early treatment.^[11]

Developed initially 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.^[12] This system includes six major organ systems (pulmonary, hematologic, hepatic, cardiovascular, central nervous, and renal), records the most deranged value on each day, and scores the derangement from 0 (normal) to 4 (most deranged). SOFA scores can be taken daily or on a 48 h basis. The best correlation of scores with the outcome in terms of morbidity and mortality is seen with maximum SOFA score and mean SOFA score.^[13] Published in 1995, the MODS includes six organ systems, records the most representative value of the day, and scores the abnormality from 0 (normal) to 4 (abnormal).^[14]

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.^[15] 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 they require proprietary computer technology and substantial data collection. In addition to being available to public, MPM, SAPS, and SOFA scoring systems require less data collection and no computer investment. Calculations are easily made from published equations.

Table 5: Relationship between total SOFA score and survival

Day	Mean \pm SD			P
	Total SOFA	Survivors SOFA	Nonsurvivors SOFA	
Day 1	5.10 \pm 3.20	3.54 \pm 2.24	7.44 \pm 3.03	0.000
Day 3	5.03 \pm 3.51	2.94 \pm 2.18	7.53 \pm 3.18	0.00
Day 5	6.60 \pm 3.53	4.25 \pm 2.43	8.17 \pm 3.32	0.009
Day 7	7.08 \pm 4.23	3.80 \pm 3.11	9.43 \pm 3.30	0.027
Day 9	6.5 \pm 2.56	3.50 \pm 1.50	5 \pm 3.600	0.365

SOFA = Sequential organ failure assessment, SD = Standard deviation

Table 6: Relation of mean, maximum SOFA score, duration of stay with survival

Outcome parameter	Mean \pm SD		P
	Survivors	Nonsurvivors	
Mean SOFA	3.48 \pm 2.23	8.0 \pm 2.89	<0,001
Maximum SOFA	3.92 \pm 2.17	8.94 \pm 3.45	<0,001
Duration of stay	8.24 \pm 12.6	11.0 \pm 9.7	0.059

SD = Standard deviation, S = Significant, NS = Not significant

We found that cardiovascular score on day 1 and 3, respiratory score on day 7, and coagulation profile on day 3 correlated significantly with the outcome. The rest of the individual system scores did not predict survival. However, when the total SOFA score was studied, a strong and significant correlation was seen between the scores on day 1, 3, and 5 and the outcome. The total SOFA score represents the cumulative organ dysfunction of the patient. This shows that though the different system scores form an important component of SOFA calculation yet individually they may not be good predictors. Hence, SOFA should be considered in its composite form as a predictive model. The relationship between organ dysfunction and mortality has also been demonstrated in studies by Vincent *et al.* and Minne *et al.*^[5,13]

The present study depicts strong correlation of mortality with SOFA scores on day 1 which implies that SOFA score at admission can be used to quantify the degree of dysfunction/failure already present on ICU admission, and can predict the future course. Hence, initial SOFA score can triage the patients into risk categories for further management and resource planning.

The highest SOFA score can identify the critical point at which patients exhibit the highest degree of organ dysfunction during their ICU stay. In our study, we found that the maximum score in survivors (3.92 \pm 2.17) was significantly lower than nonsurvivors (8.9 \pm 3.45). Moreno *et al.*^[15] also demonstrated a strong correlation of maximum SOFA score with mortality outcome.

The mean SOFA score indicates the average degree of organ failure over time. We correlated the mean score with mortality. The mean SOFA score in survivors was 3.48 \pm 2.238

and in nonsurvivors was 8.9 \pm 3.45 and the difference was statistically significant. Ferreira *et al.*^[4] also concluded that the mean SOFA score had a better prognostic value than the other SOFA derived variables. They opined that this may be because patients who present with a limited degree of organ dysfunction and have a long ICU stay still have a high likelihood of survival.

In this study, the duration of ICU stay did not correlate with the survival. Ferreira *et al.*^[4] also showed that, the LOS was not related to outcome prediction.

The limitation of the study is that since the ICU is mixed, and database small, prediction for a subset of specific diseases separately cannot be done.

Conclusion

SOFA score on admission has shown a strong correlation with the outcome, and can help triage patients.

Maximum SOFA indicates the most critical point of time in the stay of a patient in the ICU.

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Conflicts of interest

There are no conflicts of interest.

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