Annals of Medicine and Medical Sciences (AMMS)
Volume 04, 2025, *Page No.: 1085 to 1090*
Available at: *http://ammspub.com*

Original Article

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Is Sequential Organ Failure Assessment Score (SOFA) Valid for Predicting Maternal Outcomes in Pregnancy Associated Sepsis, or Limited to General Population Use?

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Abstract

Objective: To assess the prognostic value of the Sequential Organ Failure Assessment score in predicting maternal and neonatal outcomes among women with pregnancy-associated sepsis. ***Design:*** A prospective observational study. ***Subjects/Patients:*** One hundred antenatal, postnatal, and postabortal women admitted with sepsis were enrolled after informed consent. ***Methods:*** The Sequential Organ Failure Assessment score was calculated at admission. The relationship of the score with maternal survival, neonatal admission to intensive care, duration of intensive care stay, and extent of organ dysfunction was evaluated using non-parametric statistical analysis and receiver operating characteristic curve assessment. ***Results:*** The mean Sequential Organ Failure Assessment score was significantly higher in women who expired (10.08 ± 3.72) compared to survivors (3.50 ± 3.43, $p<0.001$). The score showed good diagnostic performance for predicting maternal mortality, with an area under the curve of 0.894. A cutoff value of six predicted death with 89 percent sensitivity and 76 percent specificity. Multi-organ dysfunction involving three or more organs was present in 23 percent of patients and was strongly associated with poor outcome. Higher scores correlated with longer intensive care stay and shorter overall hospital stay. The score demonstrated poor discriminative value for predicting neonatal intensive care admission. ***Conclusion:*** The Sequential Organ Failure Assessment score is a valuable tool for maternal risk stratification in pregnancy-associated sepsis, though it lacks predictive accuracy for neonatal outcomes.

Keywords: ***Intensive Care Unit, Maternal Mortality, Organ Dysfunction, Pregnancy-Associated Sepsis, SOFA Score.***

Introduction

Pregnancy-associated sepsis (PAS) is responsible for significant maternal morbidity and mortality world over. Even in high-income nations, pregnancy-associated sepsis complicates approximately 4-10 per 10,000 live births [1,2]. The Third International Consensus Definitions for Sepsis and Septic Shock Task force (2016) defined sepsis as "life threatening organ dysfunction caused by a dysregulated host response to infection" [3,4]. Organ dysfunction is denoted by an increase in the SOFA score by 2 or more points [5]. According to the Registrar General of India - Sample Registration System (RGI-SRS) Report (Special Bulletin on Maternal Mortality in India 2017–2019); the Maternal Mortality ratio (MMR) of India is 103 per 100,000 live births [6]. Critically ill obstetric patient management is challenging due to the presence of a foetus which leads to an altered physiology in the mother and the presence of disease-specific to pregnancy [7]. The Sequential Organ Failure Assessment (SOFA) score is widely utilized in critical care to assess the severity of organ dysfunction and predict outcomes in patients with sepsis. However, its application in pregnancy-associated sepsis

Received: August 23, 2025; **Revised:** September 11, 2025; **Accepted:** September 13, 2025

remains limited, largely due to the physiological changes of pregnancy that may alter baseline parameters such as cardiovascular, renal, and haematological functions. Despite this, evaluating the potential role of SOFA in maternal sepsis is important, as it may provide a standardized method for early recognition, risk stratification, and management. Further studies are warranted to determine whether SOFA can be reliably adapted for obstetric population.

Methods

Study Type: Prospective observational study

Study Place: Obstetrics & Gynecology Department, Ganesh Shanker Vidyarthi (GSVM) Medical College Kanpur

Period: 2years (March2023- March2025)

Selection Criteria of the patients: All pregnant, postabortal and postpartum female.

Exclusion Criteria: We were excluding subjects with previously known history or diagnosed pathology of pulmonary, cardiac, renal, hepatobiliary and nervous system.

Sample size calculation: By Slovin's formula (A simple way to determine the minimal sample size needed for a research study)

n=N/(1+Ne2)
n=The desired sample size
N= The total size of the population
e=The margin of study (0.05%)
Sample size=100

Procedure: After taking informed consent from participants(n=100) SOFA score was used on them.

Ethical Approval: Given by Ethical Committee of GSVM medical college Kanpur

Results

Table 1: SOFA Score- Sequential Organ Failure Assessment Score

SYSTEM	0	1	2	3	4
Respiration PaO2/FiO2, mmHg	>400	<400	<300	<200	<100
Coagulation platelets *103/uL	>150	<150	<100	<50	<20
Liver bilirubin, mg/dL	<1.2	1.2-1.9	2.0-5.9	6.0-11.9	>12.0
Cardiovascular	MAP(>70mmHg)	MAP(<70mmHg)	Dopamine<5	Dopamine (5.1-15) or Epinephrine<0.1 or Norepinephrine<0.1	Dopamine>15 or Epinephrine >0.1 or Norepinephrine >0.1
CNS (GCS Score)	15	13-14	10-12	6-9	<6
Renal (Creatinine,mg/dL)	<1.2	1.2-1.9	2.0-3.4	3.5-4.9	>5.0

Table 2: Summary of SOFA(n=100)

SOFA	Score 0	Score 1	Score 2	Score 3	Score 4
PaO2/FiO2	49 (49.0%)	10 (10.0%)	7 (7.0%)	33 (33.0%)	1 (1.0%)
Platelet Count	28 (28.0%)	18 (18.0%)	28 (28.0%)	25 (25.0%)	1 (1.0%)
Bilirubin	56 (56.0%)	29 (29.0%)	12 (12.0%)	1 (1.0%)	2 (2.0%)
MAP	75 (75.0%)	19 (19.0%)	1 (1.0%)	5 (5.0%)	0 (0.0%)
Creatinine	51 (51.0%)	18 (18.0%)	11 (11.0%)	7 (7.0%)	13 (13.0%)
GCS	54 (54.0%)	13 (13.0%)	18 (18.0%)	6 (6.0%)	9 (9.0%)

Distribution pf patient with different parameters ranging from 0-4
Maximum SOFA score=24
Minimum SOFA score=0

Table 3: Association between 'Outcome of Patient' and 'SOFA Score: Total'

SOFA Score: Total	Outcome Of Patient		Kruskal Wallis Test	
	Discharged	Expired	$\chi 2$	p value
Mean (SD)	3.50 (3.43)	10.08 (3.72)	43.623	<0.001

The mean (SD) of SOFA Score: Total in the Outcome of Patient: Discharged group was 3.50 (3.43). The mean (SD) of SOFA Score: Total in the Outcome of Patient: Expired group was 10.08 (3.72). The median (IQR) of SOFA Score: Total in the Outcome of Patient: Discharged group was 3 (0-5).

Table 4: Association between 'NICU Admission' and 'SOFA Score: Total'

SOFA Score: Total	NICU Admission		Wilcoxon-Mann-Whitney U Test	
	NO	YES	W	p value
Mean (SD)	5.00 (4.30)	6.15 (4.65)	304.500	0.410

The mean (SD) of SOFA Score: Total in the NICU Admission: No group was 5.00 (4.30). The mean (SD) of SOFA Score: Total in the NICU Admission: Yes, group was 6.15 (4.65).

Table 5: Association between 'Total Duration of ICU Stay' and UISEMH stay and 'SOFA Score: Total'

Correlation	Spearman Correlation Coefficient	P Value
Total Duration of ICU Stay vs SOFA Score: Total	0.47 (95%CI: 0.28 to 0.63)	<0.001
Total Duration of UISEMH Stay vs SOFA Score: Total	-0.43 (95%CI: -0.58 to -0.23)	<0.001

Non-parametric tests (Spearman Correlation) were used to explore the correlation between the two variables, as at least one of the variables was not normally distributed.
There was a moderate positive correlation between Total Duration of ICU Stay and SOFA Score: Total, and this correlation was statistically significant (rho = 0.47, p = <0.001).
For every 1 unit increase in Total Duration of ICU Stay, the SOFA Score: Total increases by 0.36 units.
There was a moderate negative correlation between Total Duration of UISEMH Stay and SOFA Score: Total, and this correlation was statistically significant (rho = -0.43, p = <0.001).
For every 1 unit increase in Total Duration of UISEMH Stay, the SOFA Score: Total decreases by 0.69 units.

Table 6: Correlation of SOFA score with components(n=100)

Correlation	Spearman Correlation Coefficient	P Value
PAO2/FIO2 vs SOFA Score: Total	-0.71 (95%CI: -0.8 to -0.59)	<0.001
Platelets (Lacs) vs SOFA Score: Total	-0.67 (95%CI: -0.77 to -0.54)	<0.001
S. Bilirubin (g/dL) vs SOFA Score: Total	0.56 (95%CI: 0.41 to 0.69)	<0.001
MAP (mmHg) vs SOFA Score: Total	-0.12 (95%CI: -0.31 to 0.07)	0.219
GCS vs SOFA Score: Total	-0.83 (95%CI: -0.88 to -0.76)	<0.001
S. Creatinine (mg/dL) vs SOFA Score: Total	0.71 (95%CI: 0.6 to 0.79)	<0.001

Non-parametric tests (Spearman Correlation) were used to explore the correlation between the two variables, as at least one of the variables was not normally distributed.
There was a strong negative correlation between PAO2/FIO2 and SOFA Score: Total, and this correlation was statistically significant (rho = -0.71, p = <0.001).
For every 1 unit increase in PAO2/FIO2, the SOFA Score: Total decreases by 0.02 units.
There was a strong negative correlation between Platelets (Lacs) and SOFA Score: Total, and this correlation was statistically significant (rho = -0.67, p = <0.001).
For every 1 unit increase in Platelets (Lacs), the SOFA Score: Total decreases by 4.34 units.
There was a moderate positive correlation between S. Bilirubin (g/dL) and SOFA Score: Total, and this correlation was statistically significant (rho = 0.56, p = <0.001).
For every 1 unit increase in S. Bilirubin (g/dL), the SOFA Score: Total increases by 0.93 units.
There was a weak negative correlation between MAP (mmHg) and SOFA Score: Total, and this correlation was not statistically significant (r = -0.12, p = 0.219).
For every 1 unit increase in MAP (mmHg), the SOFA Score: Total decreases by 0.02 units.
There was a strong negative correlation between GCS and SOFA Score: Total, and this correlation was statistically significant (rho = -0.83, p = <0.001).
For every 1 unit increase in GCS, the SOFA Score: Total decreases by 0.87 units.
There was a strong positive correlation between S. Creatinine (mg/dL) and SOFA Score: Total, and this correlation was statistically significant (rho = 0.71, p = <0.001).
For every 1 unit increase in S. Creatinine (mg/dL), the SOFA Score: Total increases by 3.01 units.

Table 7: Distribution of Organ Failure per patient

No. of Organ Failure	No. of Patient
No Organ Failure	26
One Organ Failure	32
Two Organ Failure	19
≥3 Organ Failure	23

Table 8: ROC Curve Analysis Showing Diagnostic Performance of SOFA Score: Total in Predicting NICU Admission: Yes, vs NICU Admission: No (n = 68)

Parameter	Value (95% CI)
Cutoff (p value)	≤ 8 (0.410)
AUROC	0.574 (0.4 - 0.748)
Sensitivity	84.6% (55-98)
Specificity	34.5% (22-49)
Positive Predictive Value	23.4% (12-38)
Negative Predictive Value	90.5% (70-99)
Diagnostic Accuracy	44.1% (32-57)
Positive Likelihood Ratio	1.29 (0.96-1.75)
Negative Likelihood Ratio	0.45 (0.12-1.68)
Diagnostic Odds Ratio	2.9 (0.58-14.46)

The area under the ROC curve (AUROC) for SOFA Score: Total predicting NICU Admission: Yes, vs NICU Admission: No was 0.574 (95% CI: 0.4 - 0.748), thus demonstrating poor diagnostic performance. It was not statistically significant (p = 0.410).
At a cutoff of SOFA Score: Total ≤8, it predicts NICU Admission: Yes, with a sensitivity of 85%, and a specificity of 34%.
The cutoff and the diagnostic parameters reported above are not reliable as the test is not statistically significant.

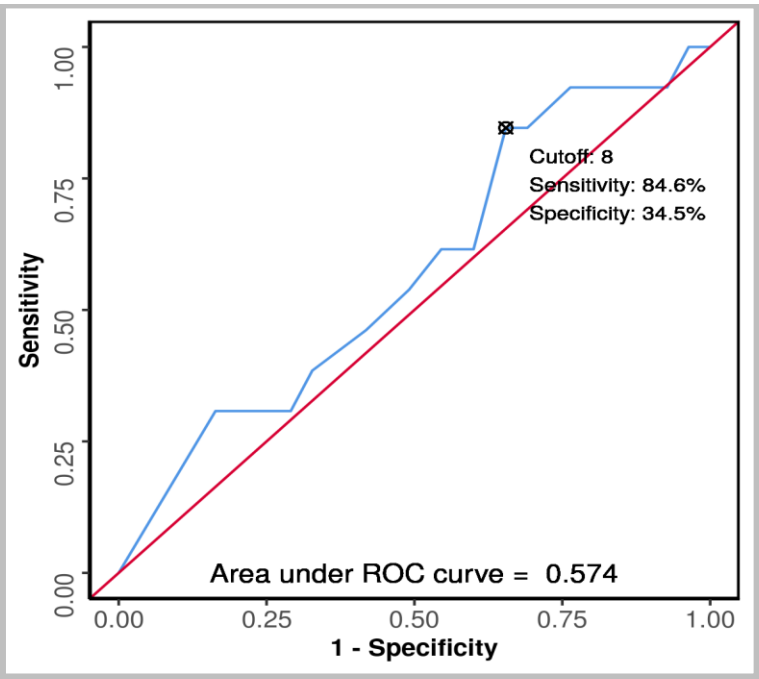

Fig. 1. ROC Curve Analysis Showing Diagnostic Performance of SOFA Score: Total in Predicting NICU Admission: Yes, vs NICU Admission: No (n = 68)

Table 9: ROC Curve Analysis Showing Diagnostic Performance of SOFA Score: Total in Predicting Outcome of Patient: Expired vs Outcome of Patient: Discharge(n=100)

Parameter	Value (95% CI)
Cutoff (p value)	≥ 6 (<0.001)
AUROC	0.894 (0.833 - 0.955)
Sensitivity	89.2% (75-97)
Specificity	76.2% (64-86)
Positive Predictive Value	68.8% (54-81)
Negative Predictive Value	92.3% (81-98)
Diagnostic Accuracy	81.0% (72-88)
Positive Likelihood Ratio	3.75 (2.37-5.91)
Negative Likelihood Ratio	0.14 (0.06-0.36)
Diagnostic Odds Ratio	26.4 (8.04-86.66)

The area under the ROC curve (AUROC) for SOFA Score: Total predicting Outcome of Patient: Expired vs Outcome of Patient: Discharged, Shifted was 0.894 (95% CI: 0.833 - 0.955), thus demonstrating good diagnostic performance. It was statistically significant (p = <0.001).
At a cutoff of SOFA Score: Total ≥6, it predicts Outcome of Patient: Expired with a sensitivity of 89%, and a specificity of 76%.

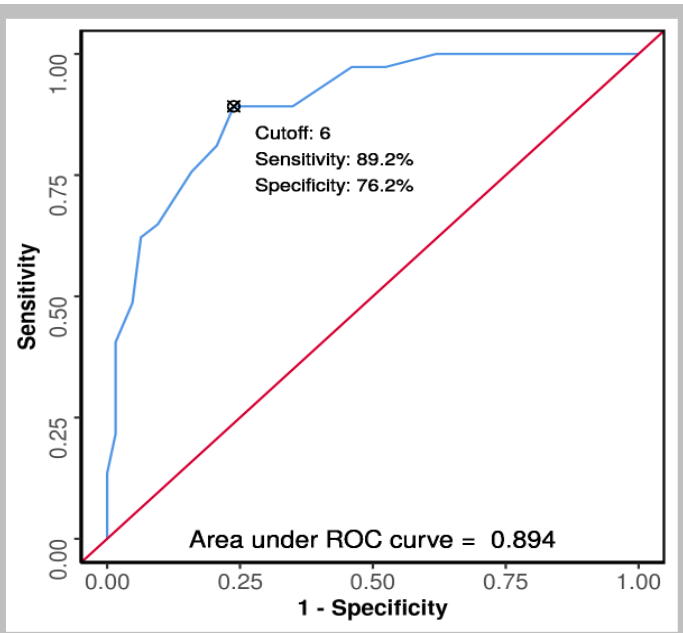

Fig. 2. ROC Curve Analysis Showing Diagnostic Performance of SOFA Score: Total in Predicting Outcome of Patient: Expired vs Outcome of Patient: Discharge(n=100)

Discussion

In my study, the SOFA score was found to be a strong predictor of maternal mortality, with a significantly higher mean score among expired patients (10.08 ± 3.72) compared to survivors (3.50 ± 3.43). ROC analysis confirmed good diagnostic accuracy (AUROC = 0.894, 95% CI: 0.833–0.955) with a cutoff ≥6 yielding 89% sensitivity and 76% specificity. These findings are in line with Anand and Gokhale (2023), who reported excellent prognostic performance of SOFA with AUROC of 0.972 (95% CI: 0.917–0.995), where rising SOFA scores were significantly associated with adverse outcomes in obstetric ICU patients [8]. Similarly, Agarwal, Goyal and Mohta (2021) demonstrated that a SOFA score ≥6 predicted mortality and critical care admission in pregnancy-associated sepsis with 84.4% sensitivity and 61.3% specificity, concluding that SOFA outperformed the pregnancy-specific SOS score [9]. The mortality rate in their study was 31.7%, closely matching our cohort, highlighting the consistency of SOFA as a reliable tool for maternal prognostication.

In our study, 23% of patients had ≥3 organ failures, which was strongly associated with higher SOFA scores and increased mortality. This is comparable to the findings of Anand & Gokhale (2023), who observed that multi-organ dysfunction was significantly linked to poor maternal outcomes in obstetric ICU patients [8]. Similarly, Agarwal *et al*. (2021) reported that rising SOFA scores reflecting multiple organ failures were predictive of critical care admission and mortality in pregnancy-associated sepsis [9].

Our analysis also revealed a moderate positive correlation between SOFA score and ICU stay duration ($\rho = 0.47$, $p < 0.001$), indicating that patients with higher SOFA scores required prolonged intensive care. Conversely, we observed a negative correlation with total hospital stay ($\rho = -0.43$, $p < 0.001$), explained by shorter survival among patients with very high SOFA scores due to early mortality. This observation is consistent with the findings of Anand and Gokhale (2023), where increasing SOFA scores over time correlated with worsening clinical status and prolonged ICU need [8]. Likewise, Agarwal *et al*. (2021) showed that higher SOFA scores were significantly associated with increased requirement for critical care admission, indirectly supporting our observation that higher scores predict greater ICU dependency [9].

When evaluating neonatal outcomes, our study found that SOFA score had poor discriminative ability for predicting NICU admission (AUROC 0.574, 95% CI: 0.40–0.748; p = 0.410), despite high sensitivity (84.6%). This suggests that while SOFA is highly predictive of maternal outcome, it is not a reliable neonatal prognostic tool. Similar observations have been made in prior systematic reviews, where maternal sepsis severity was shown to influence perinatal outcomes, but neonatal morbidity and mortality were also determined by gestational age, intrapartum management, and NICU availability (Woodd *et al*., 2019; Bonet *et al*., 2017) [2,5]. Thus, our findings confirm that SOFA should be integrated into maternal sepsis management for risk stratification of maternal outcome but not used in isolation for predicting neonatal prognosis.

Conclusion

The SOFA score proved to be a strong predictor of maternal outcomes in pregnancy-associated sepsis, with higher scores correlating significantly with mortality, multi-organ dysfunction, and longer ICU stays, while showing poor ability to predict neonatal outcomes. These findings highlight the value of SOFA as a reliable tool for maternal risk stratification and timely intervention in sepsis management, although neonatal prognosis is influenced by additional perinatal factors beyond maternal illness severity.

Declarations

Acknowledgements

None

Conflict of interest

There is no conflict of interests.

Funding Statement

None

Ethical Clearance

YES

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