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## CLINICAL ARTICLE

Use of the Sequential Organ Failure Assessment score for evaluating outcome among obstetric patients admitted to the intensive care unit<sup>☆</sup>Shruti Jain<sup>a,\*</sup>, Kiran Guleria<sup>a</sup>, Amita Suneja<sup>a</sup>, Neelam B. Vaid<sup>a</sup>, Sharmila Ahuja<sup>b</sup><sup>a</sup> Department of Obstetrics and Gynaecology, University College of Medical Sciences and Guru Teg Bahadur Hospital, Delhi, India<sup>b</sup> Department of Anaesthesiology and Critical Care, University College of Medical Sciences and Guru Teg Bahadur Hospital, Delhi, India

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## ABSTRACT

**Objective:** To evaluate the prognostic value of the Sequential Organ Failure Assessment (SOFA) score among obstetric patients admitted to the intensive care unit (ICU). **Methods:** A prospective study was conducted among 90 consecutive obstetric patients who were admitted to the ICU of Guru Teg Bahadur Hospital, Delhi, India, between October 6, 2010, and December 25, 2011. Maximum SOFA score was calculated for each of the six organ systems. Receiver operating characteristic curves were used to determine critical cutoff values for total, maximum total, and mean total SOFA scores at various time points. **Results:** Total SOFA score at admission displayed an area under the curve (AUC) of 0.949, a cutoff value of at least 8.5, sensitivity of 86.7%, and specificity of 90.0%. Maximum total SOFA score had an AUC of 0.980, a cutoff value of at least 10.0, sensitivity of 96.7%, and specificity of 90.0%. Mean total SOFA score had an AUC of 0.997, a cutoff value of at least 9.0, sensitivity of 96.7%, and specificity of 96.7%. **Conclusion:** In terms of discriminatory power for predicting mortality among obstetric patients admitted to the ICU, total SOFA score at admission was the most relevant, simple, and accurate measure.

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## 1. Introduction

Maternal mortality has long been used as a quality indicator for national health care. However, given declining maternal mortality rates and the need to understand health-system failures, two additional indicators of obstetric care have been introduced: maternal morbidity and the ratio of severe maternal morbidity to mortality [1,2].

Estimates suggest that for each maternal death that occurs there are approximately 118 cases of severe maternal morbidity [3]. Various methods have been defined by WHO to assess near-miss cases, including evaluation of obstetric admissions to the intensive care unit (ICU) [4–6]. Nevertheless, data regarding ICU admissions are lacking [7,8]. Notably, there is a knowledge gap about reliable scoring tools for classifying condition severity and mortality risk among women who are admitted to the ICU with severe maternal morbidity. The availability of such information would aid patient management, allocation of resources, counseling of families, and monitoring of risk stratification and quality of care [9].

Some investigators have used scoring tools designed for the general population, such as Acute Physiology and Chronic Health Evaluation II (APACHE II) and Simplified Acute Physiology Score II (SAPS II), among obstetric patients. However, these scores overestimate maternal mortality [10–14]. The Sequential Organ Failure Assessment (SOFA) score evaluates illness severity on the basis of the degree of organ dysfunction [15]. Although the SOFA score has been extensively studied in the general population, few studies have been conducted in the obstetric population. By comparison with APACHE II and SAPS II, which evaluate only the first 24 hours of an ICU stay, the SOFA score can be evaluated daily in the ICU. Thus, the SOFA score can quantify changes in the clinical situation. Additionally, the SOFA score can be easily used in resource-limited setting because it involves few variables that are routinely measured in every institution [16].

The aim of the present study was to evaluate the ability of the SOFA score to distinguish between survivors and non-survivors among near-miss and severe maternal morbidity cases admitted to the ICU.

## 2. Materials and methods

A prospective study was conducted between October 6, 2010, and December 25, 2011, at the University College of Medical Sciences and Guru Teg Bahadur Hospital, Delhi, India. All consecutive obstetric admissions to the ICU during the present study period were enrolled. Obstetric admissions included pregnant women and women up to 42 days after termination of pregnancy (spontaneous or induced abortion, ectopic/molar pregnancy termination, and delivery). Approval

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for the present study was obtained from the institutional ethical committee of the University College of Medical Sciences. Written informed consent was obtained either directly from patients who remained conscious or from a relative or attendant of unconscious patients.

Guru Teg Bahadur Hospital is a government tertiary care teaching hospital and referral center for a large catchment area in East Delhi and the National Capital Region of India. The hospital has a general ICU with six beds and a trauma ICU with a further six beds. Together, these two units provide care for approximately 800 patients each year, including obstetric cases. An obstetric ICU designed specifically for pregnant and postpartum women is not available.

The ICU team comprised a senior resident and a junior resident from the Department of Anaesthesiology and Critical Care, plus six nurses. The team was supervised by a consultant intensive care physician. Formulation of the plan for treatment and management of clinical complications was managed jointly by the ICU and obstetric teams (a senior resident and a consultant from the Department of Obstetrics and Gynaecology). Decisions regarding surgical interventions, including the mode and time of delivery, were made by the obstetric team.

Details were noted from the case sheet regarding previous obstetric and medical history, prenatal care, treatment received before hospital admission, delays in reaching hospital, physical examination at the time of hospital admission, and investigations and treatment provided in the hospital before admission to the ICU. All data were recorded using a predesigned form.

Patients were examined in the ICU by both an obstetrician and an anesthetist. The SOFA score was calculated daily by S.J. As shown in Table 1, the SOFA score rates six organ systems (respiratory, hematological, hepatic, cardiovascular, central nervous system, and renal) on a scale of 0–4. A score of 3 or greater is indicative of organ failure and so has a poor prognosis. Total SOFA score at admission, maximum total SOFA score, and mean total SOFA score were derived from the SOFA scores for individual organ systems. Total SOFA score at admission was calculated as soon as the patient was admitted to the ICU. All participants were followed-up daily, with progress, critical events, and any interventions recorded. Mean total SOFA score and maximum total SOFA score were calculated at time of discharge from the ICU or death.

The sample size was based on a preliminary survey conducted from January 1 to July 31, 2010. During this time, there were 47 obstetric admissions to the ICU, with a mortality rate of 33.3%. Taking this mortality rate ( $\pm 10\%$ ) and a 95% confidence interval, an optimum sample size of 90 was obtained.

Data were analyzed using SSPS version 17.0 (IBM, Armonk, NY, USA). Receiver operating characteristic curves were used to calculate the critical cutoff values of total SOFA scores and individual organ

system SOFA scores. The Mann–Whitney nonparametric test for independent samples was used to describe mean SOFA scores and standard deviations for each organ system. Sensitivity, specificity, and the area under the curve (AUC) were evaluated for each organ system. Sociodemographic characteristics were analyzed using the Fisher exact test.  $P < 0.05$  was considered statistically significant.

### 3. Results

In all, there were 22 547 obstetric admissions to Guru Teg Bahadur Hospital and 15 775 deliveries during the present study period. Of these, 90 (0.4%) women were admitted to the ICU, three during the prenatal period and 87 after delivery. Total admissions to the ICU were 949; therefore, obstetric patients comprised 9.4% of all admissions during the present study period. Because only three pregnant patients were enrolled, no distinction could be made when evaluating mortality.

Obstetric illnesses ( $n = 77$ ; 86%) were more frequent than non-obstetric illnesses ( $n = 13$ ; 14%). Hypertensive ( $n = 37$ ; 41%) and hemorrhagic disorder ( $n = 26$ ; 29%) were the most common conditions leading to ICU admission, followed by sepsis ( $n = 8$ ; 9%) and labor complications ( $n = 6$ ; 7%). Sociodemographic characteristics are shown in Table 2.

For the purposes of SOFA score analysis, participants were divided into two groups. The survivors group ( $n = 60$ ; 67%) included patients who had recovered, whereas the non-survivors group ( $n = 30$ ; 33%) included those who had died. Use of inotropic support was significantly more common among non-survivors than among survivors ( $P = 0.001$ ) (Table 2).

Total SOFA score at admission was compared for both groups and found to exhibit excellent predictability for mortality (AUC = 0.949; Fig. 1). Various cutoff points for total SOFA score at admission as predictors of mortality are shown in Table 3. A cutoff value of 9.0 or higher exhibited sensitivity of 86.7% and specificity of 90.0%.

The maximum value of the total SOFA score during the entire ICU stay was calculated for each patient. If this score reached 10 at any time during the ICU stay, it predicted mortality with a sensitivity of 96.7% and a specificity of 90.0%. The discriminatory power of the mean total SOFA score was also found to be excellent. A mean total SOFA score of at least 9 exhibited 96.7% sensitivity and 96.7% specificity for prediction of maternal mortality in the ICU (AUC = 0.997).

Maximum SOFA score was calculated for each of the six organ systems, using the worst value of each variable recorded during the entire period that the patient remained in the ICU. Analysis of organ dysfunction according to maximum SOFA score indicated that high scores correlated with maternal mortality (Fig. 2).

**Table 1**  
Components of the Sequential Organ Failure Assessment score, by organ system.

Variable	Score				
	0	1	2	3	4
Respiratory					
PaO <sub>2</sub> /FiO <sub>2</sub> , mm Hg	>400	301–400	201–300	101–200	≤100
Hematological					
Platelet count, 10 <sup>3</sup> /μL	>150	101–150	51–100	21–50	≤20
Hepatic					
Serum bilirubin, mg/dL	<1.2	1.2–1.9	2.0–5.9	6.0–11.9	>12.0
Cardiovascular					
Hypotension	None	Mean arterial pressure <70 mm Hg	Dopamine <5 μg/kg/min or dobutamine (any dose)	Dopamine >5 μg/kg/min; epinephrine <0.1 μg/kg/min; norepinephrine ≤0.1 μg/kg/min	Dopamine >15 μg/kg/min; epinephrine >0.1 μg/kg/min; norepinephrine >0.1 μg/kg/min
Central nervous system					
Glasgow Coma Scale <sup>a</sup>	15	13–14	10–12	6–9	<6
Renal					
Serum creatinine, mg/dL	<1.2	1.2–1.9	2.0–3.4	3.5–4.9	>5.0
Urine output, mL/24 h	NA	NA	NA	<500	<200

Abbreviations: PaO<sub>2</sub>/FiO<sub>2</sub>, arterial oxygen tension/inspired oxygen fraction; NA, not applicable.

<sup>a</sup> Patients given motor, verbal, and eye-opening scores. The sum of the resulting scores gives a total score between 3 (indicating deep unconsciousness) and 15 (fully alert).

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