Original Article

Serial evaluation of sofa (sequential organ failure assessment) score in critically ill pediatric patients

Muzammil Koshish[1], Nishikant Tiple[2*]

[1]Sr. Resident, [2]Assistant Professor, Department of Pediatrics, Shri. Vasantrao Naik Government Medical College, Yavatmal, Maharashtra, INDIA.

Email: nishikant_tiple@yahoo.co.in

Abstract

Introduction: Pediatric intensive care units (PICU) aims at promoting qualified care with the objective of achieving the best results and better progress for critically ill children. Mortality and length of PICU stay are the indicators of the outcomes of patient clinical condition. In order to measure severity, risk of mortality, scores are employed that establish a numerical scale and in this way they compare estimated mortality in percent with the observed mortality. Estimates of morbidity serve as a reliable indicator of intensive care performance, comparison among medical centers, cost/benefit analyses, and evaluation of new therapeutic or management modalities[1,2]. Hence the present prospective observational study is undertaken to evaluate the usefulness of serial evaluation of SOFA (Sequential Organ Failure Assessment) score for prediction of mortality in critically ill patients admitted in pediatric intensive care unit. **Aims and Objectives: 1.** To determine usefulness of repeated measurement of the SOFA score for `prediction of mortality in pediatric intensive care unit patients. **2.** To determine admission trend and average stay in Pediatric ICU. **3.** To determine outcome in Pediatric ICU. **Material and method:** The present prospective observational study was conducted in pediatrics department of tertiary care centre from Nov 2011 to Oct 2012. The study group includes patients admitted in PICU with following inclusion and exclusion criteria. The data was recorded and mean, median and range was calculated using Univariate logistic. **Observation and Results:** The study group includes 351 patients of 1-18 years with mean age of 6.3 years admitted in PICU satisfying the inclusion criteria. In present study out of 351 patients admitted in PICU, 200 were males and 151 were males with male to female ratio of 1:1.32. The mean, median and range of length of hospital stay of patients admitted in PICU were 3.12,3 and 2-13 respectively. Out of 351 patients admitted in PICU 81(23%) died. In present study we found that the initial SOFA score was significantly related to vital status. An initial SOFA score up to 11 predicted a mortality of 44 % while an initial SOFA score of greater than 11 predicted a mortality rate of 100 %. The highest SOFA score was also correlated with mortality, highest scores of 11 correlated with a mortality rate of 40% while those higher than 14 were associated with a mortality rate greater than 93 %. The mean SOFA score over the entire ICU stay was also correlated with mortality. **Conclusion:** In our study, we found that the SOFA scoring systems had an improved accuracy in predicting mortality, were well calibrated and could discriminate between survivors and non-survivors more effectively. Even though we are still far from finding an ideal scoring system, SOFA scoring system do show the way forward.

Keywords: SOFA (Sequential Organ Failure Assessment) Score, Mortality, PICU, 1-18 years children.

[*]**Address for Correspondence:**
Dr. Nishikant Tiple, Assistant Professor, Department of Pediatrics, Shri Vasantrao Naik Government Medical College, Yavatmal-445001. Maharashtra, INDIA.
Email: nishikant_tiple@yahoo.co.in

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INTRODUCTION

Pediatric intensive care units (PICU) aims at promoting qualified care with the objective of achieving the best results and better progress for critically ill children. Mortality and length of PICU stay are the indicators of the outcomes of patient clinical condition. In order to measure severity, risk of mortality, scores are employed that establish a numerical scale and in this way they compare estimated mortality in percent with the observed mortality. Estimates of morbidity serve as a reliable indicator of intensive care performance, comparison among medical centers, cost/benefit analyses, and

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evaluation of new therapeutic or management modalities[1,2]. Over the past years many scoring models have been developed to describe the severity of illness of intensive care patients or to predict the outcome of intensive care. Thus the first Sepsis-related Organ Failure Assessment score, later called the Sequential Organ Failure Assessment (SOFA) score, was introduced in 1994, aim was to quantify the severity of the patients' illness based on the degree of organ dysfunction, serially over time[3]. The SOFA score is composed of scores from six organ systems, graded from 0 to 4 according to the degree of dysfunction/failure.

The Sequential Organ Failure Assessment (SOFA) Score

SQFA Score	0	1	2	3	4
Respirationa PaO_2/FIO_2 (mm Hg) SaO_2/FIO_2	>400	<400 221-301	<300 142-220	<200 67-141	<100 <67
Coagulation Platelets $10^3/mm^3$	>150	<150	<100	<50	<20
Liver Billirubin (mg/dl)	<1.2	1.2-19	2.0-5.9	6.0-11.9	>12.0
Cardiovascular[b] Hypotension	No hypotension	MAP <70	Dopamine</=5 or dobutamine (any)	Dopamine>5 or norepinephrine</=0.1	Dopamine >15or norepinephrine >0.1
CNS Glasgow Corra Score	15	13=14	10-12	6=9	<6
Renal Creatinine (mg/dl) of urine output (ml/d)	<1.2	1.2-1.9	2.0-3.4	3.5-4.9 or <500	>5.0 or <200

MATERIAL AND METHODS

The present prospective observational study was conducted in pediatrics department of tertiary care centre from Nov 2011 to Oct 2012. The study group includes patients admitted in PICU with following inclusion and exclusion criteria. **Inclusion Criteria**

1. Age between 1 to 18 years
2. PICU stay for more the following 24 hours.

Exclusion Criteria

1. Patients less than 1 year and more than 18 years of age.
2. PICU stay less than 24 hours.
3. Parents or Guardian not willing to give consent for enrollment in the study.

After approval by the ethical board and consent from the parents or guardian, Demographic, laboratory, and clinical data were collected, and SOFA score (Components: PaO2/FiO2, Platelets, Serum bilirubin, Blood pressure, Glasgow coma scale, Serum creatinine) which includes initial, highest and mean score was calculated on admission and every 48 hours until discharge or death. The Glasgow Coma Scale was applied by two doctors and mean of it was taken. In sedated patients, the assumed Glasgow Coma Score Scale was used to evaluate the neurological status. PaO2/FIO2 ratio was preferentially used when arterial blood gases were obtained. In cases where the PaO2 was not available, peripheral arterial oxygen saturation (SaO2) to FIO2 ratio (SaO2/FIO2) was used. Serum Creatinine was measured by Jaffe reaction using alkaline Picrate and Serum Bilirubin was measured using Jendrassik and Grof method by autoanalyser. Blood pressure was taken manually with Mercury sphygmomanometer by auscultatory method. Platelet count was done by Autoanalyser and also by examination of peripheral smear stained with Wright stain by a Pathologist. The data was recorded and mean, median and range was calculated using Univariate logistic. A Chi-square statistics test was used whenever applicable to evaluate the statistical significance of categorical variables and P value <.05 is considered significant.

AIMS AND OBJECTIVES

1. To determine usefulness of repeated measurement of the SOFA score for `prediction of mortality in pediatric intensive care unit patients.
2. To determine admission trend and average stay in Pediatric ICU.
3. To determine outcome in Pediatric ICU.

OBSERVATION AND RESULTS

The study group includes 351 patients of 1-18 years with mean age of 6.3 years admitted in PICU satisfying the inclusion criteria. In present study out of 351 patients admitted in PICU, 200 were males and 151 were males with male to female ratio of 1:1.32. The mean, median and range of length of hospital stay of patients admitted

in PICU were 3.12,3 and 2-13 respectively. Out of 351 patients admitted in PICU 81(23%) died. (Table 1)

Table 1: Demographics of Study population

Characteristics	Values
No. Of patients	351
Age, mean (SD) [range]y	6.3 (4.38), 1 to 18 years
Sex	
Male	200
Female	151
Type of admission, No. (%)	
Medical	282 (80%)
Surgical	69 (20%)
Length of PICU Stay in days	
Mean	3.12
Median	3.0
Range	2 to 13
Deaths, No. (%)	81 (23%)

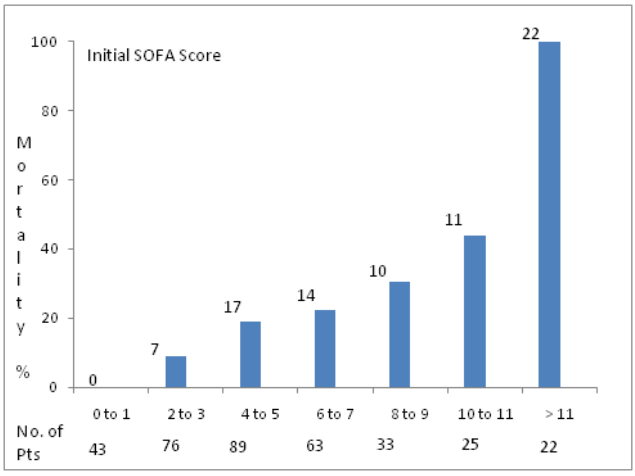

Figure 2: Mortality Rate in Relation to Change in Initial SOFA Sore

The initial SOFA score was significantly related to vital status. An initial SOFA score up to 11 predicted a mortality of 44 % while an initial SOFA score of greater than 11 predicted a mortality rate of 100 %. (FIGURE No.2) The highest SOFA score was also correlated with mortality: highest scores of 11 correlated with a mortality rate of 40% while those higher than 14 were associated with a mortality rate greater than 93 % (Figure No.3) The mean SOFA score over the entire ICU stay was also correlated with mortality. The predictive value of the mean SOFA score for mortality was similar regardless of the length of stay.

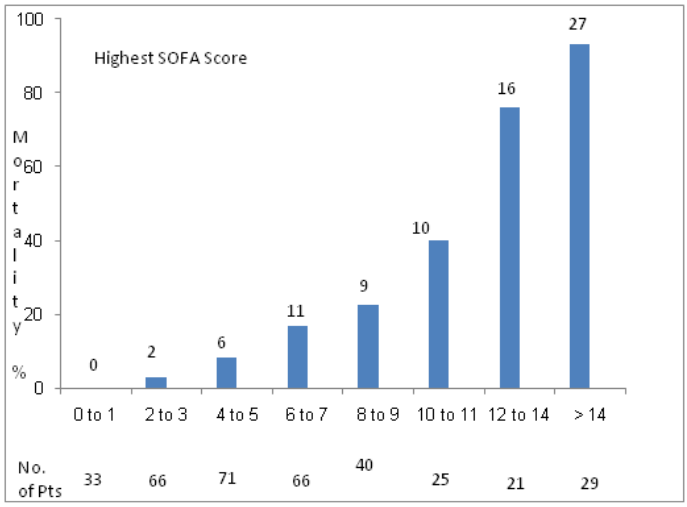

Figure 3: Mortality Rate in Relation to Change in Highest SOFA Score

Table 2: Univariate Logistic Analysis of Sequential Organ Failure Assessment (SOFA) Derived Parameters as Predictors of Mortality

Variables	Coefficient, Mean (SE)
Mean SOFA Score	1.49, 0.32
Highest SOFA Score	1.17, 0.25
Initial SOFA Score	1.10, 0.18
SOFA Score at 48 hours	1.03, 0.22
Delta SOFA Score 96-0 *	0.92, 0.53
SOFA Score at 96 hours	0.89, 0.56
Delta SOFA Score 48-0 #	0.8, 0.2

*Represents the difference between the 96 hour SOFA score and admission score

Represents the difference between the 48 hours SOFA score and admission score

By Univariate logistic analysis, the mean SOFA score correlated most closely with mortality followed by the Highest SOFA score, the Initial SOFA score, and the SOFA Score at 48 hours.

Table 3: Changes in SOFA Score in first 48 hours and its Relation to Outcome

0-48 hours SOFA Score
Evolution No. at % of deaths 95% CI Risk
Increased 101 57 44 to 75
Unchanged 37 27 5 to 18
Decreased 213 6 6 to 21
Total 351

Table 4: Changes in SOFA Score in next 48 hours and its Relation to Outcome

48 to 96 hours
Evolution No. at % of deaths 95% CI Risk
Increased 9 100 4 to 17
Unchanged 36 25 2 to 13
Decreased 48 6 0.6 to 9
Total 93

Table 5: Changes in SOFA Score in first 96 hours and its Relation to Outcome

0-96 hours SOFA Score			
Evolution	No. at	% of deaths	95% CI Risk
Increased	25	64	9 to 26
Unchanged	7	0	0 to 4
Decreased	61	3	0.24 to 7
Total 93			

Trends in SOFA scores during the first 48 hours shows that regardless of the initial score, the mortality rate was 57 % or higher when the score increased, 27 % to 6 % when it did not change, and less than 6 % when it decreased. Trends in SOFA scores during the first 96 hours shows that regardless of the initial score, the mortality rate was 64 % or higher when the score increased, less than 1 % when it decreased or remained unchanged (TABLE No.6). Trends in SOFA scores during 48 to 96 hours shows that regardless of the initial score, the mortality rate was 100 % when the score increased, less than 7 % when it decreased and 17 % to 7 % when it remained unchanged. Differences in mortality were predicted better during the subsequent 48 hours then first 48 hours. There was no significant difference in LOS among these groups. (Table 3, 4 and 5)

DISCUSSION

Due to continued developments in the field of critical care, leading to improved patient outcomes, newer scoring systems need to be developed which are more in sync with the times. Their utility in predicting outcomes in ICU population other than where these were developed is also unknown, which may prevent their wider acceptability. An ideal scoring system should be able to predict mortality rate correctly, that is, predicted mortality should be close to the actual mortality rate; should be well calibrated, that is, it should be able to provide risk estimate corresponding to the observed mortality; should have high levels of discrimination, that is, it should be able to identify which patients are at higher risk of dying; it should be easy to compute and should be based on easily available patient parameters. Moreover, it also has to be dynamic, reflecting the change in management and case mix over time. In our study, the SOFA scoring systems had an improved accuracy in predicting mortality, were well calibrated and could discriminate between survivors and non-survivors more effectively. Even though we are still far from finding an ideal scoring system, SOFA scoring system do show the way forward. In developing a scoring system, such as SOFA, for assessing and monitoring organ dysfunction, several important features need to be considered. First, organ failure is not an all-or-nothing phenomenon; rather, it is a continuum of alterations in organ function from normal function, through varying degrees of dysfunction, organ failure. Second, the description of organ dysfunction needs to be based on simple, easily repeatable variables specific to the organ in question and readily available in all institutions. Third, organ dysfunction is not static. It will alter over time, and a scoring system needs to be able to take this time factor into account. In using the SOFA for outcome prediction, the ability to perform serial SOFA scores allow a more effective representation of the dynamics of illness including the effects of therapy compared with traditional outcome prediction models at the time of ICU admission. Although some investigators have used the APACHE II score over time[4,5,6], this process has never been validated. Derived measures from the APACHE III system have also been proposed for use on a daily basis[7], but APACHE III is not available in the public domain, and its daily use has again not been validated. The SOFA score is a useful tool to stratify and compare patients in clinical trials[8,9]. Moreno *et al*[10] recently demonstrated that the initial SOFA score can be used to quantify the degree of organ dysfunction or failure present on admission, that the Delta SOFA score can demonstrate the degree of dysfunction or failure developing during an ICU stay, and that the total maximum SOFA score can represent the cumulative organ dysfunction experienced by the patient. They also demonstrated a strong correlation of all these parameters with mortality outcome. In our study, we have moved a step further, presenting selected SOFA parameters, the mean and the highest SOFA scores, as reliable predictors of outcome throughout the ICU stay. The mean SOFA score gives an indication of the average degree of organ failure over time and could also be a useful tool for stratifying patients in clinical trials, according to the total score or the scores for individual organs. The highest SOFA score can identify the critical point at which patients exhibit the highest degree of organ dysfunction during their ICU stay. With these 2 variables, we can thus define the peak and the total amount of organ impairment for any patient or group of patients during their ICU stay. Others have shown that the development of organ failure may occur early during an ICU stay[11], and a scoring system that allows regular surveillance of organ function is thus needed. Trends in the SOFA score over the first 48 hours of an ICU stay could provide such a system and be a sensitive indicator of outcome, as reflected in the fact that a decreasing value was associated with a decrease in mortality rates from 57 % to 27 %. Interestingly, the length of stay was not related to outcome prediction.

CONCLUSION

An ideal scoring system should be able to predict mortality rate correctly, that is, predicted mortality should

be close to the actual mortality rate; should be well calibrated, that is, it should be able to provide risk estimate corresponding to the observed mortality; should have high levels of discrimination, that is, it should be able to identify which patients are at higher risk of dying; it should be easy to compute and should be based on easily available patient parameters. Moreover, it also has to be dynamic, reflecting the change in management and case mix over time. In our study, the SOFA scoring systems had an improved accuracy in predicting mortality, were well calibrated and could discriminate between survivors and non-survivors more effectively. Even though we are still far from finding an ideal scoring system, SOFA scoring system do show the way forward.

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