Original Article

DOI: 10.7860/JCDR/2024/72694.20377

Role of Sepsis in Obstetric Score (SOS) to identify severe sepsis in pregnant women requiring ICU admission: A prospective observational study

Obstetrics and Gynaecology Section

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ABSTRACT

Introduction: Sepsis is a life-threatening organ dysfunction caused by a dysregulated host response to infection. Obstetric sepsis is a significant contributor to maternal and perinatal morbidity and mortality, especially in low-income countries. Several scoring systems can help in identifying sepsis and its severity; however, their application in the obstetric population is not well-defined because of the altered physiology of pregnancy. The Sepsis in Obstetrics Score (SOS) is designed specifically for the obstetric population to identify the likelihood of the need for critical care admission for the obstetric population presenting with signs of sepsis.

Aim: To determine whether the SOS can be used to identify the severity of sepsis.

Materials and Methods: This was a prospective observational time-bound study conducted at Gandhi Hospital, Secunderabad, Hyderabad, Telangana, India over six months from February 2023 to July 2023 on 100 subjects that included pregnant women, postpartum women within six weeks, and postabortal women within two weeks of abortion with suspected obstetric sepsis presenting to Gandhi Hospital. SOS score was calculated for all study participants and grouped into scores of <6 and ≥6. Organ failure was assessed. SOS score was associated with culture positivity, organ involvement, need for critical care support, and the severity of sepsis. Data were analysed using Statistical Packages for Social Sciences (SPSS) software, and appropriate statistical tests were applied; the p-value for significance was set at 0.05.

Results: The mean age of the study population was 25.48±5.13 years. Out of 100 women with obstetric sepsis, 50% had severe sepsis, graded by the presence of organ failure. When the cut-off score was considered as 6, SOS score had a sensitivity of 64% and specificity of 84%, a Positive Predictive Value (PPV) of 80.0%, a Negative Predictive Value (NPV) of 70.0%, and a diagnostic accuracy of 74.0% to detecting severe sepsis.

Conclusion: The findings emphasised the utility of the SOS score as a valuable tool for assessing the severity of illness, predicting outcomes, and guiding clinical management.

Keywords: Intensive care unit, Organ failure, Pregnancy-associated sepsis, Sepsis scores

INTRODUCTION

Maternal sepsis, as defined by the World Health Organisation (WHO), is a life-threatening condition defined as organ dysfunction resulting from infection during pregnancy, childbirth, post-abortion, or the postpartum period [1]. Maternal infections around the time of childbirth account for about one-tenth of the global burden of maternal mortality and are also associated with an estimated 1 million newborn deaths annually [2], making obstetric sepsis a significant contributor to maternal and perinatal morbidity and mortality, especially in low- and middle-income countries. Pregnancy-related infections are the second most common cause of maternal death in India [3].

Several scoring systems like Sequential Organ Failure Assessment (SOFA), quick SOFA (qSOFA), Modified Early Warning Score (MEWS), and Rapid Emergency Medicine Score (REMS), etc., were defined for identify sepsis and its severity However, the application of these systems in the obstetric population is not well-defined because of the altered physiology of pregnancy. Standardising the criteria for maternal sepsis optimises clinical audits and research, that may facilitate the evaluation of the role of different clinical parameters and biomarkers in the diagnosis, earlier recognition, and management of maternal infection and sepsis [4]. Delays in the diagnosis and management of sepsis may lead to multiple organ failure, septic shock, and even death.

Albright CM et al., described the SOS score, designed specifically for the obstetric population, to identify the likelihood of the need for critical care admission for obstetric population who presented with signs of sepsis [5]. The SOS score modifies parameters from the REMS, as well as the sepsis criteria defined by the Surviving Sepsis Campaign [6], in accordance with well-known physiological changes in pregnancy. It recommends critical care support for patients with severe sepsis or septic shock who experience persistent hypotension despite fluid resuscitation, multiple organ dysfunction, or a high risk of rapid deterioration. Patients requiring advanced interventions, like vasopressors or continuous renal replacement therapy, also need critical care [7]. Existing scoring systems have limited validation in obstetric populations.

With this background, the present study was conducted with the aim of determining whether SOS can be used to identify the severity of sepsis, to associate the SOS score with culture positivity in obstetric sepsis and to determine whether the SOS score could predict the need for critical care support.

MATERIALS AND METHODS

The present study was a time-bound prospective observational study, conducted at Gandhi Hospital, Secunderabad, Hyderabad, Telangana, India done over six months from Febraury 2023 to July 2023, after approval from the Institute's Ethical Committee (IEC/GMC/2022/11/13). A hundred subjects were included in the study with the following criteria:

Inclusion criteria: All singleton pregnant women, postabortal within two weeks, and postpartum women within six weeks with suspected obstetric sepsis, according to the Systemic Inflammatory Response Syndrome (SIRS) criteria [Table/Fig-1] [6], presenting to Gandhi Hospital were included in the study.

Findings	Value
Temperature	<36 °C (96.8 °F) or >38°C (100.4 °F)
Heart rate	>90/min
Respiratory rate	>20/min or $PaCO_2$<32 mmHg.
WBC	<4×10^9/L (<4000/mm^3), >12×10^9/L (>12,000/mm^3), or ≥10% bands

[Table/Fig-1]: Systemic Inflammatory Response Syndrome (SIRS) criteria [6].
WBC: White blood cells

Exclusion criteria: Multifoetal pregnancy, ectopic pregnancy, molar pregnancy, and pre-existing organ failure were excluded from the study.

Study Procedure

All obstetric women fulfilling the inclusion criteria (i.e., ≥2 criteria of SIRS) attending study Institute were labelled as having obstetric sepsis and were taken for study. Detailed history, clinical examination, and laboratory investigations were performed. Blood cultures, urine cultures, genital swabs, and wound swabs (when applicable) were sent for culture and sensitivity. SOS score was obtained by clinical and laboratory parameters, with a maximum score of 28 can be obtained from SOS [Table/Fig-2]. The subjects were divided into two groups based on SOS: <6 and ≥6. The cut-off of six was taken in the context of the previous study by Agarwal R et al., [8]. Organ failure was assessed by certain parameters [Table/Fig-3] [9]. Severe sepsis is defined as infection-related organ dysfunction or tissue hypoperfusion within 24 hours of admission. Non severe sepsis involves at least one organ dysfunction (e.g., mild changes in blood pressure, respiratory rate, or kidney function) but does not meet the criteria for severe organ dysfunction or acute organ failure. Patients with non severe sepsis typically do not have persistent hypotension [10]. The association of the SOS was done with organ involvement, need for critical care support, and severity of sepsis.

STATISTICAL ANALYSIS

Data were entered into Microsoft Excel (Windows 7; Version 2007), and analyses were performed using the SPSS for Windows software (version 22.0; SPSS Inc, Chicago). Descriptive statistics such as mean and Standard Deviation (SD) were calculated for continuous variables. Frequencies and percentages were calculated for categorical variables. The association between variables was analysed using the Chi-square test for categorical variables. The unpaired t-test was used to compare the means of continuous variables between study groups. The level of significance was set at 0.05.

RESULTS

A total of 60% subjects had <6 SOS and 40% ≥6 SOS. The mean age of study subjects with an SOS score <6 was 25.48±5.13 years. There was no significant association between age and SOS score. The association between pregnancy status and SOS score was statistically significant. Among the subjects, 69.2% of antepartum subjects, 58.3% of post-abortive subjects had an SOS score of ≥6 [Table/Fig-4]. There was a significant association between clinical and biochemical parameters and the SOS score [Table/Fig-5]. Organ involvement was observed in 50% of the study subjects, with at least one organ affected. The majority of severe sepsis cases had renal involvement (30.9%) [Table/Fig-6].

Blood culture was positive in 39% of subjects, with *Staphylococcus* being the most common bug. Urine culture was positive in 40% of subjects, with E. coli being the most common organism, followed by *Klebsiella*. Vaginal swabs were positive in 38% of subjects, with Candida being the most commonly isolated organism. In six subjects with wound gaps, Methicillin-resistant Staphylococcus aureus (MRSA) culture was positive [Table/Fig-7].

There was a significant association between the SOS score and the need for critical care support. The need for inotropic support, transfusions, and ventilatory support was most commonly needed with higher SOS scores. It was observed that 10 out of 11 cases requiring dialysis had SOS scores of ≥6 [Table/Fig-8].

Among the 18 deceased individuals, 8 (13%) had SOS scores <6, while 10 (25%) had SOS scores ≥6, with a significant association between mortality and SOS scores [Table/Fig-9]. When the SOS score of 6 was used as a cut-off, it had a sensitivity of 64%, specificity of 84%, and diagnostic accuracy of 74% [Table/Fig-10].

Variables	High abnormal range				Normal	Low abnormal range			
Score	+4	+3	+2	+1	0	+1	+2	+3	+4
Temperature (°c)	>40.9	30-40.9		38.5-38.9	36-38.4	34-35.9	32-33.9	30-31.9	<30
SBP (mmHg)					>90		70-90		<70
Heart rate (beats per minute)	>179	150-179	130-149	120-129	≤119				
Respiratory rate (breaths per minute)	>49	35-49		25-34	12-24	10-11	6-9		≤5
SpO_2 (%)					≥92	90-91		85-89	<85
White blood cell count (103/mm^3)	>39.9		25-39.9	17-24.9	5.7-16.9	3-5.6	1-2.9		<1
Immature neutrophils (%)			≥10		<10				
Lactic acid (mmol/L)			≥4		<4				

[Table/Fig-2]: Sepsis in Obstetrics score (SOS).
SBP: Systolic blood pressure

Organ system	Features of failure
Pulmonary	• Arterial hypoxemia (PaO_2/FiO_2<300 mmHg)
Cardiac	• Increased capillary refill time or mottling • Arterial hypotension (SBP <90 mmHg, MAP <70, or an SBP decrease >40 mmHg)
Renal	• Acute oliguria (urine output <0.5 mL/kg/hr for atleast 2 h) • Creatinine increase more than 0.5 mg/dL in 24 h period
Hepatobiliary	• Coagulation abnormalities (INR >1.5 or aPTT >60 s) Ileus (absent bowel sounds) • Thrombocytopenia (platelet count <100000/μL) • Hyperbilirubinemia (plasma total bilirubin >4 mg/dL)
Neurological	• Abnormal Glasgow coma score (<13)

[Table/Fig-3]: Clinical parameters suggesting organ involvement [8].
INR: International normalised ratio; aPTT: activated partial thromboplastin time; Pao2: Partial pressure of oxygen; Fio2: Fraction of inspired oxygen; MAP: Mean arterial pressure

DISCUSSION

The present study observed a distribution of SOS scores, with 60% of subjects having SOS scores <6 and 40% having SOS scores ≥6. This distribution reflects the severity of illness among the study population, with a significant proportion exhibiting higher SOS scores. There was no significant association between demographic

Demographic factors		SOS score <6 n (%)	SOS score ≥6 n (%)
Age (years)	≤20	12 (85.7)	2 (14.3)
	21-25	19 (47.5)	21 (52.5)
	26-30	23 (67.6)	11 (32.4)
	>30	6 (50.0)	6 (50.0)
	Mean±SD	25.48±5.13	25.98±5.02
	Median	25.0	24.0
	Unpaired t-test, p-value=0.637, Not significant		
Pregnancy status	Pregnant	4 (30.8)	9 (69.2)
	Postabortal	5 (41.7)	7 (58.3)
	Postpartum	51 (68.0)	24 (32.0)
	Chi square test, p-value=0.015, Significant		
Gestational age (weeks)	20-28	2 (66.7)	1 (33.3)
	28-34	1 (50.0)	1 (50.0)
	34-40	1 (20.0)	4 (80.0)
	>40	-	3 (100.0)
	Chi square test, p-value=0.287, Not significant		
Mode of delivery	LSCS	35 (58.3)	19 (47.5)
	Vaginal	12 (20.0)	9 (22.5)
	Mediolateral Episiotomy	10 (1.7)	12 (30)
	Hysterotomy	2 (3.3)	-
	Outlet forceps	1 (1.7)	-
	Chi-square test, p-value=0.608, Not Significant		

[Table/Fig-4]: Demographic factors and SOS Score (N=100).
LSCS: Lower segment caesarean section; LMLE: Left mediolateral episiotomy

Vitals		SOS score <6 Mean±SD	SOS score ≥6 Mean±SD	p-value
SBP (mmHg)		115.00±15.89	91.00±13.73	<0.001*
HR (beats per minute)		99.07±18.54	114.53±12.16	<0.001*
RR (breaths per minute)		19.87±2.69	22.78±4.17	<0.001*
SpO_2 (%)		97.22±4.23	95.53±5.62	0.005
Temperature (°C)		37.2±3.81	38.1±4.12	<0.001*
WBC (thousand)		13.44±6.35	26.57±12.05	0.001*
Immature neutrophils (%)		4.91±5.72	11.71±6.40	<0.001*
Lactate levels (mmol/L)	<4	36±60.0	5±12.5	<0.001*
	≥4	24±40.0	35±87.5	
Number of SIRS criteria met	2	14±31.8	2±5.0	<0.001*
	3	30±68.2	23±57.5	
	4	-	15±37.5	
	* Significant			

[Table/Fig-5]: Association between clinical and biochemical parameters and SOS score (N=100).
HR: Heart rate; RR: Respiratory rate; SBP: Systolic blood pressure

Organ involvement		SOS score <6 n (%) (n=28)	SOS score ≥6 n (%) (n=68)
Types of organ failure (n=96)	CNS	3 (10.7)	10 (14.7)
	CVS	3 (10.7)	13 (19.1)
	Respiratory	2 (7.1)	6 (8.8)
	Renal	11 (39.2)	21 (30.9)
	Hepatobillary	9 (32.1)	18 (26.4)
	Chi-square test, p-value=0.005, Significant		
		SOS score (<6)	SOS score (≥6)
		(n=18)	(n=32)
No. of organ failure (n=50)	1	11 (61.1)	13 (40.6)
	2	4 (22.2)	6 (18.8)
	3	3 (16.7)	10 (31.3)
	4	-	2 (6.3)
	5	-	1 (3.1)
	Chi-square test, p-value=0.005, Significant		

[Table/Fig-6]: Organ involvement and SOS score.
CNS: Central nervous system; CVS: Cardiovascular system

Variables	Culture Frequency	Culture Percentage
Blood culture	39	39.0
Staphylococcus	14	35.9
Klebsiella	11	28.2
Citrobacter	6	15.4
Acinetobacter	8	20.5
Urine culture	40	40.0
E-coli	29	72.5
Klebsiella	5	12.5
Yeast	1	2.5
Insignificant bacteria	5	12.5
Vaginal swab	38	38.0
E-coli	8	21.1
Staphylococcus	5	13.2
Candida	25	65.8
Wound site swab	6	100.0
MRSA	4	66.7
Klebsiella	1	16.7
Acinetobacter	1	16.7

[Table/Fig-7]: Distribution of different types of cultures done and organisms identified (N=100).

Variables	SOS score <6 n (%)	SOS score ≥ 6 n (%)
Ionotrope support		
Yes	8 (13.3)	17 (42.5)
No	52 (86.7)	23 (57.5)
Chi-square test, p-value=0.001, Significant		
Dialysis		
Yes	1 (1.7)	10 (25.0)
No	59 (98.3)	30 (75.0)
Chi-square test, p-value <0.001, Significant		
Ventilator		
Yes	8 (13.3)	14 (35.0)
No	52 (86.7)	26 (65.0)
Chi-square test, p-value=0.010, Significant		
Transfusions		
Yes	26 (43.3)	27 (67.5)
No	34 (56.7)	13 (23.5)
Chi-square test, p-value=0.017, Significant		

[Table/Fig-8]: Association between need for critical care support and SOS score (N=100).

factors and SOS score in the present study, contradicting the findings of Bauer ME et al., which demonstrated that age >35 years is an independent risk factor for sepsis [11]. The significant association between pregnancy status and SOS score suggests that pregnant individuals may have varying degrees of illness severity, with antepartum and postabortal subjects exhibiting higher SOS scores compared to postpartum subjects. This is similar to a study

Outcomes		SOS score <6 n (%)	SOS score ≥6 n (%)
Patient outcome	Death	8 (13.3)	10 (25.0)
	Alive	52 (86.7)	26 (65.0)
	LAMA	-	2 (5.0)
	Absconded	-	2 (5.0)
	Chi-square test, p-value-0.026 Significant		
Neonatal outcome	Alive (n=65)	48 (73.8)	17 (26.1)
	Death (n=23)	10 (43.4)	13 (56.5)
	Chi-square test, p-value-0.005 Significant		

[Table/Fig-9]: Outcomes and SOS score (N=100).
LAMA: Leave against medical advice

Severity of sepsis	SOS score <6 n (%)	SOS score ≥6 n (%)
Non severe sepsis	42 (70.0)	8 (20.0)
Severe sepsis	18 (30.0)	32 (80.0)
Chi-square test, p-value <0.001, Significant, Sensitivity= 64.0%, Specificity= 84.0%, Positive predictive value= 80.0% Negative predictive value= 70.0% Diagnostic accuracy= 74.0%		

[Table/Fig-10]: SOS score and it's validity in severe sepsis.

by Champagne HA and Garabedian MJ, in which most patients (71%) developed sepsis intrapartum [12].

Increasing SOS scores were associated with meeting a higher number of SIRS criteria and experiencing organ failure, similar to study by Champagne HA and Garabedian MJ [12]. This indicates that SOS score effectively reflects the severity of illness and the extent of physiological derangement. The calculated sensitivity (64.0%), specificity (84%), PPV: 80.0%, NPV: 70.0%, and diagnostic accuracy (74.0%) were similar to the findings of Agarwal R et al., who reported a sensitivity of 68.9%, specificity of 80.9%, PPV of 83%, and NPV of 65% in predicting severe sepsis [8].

Culture positivity did not associate with the SOS score in our study. This was similar to the study by Agarwal R et al., where overall culture positivity rate (any culture positive) of 35% of subjects with pregnancy-associated sepsis [8]. The distribution of positive cultures provides insight into the prevalence of different pathogens in various clinical conditions, aiding in the development of appropriate treatment strategies and infection control measures. A significant association was observed between interventions like ionotrope support (42.5%), ventilator support (35%), and the need for transfusion (67.5%) and high SOS scores. This is similar to the study by Anwari JS et al., in which ventilatory support was required by 36% of patients, inotropic support by 9%, and blood (and its products) was given to 46% of patients [13].

The present study showed 25% maternal mortality rate and a 35% neonatal deaths with higher SOS scores. This highlights the prognostic value of the SOS score in predicting maternal and perinatal outcomes. Similar findings from a study by Stephens A et al., showed patients with a higher SOS score had five times more adverse maternal outcomes [14].

Limitation(s)

A limitation of present study is its smaller sample size. Author recommended further validation on larger sample size to bring the SOS score into routine clinical practice.

CONCLUSION(S)

In conclusion, the present study emphasises the utility of the SOS score as a valuable tool for assessing the severity of illness, predicting outcomes, and guiding clinical management. Further research and validation of SOS scoring systems are warranted to enhance their utility and effectiveness in clinical practice.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: May 09, 2024
- Manual Googling: Sep 24, 2024
- iThenticate Software: Sep 26, 2024 (16%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **May 08, 2024**
Date of Peer Review: **Jul 25, 2024**
Date of Acceptance: **Sep 28, 2024**
Date of Publishing: **Dec 01, 2024**