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ORIGINAL RESEARCH

Study of SOFA scoring in predicting mortality among patient admitted with sepsis and septic shock at a tertiary level institute

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ABSTRACT

Background: The Sequential Organ Failure Assessment (SOFA) Score has been developed, to describe the degree of organ dysfunction/failure over time in groups of patients. Present study was aimed to evaluate the SOFA score at 0 and 72 hrs and predict the outcome in patients admitted in sepsis through emergency department. Material and Methods: Present study was single-center, prospective, observational study, conducted in patients age more than 18 years, both gender, with suspected infection, had any 2 of the q SOFA criteria (Altered mental status OR Respiratory rate >22 OR Systolic BP <= 100mmhg) & SOFA scoring more than 2, relatives willing to participate in present study. Results: In present study, 50 patients were studied. Mean age was 53.26 ± 11.619. Of the 50 subjects who were enrolled in our study 32 (64%) were male and 18(36%) were female. Final outcome of the study was 46% dead and 54% alive. Mean length of stay in hospital was 7.26 ± 3.82 days. SOFA score at admission, scores 4-5 have highest frequency and 2-3 has the lowest frequency of occurrence. As the SOFA score increases the mortality increases and as the SOFA score decreases mortality decreases. SOFA score at 72 hrs, when SOFA score is >11 it has a 78% mortality. Initial score from 2-7 had a mortality rate of 12.5%, 8-11 had a mortality rate of 60% and above 11 had a mortality rate >91%. Delta SOFA with mortality when the score is > 2 there is a mortality of 20 persons and when the score is <-2 there is less mortality. Conclusion: The SOFA score demonstrated fair to good accuracy for predicting in-hospital mortality when applied to patients with severe sepsis with evidence of hypo-perfusion at the time of ED presentation.

Keywords: SOFA score, in-hospital mortality, severe sepsis, DELTA SOFA score

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INTRODUCTION

Sepsis is one of the most important cause of mortality in intensive care setting an effective predictor of prognosis of sepsis is required to assess morbidity and mortality of this condition. Sepsis is now recognized to involve early activation of both pro-and anti-inflammatory responses, along with major modifications in non-immunologic pathways such as cardio- vascular, neuronal, autonomic, hormonal, bio- energetic, metabolic, and coagulation all of which have prognostic significance."[1,2]

Emergency department (ED) is one of the most important hospital departments and the frontline of facing critically ill patients. There are several outcome prediction models that are currently available for use in clinical practice, Among them are the Acute Physiology And Chronic Health Evaluation Score (APACHE), Simplified Acute Physiology Score (SAPS), Sequential Organ Failure Assessment (SOFA) score, Logistic Organ Dysfunction System (LODS), and Multiple Organ Dysfunction Score (MODS).[3,4] These systems have been successful in evaluating the efficacy of the diagnostic methods, pre and in-hospital triage, and finally improving the quality of therapeutic and preventive measures In addition, scoring systems are capable of converting the severity of patient's disease to a number, which leads to a common understanding between the physicians and making the same decision.

The Sequential Organ Failure Assessment (SOFA) Score has been developed by European Society of Critical Care Medicine (ESCCM), to describe the degree of organ dysfunction/failure over time in groups of patients or even in individual patients, it performs based on evaluating the function of 6 vital organs respiratory, coagulation, cardiovascular and circulatory, liver, central nervous system and renal.[1,5,6] This tool is easy to use and evaluates the status of the mentioned organs systematically and continuously during hospitalization.

Present study was aimed to evaluate the SOFA score at 0 and 72 hrs and predict the outcome in patients admitted in sepsis through emergency department.

MATERIAL AND METHODS

Present study was single-center, prospective, observational study, conducted in department of Emergency Medicine and Critical Care Medicine, Apollo Hospital, Chennai, India. Study duration was of 15 months (July 2016 to September 2017). Study approval was obtained from institutional ethical committee.

Inclusion criteria

- Age more than 18 years, both gender, with suspected infection, had any 2 of the q SOFA criteria (Altered mental status OR Respiratory rate >22 OR Systolic BP <= 100mmhg) & SOFA scoring more than 2, relatives willing to participate in present study

Exclusion criteria

- Patients under any limitation of care which includes patients who have given DNR/DNI orders
- Age less than 18.
- Pregnant and lactating women.

After Institutional Ethics Committee (IEC) clearance, informed written consent was obtained from all the study participants after thoroughly explaining the study protocol, benefits and risks. Confidentiality of the study participants was maintained throughout the study.

Eligible subjects were identified by certified Emergency physicians and were treated in ED and medical ICU. All data elements required for calculation of the SOFA score at the time of ED recognition and resuscitation (T0) and at 72 hours (T72) after admission were prospectively collected on standardized forms and entered into a database for later analysis. For T0 data available in the ED were used for calculation and for T72 scores, data available within 12 hours of 72 hour time point were used for calculation. For the purpose of the study we made one modification in the calculation of Respiratory component of SOFA score, we

preferentially used Pao2 to Fio2 when arterial blood gases were obtained. In cases where Pao2 was not available, we used peripheral oxygen saturation (Sao2) to Fio2 ratio. This substitution has been previously validated with high correlation. This study examines both values and changes in SOFA score at 2 time points. There was the potential for subjects to die, or to be discharged from the hospital before 72 hours, to account for these potential dropouts, We followed the last observation carried forward principle, thus for subjects who were not available for calculation of 72 hour SOFA, We used the available data that were most temporally related to 72 hours time point. Patients going against medical advice to other hospitals are considered drop outs and are not included in the study.

The parameters like mean SOFA and the delta SOFA are calculated and entered in a datasheet. The duration of stay of the patient in the hospital, the condition of the patient during discharge, the development of complication during the hospital stay are also recorded for the estimation of mortality and morbidity.

All the continuous variables were assessed for the normality using Shapiro test.If they are normally distributed they were expressed as mean +/- standard deviation. All categorical variables were expressed as %(percentage), and comparison of continuous variables was done by independent sample t test. Comparison of categorical variables done by chi square test and Fisher's exact test. Data entry was done in MS-EXCEL spread sheet. Data analysis was carried out by SPSS version 25.0. All p values <0.05 was considered as statistically significant.

RESULTS

In present study, 50 patients were studied. Mean age was 53.26 ± 11.619. Of the 50 subjects who were enrolled in our study 32 (64%) were male and 18(36%) were female. Final outcome of the study was 46% dead and 54% alive. Mean length of stay in hospital was 7.26 ± 3.82 days.

TABLE 1: General characteristics

	No. of patients/ Mean ± SD	**Percentage**
Mean age (years)	53.26 ± 11.619	
Gender		
Male	32	64
Female	18	36
Outcome		
Alive	27	54
Dead	23	46
Mean length of stay in hospital (days)	7.26 ± 3.82	

The statistical analysis shows that males have higher mortality accounting for about 60.9% (14/32) of deaths as compared to deaths in female population 39.1% (9/18).

TABLE 2: Gender wise outcome

Gender	**Outcome**		**Total (n=50)**
	Alive (n=27)	**Dead (n=23)**	
Male	18 (66.7 %)	14 (60.9 %)	32 (64 %)
Female	9 (33.3 %)	9 (39.1 %)	18 (36 %)

32% (16/50) of population didn't have any associated co morbidities while 18% had DM, 26% had DM+HTN, 6% had HTN+CAD, 14% had HTN+DM+CAD and 4% had DM+HTN+CAD+CKD. We can clearly see a high mortality rate of 30.4% in the study population with DM+HT group, to 13% mortality in DM group, 8.7% mortality in

HTN+CAD group, 21.7% mortality with HTIN+DM+CAD group and 4.3% mortality in DM+HTN+CAD+CKD group.

TABLE 3: Comorbidity

Comorbidity	Outcome		Total (n=50)
	Alive (n=27)	Dead (n=23)	
No comorbidity	11 (40.7 %)	5 (21.7 %)	16 (32 %)
DM	6 (22.2 %)	3 (13 %)	9 (18 %)
DM + HTN	6 (22.2 %)	7 (30.4 %)	13 (26 %)
HTN + CAD	1 (3.7 %)	2 (8.7 %)	3 (6 %)
DM + HTN + CAD	2 (7.4 %)	5 (21.7 %)	7 (14 %)
DM + HTN + CAD + CKD	1 (3.7 %)	1 (4.3 %)	2 (4 %)

Urosepsis was seen in maximum number of study population with an incidence of 18% and conditions like pyelonephritis, peuperal sepsis, ruptured appendix, necrotising fasciitis and pyonephritis are seen the least with an incidence of 1% each. cause of mortality among our study population showing urosepsis (13%), surgical site infection (17.4%), community acquired pneumonia(13%) and necrotizing pancreatitis(13%)being the leading causes of mortality.

TABLE 4: Diagnosis with outcome

Comorbidity	Outcome		Total (n=50)
	Alive (n=27)	Dead (n=23)	
Urosepsis	6 (22.2 %)	3 (13 %)	9 (18 %)
Meningitis	4 (14.8 %)	1 (4.3 %)	5 (10 %)
Community acquired Pneumonia	2 (7.4 %)	3 (13 %)	5 (10 %)
Abscess	3 (11.1 %)	2 (8.7 %)	5 (10 %)
surgical site infection	0	4 (17.4 %)	4 (8 %)
Cellulitis	4 (14.8 %)	0	4 (8 %)
Peritonitis	2 (7.4 %)	1 (4.3 %)	3 (6 %)
H1N1 pnemonia	1 (3.7 %)	2 (8.7 %)	3 (6 %)
Necrotising pancreatitis	0	3 (13 %)	3 (6 %)
DIC with sepsis	2 (7.4 %)	0	2 (4 %)
Puerperial sepsis	1 (3.7 %)	0	1 (2 %)
Ruptures appendix	1 (3.7 %)	0	1 (2 %)
Necrotising fasctis	1 (3.7 %)	0	1 (2 %)
AGE with Sepsis	0	1 (4.3 %)	1 (2 %)
Pyonephrosis	0	1 (4.3 %)	1 (2 %)
Pyelonephritis	0	1 (4.3 %)	1 (2 %)

26% of subjects had a MAP of >70 36% had MAP <=70, 24 % were given DOPA > 5 MC or NorAd<=0.1 and 14 % of subjects were given DOPA >15 or NorAd>0.1 to be stable.

56 % of subjects had a MAP of >70, 2 % had MAP <=70, 6 % were given DOPA > 5 MC or NorAd<=0.1 and 36 % of subjects were given DOPA >15 or NorAd>0.1 to be stable. This shows that condition of the subjects improved of got deteriorated at 72 hours' time. Highest mortality of 34.8 % was seen in the study population needing DOPA > 5 MC or Nored<=0.1 to have a stable BP, 30.4% mortality in group with MAP >70, 21.7% mortality in population

who needed DOPA >15 or Nored>0.1 to have a stable BP and 13% mortality in group with MAP<=70.

TABLE 5: Blood pressure at admission

Blood pressure at admission	Outcome		Total
	Alive (n=27)	Dead (n=23)	
MAP > 70	6 (22.2 %)	7 (30.4 %)	13 (26 %)
MAP ≤ 70	15 (55.6 %)	3 (13 %)	18 (36 %)
DOPA > 5 MC or NorAd ≤ 0.1 & MAP ≤ 70	4 (14.8 %)	8 (34.8 %)	12 (24 %)
DOPA >15 or NorAd>0.1	2 (7.4 %)	5 (21.7 %)	7 (14 %)

Highest mortality of 56 % was seen in the study population MAP >70, 36% mortality in population who needed DOPA >15 or Norad>0.1 to have a stable BP, 6 % mortality in group needing DOPA > 5 MC or Norad<=0.1 to have a stable BP and 2% mortality in group with MAP<=70.

TABLE 6: Blood pressure at 72 Hours

Blood pressure at admission	Outcome		Total
	Alive (n=27)	Dead (n=23)	
MAP > 70	24 (88.9 %)	4 (17.4 %)	28 (56 %)
MAP ≤ 70	0	1 (4.3 %)	1 (4 %)
DOPA > 5 MC or NorAd ≤ 0.1 & MAP ≤ 70	2 (7.4 %)	1 (4.3 %)	3 (6 %)
DOPA >15 or NorAd>0.1	1 (3.7 %)	17 (73.9 %)	18 (36 %)

SOFA score at admission, scores 4-5 have highest frequency and 2-3 has the lowest frequency of occurrence. As the SOFA score increases the mortality increases and as the SOFA score decreases mortality decreases.

TABLE 7: CLASSIFICATION OF SOFA AT ADMISSION

CLASSIFICATION OF SOFA AT ADMISSION	Outcome		Total
	Alive (n=27)	Dead (n=23)	
2-3	1 (3.7 %)	0	1 (2 %)
4-5	11 (40.7 %)	5 (21.7 %)	16 (32 %)
6-7	7 (25.9 %)	1 (4.3 %)	8 (16 %)
8-9	5 (18.5 %)	3 (13 %)	8 (16 %)
10-11	2 (7.4 %)	3 (13 %)	5 (10 %)
>11	1 (3.7 %)	11 (47.8 %)	12 (24 %)

SOFA score at 72 hrs, when SOFA score is >11 it has a 78% mortality. As the score increases mortality increased more than 50% and when there is no change in the SOFA score mortality was maintained to 27-35% and when the score decreases mortality was less than 27%. Initial score from 2-7 had a mortality rate of 12.5%, 8-11 had a mortality rate of 60% and above 11 had a mortality rate >91%.

TABLE 8: CLASSIFICATION OF SOFA score at 72 hours

CLASSIFICATION OF SOFA score at 72 hours	Outcome		Total
	Alive (n=27)	Dead (n=23)	
0-1	5 (18.5 %)	0	5 (10 %)
2-3	10 (37 %)	0	10 (20 %)
4-5	7 (25.9 %)	0	7 (14 %)
6-7	2 (7.4 %)	1 (4.3 %)	3 (6 %)

8-9	2 (7.4 %)	2 (8.7 %)	4 (8 %)
10-11	1 (3.7 %)	2 (8.7 %)	3 (6 %)
>11	0	18 (78.3 %)	18 (36 %)

Mean SOFA at admission in alive patients is 6.30 and for dead patients is 10.61 at admission, mean SOFA at 72 hrs for alive patients is 3.74 and 15.09 for dead patients at 72 hrs. This shows the drastic change in the SOFA score of alive.

TABLE 9: SOFA score in patients at admission and at discharge

	Outcome	
	Alive	**Dead**
SOFA at admission	6.3 ± 2.28	10.84 ± 4.34
SOFA at72 hs	3.74 ± 2.52	15.09 ± 3.48
Mean SOFA	5.01 ± 2.22	13.03 ± 2.63

In 26 people there is decrease in SOFA score in | person there is no change in the SOFA score whereas in 23 people there is increase in SOFA score.

Change in SOFA score with their mortality when SOFA score decreases 25 are alive, when the SOFA score increases there are 21 deaths.

TABLE 10: Change in SOFA score comparing with mortality

	Outcome		**Total**
	Alive (n=27)	**Dead (n=23)**	
Decrease in SOFA	25 (92.6 %)	1 (4.3 %)	26 (52%)
No Change in SOFA	0	1 (4.3 %)	1 (2 %)
Increase in SOFA	2 (7.4 %)	21 (91.3 %)	23 (46 %)

Delta SOFA with score <-2 is 42%,<-1 is 10%, 0 is 2%, 1 is 4% and >2 is 42%. delta SOFA with mortality when the score is > 2 there is a mortality of 20 persons and when the score is <-2 there is less mortality.

TABLE 11: DELTA SOFA with outcome.

CLASSIFICATION OF SOFA AT ADMISSION	**Outcome**		**Total**
	Alive (n=27)	**Dead (n=23)**	
-2	21 (77.8 %)	0	21 (42 %)
-1	4 (14.8 %)	1 (4.3 %)	5 (10 %)
0	0	1 (4.3 %)	1 (2 %)
1	1 (3.7 %)	1 (4.3 %)	2 (4 %)
2	1 (3.7 %)	20 (87 %)	21 (42 %)

DISCUSSION

Increasing organ dysfunction scores and mean SOFA scores reflected the worsening function in organ systems during the course of severe sepsis mostly in non-surviving patients. The SOFA score at 72 hrs was better compared with SOFA score on day 0 as the tool for outcome prediction. The assessment of organ dysfunction scores are often used to determine the baseline severity of illness and the pattern of changes in organ function over the course of various critical illnesses.[7,8]

SOFA score was developed as a tool for sepsis-related organ failure assessment. Further, it was validated in general ICU population in multicenter studies showing the best results, as it included all organ system, though other scoring systems were available calculating them were a tedious process and required a calculator, this system being easier gained more validation than others,[5,6] They had also simplified the score to SOFA which has been used as our

inclusion criteria to clinically identify patients with sepsis. The SOFA system was also applied to many other diagnostic groups of the ICU patients (medical, cardiac, trauma, pancreatitis, acute renal failure).

Our study stated that as the SOFA score increased the mortality increased upto 91% and as the SOFA score decreased or as they don't change the mortality remained as 4.3%, Study done by Ferreira et al.,[5] determined that regardless of the initial score, an increase in SOFA score during the first 48 hours in the ICU predicts a mortality rate of at least 50%.

Our result showed when the initial score was 4-5 showed a mortality of 31.3% and 6-7 as the initial score showed a mortality of 12.5% which is lesser than 4-5 as the initial SOFA score, so analysis was done to review the decreased mortality rates. It was found that age, diagnosis, co-morbidities, duration of illness all made an impact in this change in mortality when compared to international study. We also found that our study of initial SOFA score and comparing it with mortality of international standards our mortality was slightly lesser than their study.

Study by Ferreira et al.,[5] also used the initial, highest and mean SOFA score. Initial and highest scores of more than 11 or mean scores of more than 5 corresponded to mortality of more than 95%. The predictive value of the mean score was independent of the length of ICU stay. In univariate analysis, mean and highest SOFA scores had the strongest correlation with mortality, followed by Delta-SOFA and initial SOFA scores. Except for initial scores of more than 11 (mortality rate >90%), a decreasing score during the first 48 hours was associated with a mortality rate of less than 6%, while an unchanged or increasing score was associated with a mortality rate of 22% when the initial score was 2 to 7 and 90% when the initial score was 8 to 11. Sequential assessment of organ dysfunction during the first few days of ICU admission is a good indicator of prognosis. Both the mean and highest SOFA scores are particularly useful predictors of outcome

Study by Bale C et al.,[9] noted that in the group of patients in whom SOFA was <7, there were 48% survivors and 52% non-survivors. In the patient group, which had scores of 8-15, there were 88% non-survivors. Mean score of the patients who did not survive was 6.96 and the score in those who survived was 2.5 (t-test = 4.33, P <0.001), which was statistically significant. Comparing with our study <7 SOFA score at 72 hrs only 3 survived 14% and 86% non survivors.

Study by Samir Desai et al.,[10] analysed the utility of SOFA and APACHE II score in sepsis, SOFA score was calculated on day 1, 3 and 7. APACHE II score was also calculated on day of admission. They used both the scores for predicting the outcome. The mortality rate was 48% in their study group which had alarming proportion of MODS patients (78%). On day 3, the mortality rate of patients with SOFA score less than nine was 9.1%, while the mortality rate of patients with score more than nine was 78%*. The trend of mean SOFA score was progressively declining in survivor group.

In study by Grissom et al.,[11] mortality with initial SOFA score >11 was 53% which was very less compared to our study. Jones et al.,[4] in their study concluded that SOFA scoring system provides valuable prognostic information regarding in-hospital mortality for the medical team. Similar findings were noted in present study.

In study by, Safari et al.[12] aimed to use SOFA system in ICU for prediction of mortality and showed that there is a significant correlation between. SOFA score at ED presentation and repeated every 24 hrs correlated well with mortality rate (p = 0.0001) and concluded that SOFA is an appropriate tool for predicting length of stay and mortality for ICU patients.

Study by Grissom et al.,[11] the area under curve of day 1 SOFA is 0.83 and 72 hrs SOFA with area under curve was 0.78. Our study has almost had good accuracy in identifying the patients with sepsis and septic shock and predicted mortality to a desirable extend when compared to other study models which has the background like our study.

Study by Jones et al.,[4] similar to our study compared the delta SOFA which is the change in the SOFA score, according to their study when the score is -2 most patients survived and when the score is +2 there were increased mortality, this had a positive relationship. Furthermore, in our study we found that the A SOFA over 72 hours has a statistically significant positive relationship to in-hospital mortality which was showing similar result as the above mentioned study.

The ROC curve of SOFA at admission is 0.787 and the area under the curve for 72 hrs is 0.990, the delta SOFA score was also studied which has an area under the curve of 0.986. Studies which correlated well with our studies like study by Grissom et al.,[11] Day 1 SOFA and MSOFA scores performed equally well at predicting mortality with an area under the receiver operating curve (AUC) of 0.83 and 0.84 respectively. Anami et al.,[13] also showed that when SOFA score is higher, mortality increases. Area under the curve was reported to be 0.82 in this study.

The researchers revealed that using SOFA score in critically ill patients efficiently describes the severity of organ failure and high SOFA score directly correlates with mortality. The SOFA at admission in our study had a sensitivity of 56% and specificity of 96% which is higher when compared to 72 hrs SOFA with sensitivity of 95% and specificity of 96% in our study. Studies by Desai S et al.,[10] studied the SOFA score at admission with sensitivity of 86.2% and specificity of 82.4%.° Study by Fagon JY et al.,[14] well correlated with our study with a sensitivity of 51.4%, and specificity of 93.4%.

The SOFA score has several desirable characteristics for application in the ED, because it is easy to calculate at the bedside and includes clinical and laboratory data that are routinely available in the ED.[15,16] We are aware of no previous study that has demonstrated the utility of applying the SOFA score in the ED at the time of recognition and resuscitation of patients with severe sepsis with evidence of hypo-perfusion. These data suggest that use of the SOFA score is an acceptable method for risk stratification and prognosis of patients with severe sepsis with evidence of hypo-perfusion at the time of ED presentation.

Severity of organ dysfunction proved to be a good factor in discriminating outcome for the patients with severe sepsis. The SOFA scores showed high accuracy describing the course of organ dysfunction in these patients. Evolving organ dysfunction following admission to the ICU strongly affected the outcome. Cumulative SOFA scores, particularly 72 hrs score, was better in predicting outcome compared to single organ dysfunction score.

Limitations of present study were, score was not performed in individuals with pre-existing organ failure, relatively small size of the sample studied & study was only conducted in Adult, Children were not included in the study. Therefore, our results may not be generalizable to severe sepsis patients with other criteria for organ dysfunction.

CONCLUSION

The SOFA score demonstrated fair to good accuracy for predicting in-hospital mortality when applied to patients with severe sepsis with evidence of hypo-perfusion at the time of ED presentation. The SOFA score over 72 hours and the A SOFA predicted mortality much higher than the initial SOFA score. The initial SOFA score in ED was the baseline value in calculating the 72 hours SOFA score. Thus we concluded that SOFA scoring predicted mortality to a better extend. The 72 hours SOFA & the A DELTA SOFA score were much useful in predicting mortality to a desirable intend.

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