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ORIGINAL RESEARCH

Predicting maternal outcomes in critically ill patients with SOFA, q SOFA and SOS scoring systems: A comparative study

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ABSTRACT

Aim: To compare maternal outcomes in critically ill patients using SOFA, q SOFA and SOS scoring systems.

Material and Methods: The present hospital based observational study was conducted at Department of General Medicine and Casualty, Rajmata Vijaya Raje Scindia, Bhilwara, Rajasthan from January 2023 to March 2024. As it is a time bound study, we were able to recruit 81 patients during the study period. A detailed general and obstetric examination was done. Relevant laboratory and imaging tests were undertaken and blood samples drawn for hematological examination. QSOFA, SOFA and SOS was applied prospectively in enrolled patients. Organ failure assessment and monitoring was done at 48hrs and discharge/mortality was recorded.

Results: In the present study; mortality rate was (n=18, 22.22%). Serum urea showed a statistically significant difference between survivors and non-survivors (p=0.006).For our study population, a threshold of SOFA ≥ 6 had the best combination of sensitivity (92.5%) and specificity (66.8%) for critical care admission and maternal mortality. For SOS, a cut-off value of ≥ 6 gave best sensitivity (68.2%) and specificity (60.4%) for the same. qSOFA≥1.7 was far more predictive of patient's critical condition as well as mortality compared to SOS with sensitivity 86.4% and specificity 61.9%.

Conclusion: SOFA was best to decide critical care admission and predict mortality in pregnancy-associated sepsis when tested in a severe morbidity and high mortality clinical setting. The q SOFA however is more predictive than SOS for maternal mortality and ICU admission.

Keywords: Sequential Organ Failure Assessment, quick Sepsis Related Organ Failure Assessment, Sepsis in Obstetrics Score, Mortality

INTRODUCTION

Maternal mortality is an important health indicator for any country and maternal, and child health is a subject of national focus[1]. Although good perinatal outcome depends on socioeconomic factors and orchestrated functioning of various levels of population and hospital based care, the importance of obstetric critical care services to manage the severely sick pregnant or postpartum patients cannot be undermined[2-3].

Critically ill obstetric patients pose a burden on the healthcare system and their outcome is a predictor of the healthcare services of the country.MMR of India according to SRS 2016-18 was 113. There are multiple scoring systems for use with obstetric patients with multiple controversies[4]. An efficient scoring system can be a valuable tool to reduce maternal morbidity and mortality by aiding in the timely identification of high-risk patients and intensifying their management along with ensuring appropriate allocation of resources. Accurate predictive scores in the ICUs apart from directing aggressive management in patients, predicted for a poor outcome could also lead to better productive utilization of the limited resources, along with accurate monitoring of the quality of care and risk stratification for clinical and therapeutic trials[5].

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Finding out a score for easy and early assessment of women at risk, is therefore very important. Various studies have been done considering ability of SOFA, QSOFA, SOS, APACHE, SAPS, SIRS, MEWS, NEWS, etc to predict maternal outcome[6-8] .

Recently, the Third International Consensus Definitions for Sepsis and Septic Shock proposed to update and revise the definition and clinical criteria for sepsis (Sepsis-3). Seymour et al. Validated the new sepsis criteria (Sepsis-3) by showing that two or more points of Sequential Organ Failure Assessment (SOFA) and quick SOFA (qSOFA) was found to have a better ability than SIRS criteria to predict hospital mortality and ICU stay in sepsis patients[9].

The SOFA score was proven to offer the best discrimination among ICU sepsis patients while qSOFA provide the best indicators to identify high hospital mortality of sepsis patients treated in the emergency department orwards[9].

Albright et al. (2014)[10] focused on pregnant and post-partum women and developed an obstetric sepsis scoring system, the Sepsis in Obstetrics Score (SOS), to describe their risk of critical care admission. The score took into account parameters which are physiologically altered in pregnancy [SBP, heart rate (HR) and total leucocyte count (TLC)], combined them with those of Acute Physiology and Chronic Health Evaluation (APACHE) II and Rapid Emergency Medicine Score (REMS), i.e. temperature, HR, RR, oxygen saturation and TLC and the Systemic Inflammatory Response Syndrome (SIRS) criteria (SBP, TLC, percentage of immature neutrophils in blood and lactic acid levels) for PAS. A SOS $\geq$ 6 carried risk of positive blood cultures, increased critical care admissions and fetal tachycardia[11].

Many studies are available using various scores but no scale is available that is specific for critically ill obstetric females. SOFA has its own limitations. No study has been found that has compared these 3 scores and has proven to be fast, quick and easy to apply.

This work will expose gaps between disease profile and healthcare support available and therefore help in proper utilization of ICU resources. No such study is done in our socio-demographic area using these variables. A scientifically validated scoring system for critically ill obstetric patients will prove to be instrumental in early recognition of at-risk females and their effective management. The aim of the present study to compare SOFA, q SOFA and SOS scoring systems for predicting maternal outcomes in critically ill obstetric patients.

MATERIAL AND METHODS

The present hospital based observational study was conducted at Department of General Medicine and Casualty, Rajmata Vijaya Raje Scindia Government Medical College and Mahatma Gandhi Hospital, Bhilwara, Rajasthan from January 2023 to March 2024. As it is a time bound study, we were able to recruit 81 patients during the study period.

Case definition

All critically ill obstetric patients -

1. Threatened airway
2. All respiratory arrests
3. RR>/= 40 or <8
4. O2 saturation <90%
5. All cardiac arrests
6. PR <40 or >140
7. SBP <90mmHg
8. Fall in consciousness GCS >2
9. Repeated, Prolonged seizures
10. Rising arterial CO2 with respiratory acidosis
11. Any patient giving cause of concern

Inclusion Criteria

Critically ill obstetric patients coming to our Hospital in age group (18-40 yrs) during study period [7]

1. Antepartum haemorrhage
2. Atonic PPH
3. Traumatic PPH
4. Peripartum cardiomyopathy
5. Septic cardiomyopathy
6. Rheumatic Heart Disease
7. Pre Eclampsia
8. Eclampsia
9. HELLP
10. Intra-abdominal sepsis
11. Amniotic Fluid Embolism
12. Sepsis of pelvic cause

Exclusion Criteria

- Critically ill obstetric patients who die immediately after admission.
- Do not resuscitate patients.

Methodology

a. All critically ill obstetric patients of age group (18-40 yrs) during the study period fulfilling the inclusion and exclusion criteria.
b. Consent (written and informed) was obtained either from the patients or attendants. Confidentiality of the patient's details was maintained in the study.
c. After eliciting detailed history from the patient herself, or from the attendants, thorough general, systemic and obstetric examination was done as per proforma.
d. A detailed general and obstetric examination was done.
e. Relevant laboratory and imaging tests were undertaken and blood samples drawn for hematological examination.
f. QSOFA, SOFA and SOS was applied prospectively in enrolled patients.
g. Organ failure assessment and monitoring was done at 48hrs and discharge/mortality based on:

- Need for invasive ventilation

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- Need for catecholamine
- Hospital/ICU stay
- Sepsis
- Morbidity
- Mortality

Statistical analysis

Data so collected was tabulated in an excelsheet, under the guidance of statistician. The means and standard deviations of the measurements per group were used for statistical analysis (SPSS 22.00 for windows; SPSS inc, Chicago, USA). Difference between two groups was determined using t test and the level of significance was set at $p < 0.05$. Sensitivity, specificity and accuracy of QSOFA, SOFA and SOS was calculated.

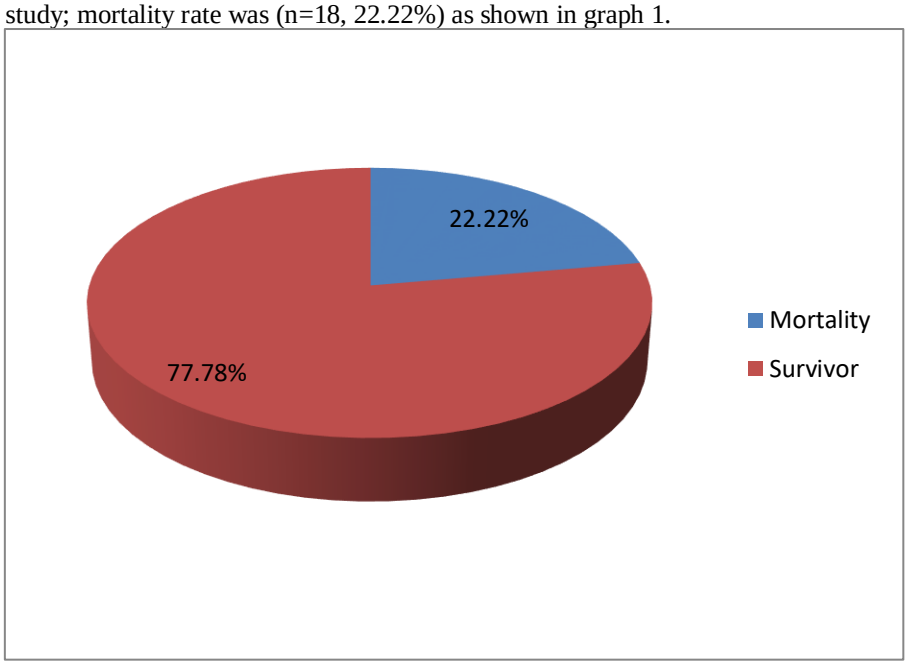
RESULTS

Of the total 81 females included in study, maximum study subjects were in age range 18-25 years (n=42, 51.85%), followed by 27 (33.33%) between 26-30 years of age and 12 (14.81%) between 31-40 years of age. Majority of the females were multigravida (n=62, 76.54%) and remaining 19 (23.46%) were primigravida. As depicted in table 1, ICU admissions for non-obstetric causes of sepsis (n=52, 64.2%) was mostly due to respiratory tract infections (n=37, 45.68%) followed by UTI (n=15, 18.52%).Puerperal sepsis (n=11, 13.58%) was the most frequent cause of obstetric sepsis (n=29, 35.80%) followed by Chorioamnionitis (12.35%), Septic (8.64%) and wound infection (1.23%).

Table 1: Cause of sepsis among the study subjects

Variables	N	%
Obstetric	29	35.80
Septic	7	8.64
Chorioamnionitis	10	12.35
Puerperal sepsis	11	13.58
Wound infection	1	1.23
Non obstetric	52	64.20
Respiratory	37	45.68
UTI	15	18.52

In the present study; mortality rate was (n=18, 22.22%) as shown in graph 1.



Graph 1: Mortality among the study subjects

Serum urea showed a statistically significant difference between survivors and non-survivors (p=0.006). But level of Hb, TLC, platelet count and serum creatinine level did not had any significant difference. (graph 2)

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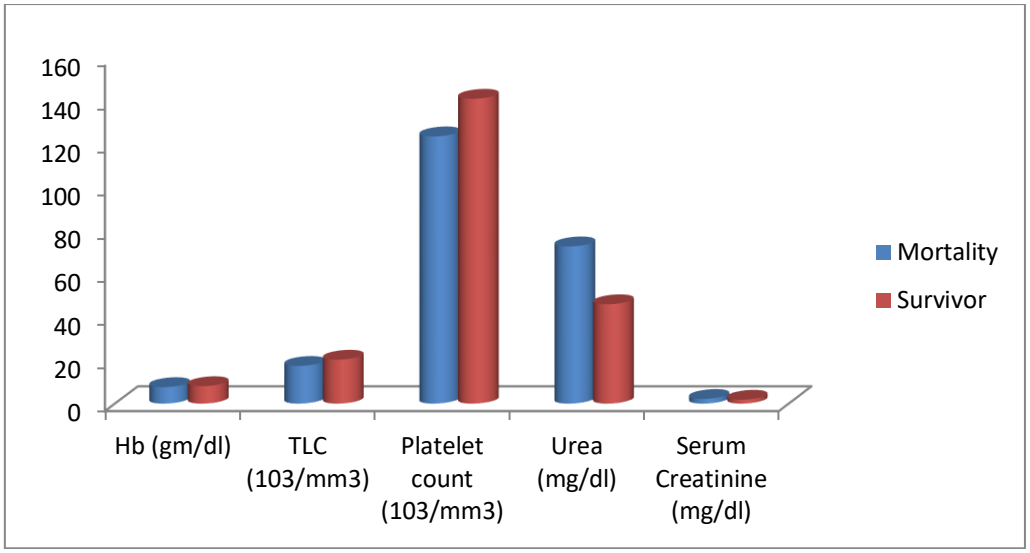

Graph 2: Comparison of investigative profile according to outcome

As depicted in table 2, q SOFA score at day of admission showed a statistically significant difference among survivors and non-survivors (p=0.017).SOFA score at day of admission showed a statistically significant difference among survivors and non-survivors (p=0.002). Total SOS score at day of admission showed a statistically significant difference among survivors and non-survivors (p=0.045).

Table 2: Score at admission according to outcome

Group	q SOFA		SOFA		Total SOS	
	Mean	SD	Mean	SD	Mean	SD
Died	2.05	0.42	12.03	1.77	9.10	1.49
Survived	1.41	0.31	7.08	1.04	7.18	1.23
p value	0.017*		0.002*		0.045*	

*: statistically significant

For our study population, a threshold of SOFA ≥ 6 had the best combination of sensitivity (92.5%) and specificity (66.8%) for critical care admission and maternal mortality. For SOS, a cut-off value of ≥ 6 gave best sensitivity (68.2%) and specificity (60.4%) for the same. qSOFA≥1.7 was far more predictive of patient's critical condition as well as mortality compared to SOS with sensitivity 86.4% and specificity 61.9%. (Table 3)

Table 3: Diagnostic accuracy of SOFA and SOS for critical care admission and maternal mortality in PAS patients

Variables	Sensitivity (%)	Specificity (%)
SOFA≥6	92.5	66.8
SOS≥	68.2	60.4
qSOFA≥1.7	86.4	61.9

DISCUSSION

Obstetric patients in societies with limited resources face a substantial PAS load, making resource allocation hard. The high death rate (32.1%), as well as the high rate of intensive care (52.3%), in PAS patients reflected the severity of sepsis and the pre-admission morbidity of women. The third international consensus on sepsis has defined sepsis as a life-threatening organ dysfunction due to dysregulated response to infection. It has also given the SOFA score which does not give a cut off value to confirm or decline sepsis; rather it gives a prognostic indicator of the ominous outcomes. A SOFA score above 2 predicts a mortality of 10%[9]. This consensus was given based on large data bases. However it excluded pregnancy, which is a unique condition because of the associated physiological and immunological changes and the presence of the fetus which could be thought of as another organ. It is because of these changes in pregnancy that the SOFA score would not be as accurate when predicting mortality outcomes in maternal sepsis[12].

In present study, maximum study subjects were in age range 18-25 years (n=42, 51.85%), followed by 27 (33.33%) between 26-30 years of age and 12 (14.81%) between 31-40 years of age. Majority of the females were multigravida (n=62, 76.54%) and remaining 19 (23.46%) were primigravida. This were same as found by **Agarwal R et al., (2021)**[9] that multigravida constituted 74.6% of study population.

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In a study by **Naz R et al., (2022)**[13], the average age of the patients was 27+2 years.

Most ICU admissions were for non-obstetric causes of sepsis (n=52, 64.2%), the most common being respiratory tract infections (n=37, 45.68%) followed by UTI (n=15, 18.52%).Puerperal sepsis (n=11, 13.58%) was the most frequent cause of obstetric sepsis (n=29, 35.80%) followed by Chorioamnionitis (12.35%), Septic (8.64%) and wound infection (1.23%). These findings were in accordance to results of **Ray A et al., (2021)**[14] who found that maximum ICU admissions were for non-obstetric causes of sepsis, the most common being respiratory tract infections. Puerperal sepsis was the most frequent cause of obstetric sepsis.

Q SOFA score at day of admission showed a statistically significant difference among survivors and non-survivors (p=0.017). SOFA score at day of admission showed a statistically significant difference among survivors and non-survivors (p=0.002). Total SOS score at day of admission showed a statistically significant difference among survivors and non-survivors (p=0.045).These findings were in accordance to results of **Ray A et al., (2021)**[14] who found that a significant association (p< 0.001) between mortality and the SOFA. The qSOFA score was not significantly associated with mortality (p value 0.315).

For our study population, a threshold of SOFA ≥ 6 had the best combination of sensitivity (92.5%) and specificity (66.8%) for critical care admission and maternal mortality. For SOS, a cut-off value of ≥ 6 gave best sensitivity (68.2%) and specificity (60.4%) for the same. qSOFA≥1.7 was far more predictive of patient's critical condition as well as mortality compared to SOS with sensitivity 86.4% and specificity 61.9%. This was in accordance to results of **Agarwal R et al., (2021)**[9] who found that SOFA ≥ 6 had the best combination of sensitivity (84.4%) and specificity (61.3%) for critical care admission. SOFA threshold for maternal mortality was also ≥ 6 with sensitivity and specificity at95% and 63.4%, respectively. For SOS, a cut-off value of ≥ 6 gave best sensitivity (64%) and specificity (40%) for the same. SOFA was far more predictive of patient's critical condition as well as mortality compared to SOS.

Similar were findings of **Naz R et al., (2022)**[13] who found that SOFA 6cutoff gave the optimal combination of sensitivity (83.9% of the time) and specificity (60.9% of the time) for predicting admission to intensive care in study population. Taking this SOS criterion into consideration, however, there was no statistically significant difference between groups.

SOS is a newly developed obstetric scale with few supporting studies. It was developed for use in an emergency department to predict critical care need for women with obstetric sepsis. The score made adjustments for known physiological changes in pregnancy. In the original study of 850 women, SOS ≥ 6 represented a sensitivity 88.9% and specifcity 99.2% for critical care admission with an area under the curve of 0.92. There were just 9 critical care admissions (1.1%) and no mortality in this series. Besides a retrospective study design, a high percentage of missing parameters (23%) was an obvious limitation. In a follow-up validation study of SOS in 425 women, the same researchers found 14 (3.3%) critical care admissions and no maternal deaths. SOS predictive value for critical care admission at threshold of≥6 was sensitivity 64% and specifcity of 84% (AUC 0.85; 95%CI 0.76–0.95)[15].

Aarvold et al[15]. in a retrospective study conducted in various critical care units, evaluated 5 different scales [SOS, APACHEII, SAPSII, SOFA and Multiple Organ Dysfunction Scores (MODS)] for mortality - related outcomes in 146 women with sepsis. An age-matched non-obstetric cohort (n=299) was kept as control. Twenty-eight (19.18%) women died in this series. In the obstetric cohort, the area under the receiver-operator curves for prediction of mortality by SOS, APACHE II, SAPS II, SOFA and MODS scores was 0.67, 0.68, 0.72, 0.79 and 0.84, respectively. In the nonobstetric cohort, the respective values were 0.64, 0.72, 0.61, 0.78 and 0.74. SOFA performed better than SOS in predicting mortality both in obstetric and non-obstetric populations.

Results of our study showed that SOFA, qSOFA and total SOS were significantly associated with mortality and all three thus could be used as good prognostic markers for adverse outcomes in maternal sepsis as well as to guide management. Among the three the SOFA score performs better than the other two. The qSOFA however is more predictive than SOS for maternal mortality and ICU admission. More importantly these scores can be very useful both for evaluating, triaging, guiding management as well as counseling as soon as a case of maternal sepsis arrives to the hospital without having to wait for investigation results.

In terms of predicting obstetric and non-obstetric patient mortality, SOFA exceeded SOS. This was true regardless of pregnancy status. For our patients, SOFA predicted critical care admission and mortality more accurately than pregnancy-specific SOS. SOFA really outperformed SOS. Using diagnostic scales with caution can assist identify women at risk and propose additional surveillance or preventive. This could be achieved by supporting surveillance and prevention. In a premorbid situation with a high mortality rate, our study revealed that the SOFA score could predict admission to intensive care and mortality rates for PAS patients. It accurately predicted admission to intensive care. Using a common scale, obstetric and non-obstetric sepsis patients can be triaged or assigned intensive care beds in an emergency. Standard scales can accomplish these objectives. SOS should be evaluated at an

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obstetric facility with a comparable patient population.

LIMITATIONS

Unlike other studies which have considered adverse outcomes in all obstetric critical care cases this study has specifically outlined its findings for cases of maternal sepsis using the validated sepsis scores. This study has the limitations of being a single centric study with a small number of patients. Predictability may have been affected by this.

CONCLUSION

SOFA was best to decide critical care admission and predict mortality in pregnancy-associated sepsis when tested in a severe morbidity and high mortality clinical setting. The qSOFA however is more predictive than SOS for maternal mortality and ICU admission. Compared to SOS, SOFA produced a significantly more accurate forecast of both the patient's dire health and the likelihood of their death.

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