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Sofa scoring tool for prediction of outcome in obstetric ICU at a tertiary care centre

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Introduction: Maternal deaths are defined by the WHO as the death of a woman while she is pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes. The Sequential Organ Failure Assessment (SOFA) score is one of the tools to evaluate the degree of organ failure in the patients leading to morbidity or mortality. **Aims and Objectives**: To validate that SOFA score can be used to know the prognosis of patients in obstetric ICU and to decide treatment accordingly. **Materials and Methods:** Organ failure was evaluated according to the maximum score for each one of its six components and the total SOFA score was calculated. The study was conducted in the Dept of Obstetrics and Gynaecology, Medical college and SSG Hospital, Baroda from 1st September 2017 to 31st August 2018. **Result:** The SOFA score trend in the patients who recovered showed a significant decrease with respect to time whereas the SOFA score trend in the patients who expired showed a significant increase. Interpretation of the area under the ROC curve showed that the performance of the total maximum SOFA score was excellent (AUC 0.972; 95% CI: 0.917 to 0.995). **Conclusion:** Total SOFA score proved to be an effective tool for evaluating the severity and estimating prognosis in obstetric ICU.

Keywords: Maternal mortality, Obstetric ICU, SOFA Score

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Introduction

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Maternal deaths are defined by the WHO as the death of a woman while she is pregnant or within 42 days of termination of pregnancy, irrespective of the duration and the site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes [1].

As per the latest Registrar General of India- Sample Registration System (RGI-SRS) Report (Special Bulletin on Maternal Mortality in India 2014-16); the Maternal Mortality Ratio (MMR) of India is 130 per 100,000 live births [2]. Critically ill obstetric patients management is challenging due to the presence of a fetus, altered physiology of mother, and presence of disease-specific to pregnancy [3].

In developed countries, pregnant patients account for a small number of ICU admissions (2%), but in developing countries like India they reach up to 10% or more [3,4]. The two main indications contributing to admission in obstetrics ICU are hypertensive disorders (17.2% - 46%) and massive haemorrhage (10% - 32.8%) worldwide [5].

In Indian obstetric ICU admissions due to neurologic failure is the most common (63%) followed by hematologic (56%), renal (49%), respiratory (46%), cardiovascular (38%) and hepatic failure (36%) [6].

Scores traditionally used in ICUs, such as the Acute Physiology and Chronic Health Evaluation II (APACHE II), Mortality Probability Models (MPMs), and the Simplified Acute Physiology Score II (SAPS II) [7], when used in obstetric patients had conflicting results, generally overestimating the severity of illness and maternal mortality. Among these methods used in ICU, those scores which evaluated organ dysfunction appeared to have greater sensitivity and specificity [8].

The Sequential Organ Failure Assessment (SOFA) score assess the degree of organ system dysfunction of a patient. This score has a score for each of six major organ systems of our body on a scale of 0 to 4 depending on the severity and thus calculates the total score on each day of stay of the patient in ICU.

Aims and objectives

To validate that SOFA score can be used to know the prognosis of patient in obstetric ICU and to decide treatment accordingly

Methodology

Study Setting: Clinical setting in Obstetric ICU (SSG Hospital, Baroda)

Study Population: Women admitted to the obstetric ward ICU and the labour room of Ob-Gyn department in morbid conditions during pregnancy or up to 42 days postpartum requiring ICU admission.

Study Duration: 1st September 2017 to 31st August 2018.

Study Design: Hospital-based Prospective Study

Sample size: 100 cases

(Average admission satisfying the inclusion criteria of this study in obstetric ICU in SSG Hospital is 8 to 10 admissions per month)

Inclusion criteria: Subjects were included if they were admitted during pregnancy or up to 42 days postpartum requiring ICU admission satisfying the criteria as follows-

Major haemorrhage
01. Antepartum haemorrhage

02. Atonic postpartum haemorrhage

03. Traumatic postpartum haemorrhage

04. Others

-Preeclampsia

-Eclampsia

-HELLP syndrome

-Amniotic fluid embolism

-Sepsis of pelvic origin

Data collection procedure- Each patient was examined; general information and obstetric history of the patient were taken which was followed by evaluating indication of obstetric ICU admission and associated co-morbid conditions.

Presenting complaints during admission with duration was also noted and SOFA Score was calculated; on admission, 12 hours after admission and 24 hourly during ICU stay. All data elements required for the calculation of the SOFA score (Table 1) were prospectively collected on standardized forms and entered into a prescribed sheet/proforma for analysis.

Table-1: SOFA score [9]- The Sequential Organ Failure Assessment (SOFA) score to assess the degree of organ system dysfunction of a patient. This score has a score for each of six major organ systems of our body on a scale of 0 to 4 depending on the severity and thus calculates the total score on each day of stay of the patient in ICU.

Variables	0	1	2	3	4
Respiratory PaO2/FiO2 mm hg	>400	<=400	<=300	<=200	<=100
Coagulation Platelets X10*3/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
Cardiovascular Hypotension	No hypotension	Mean arterial pressure<70 mm hg	Dopamine<=5 or Dobutamine any dose(microgm/kg)	Dopamine>5 or Epinephrine<=0.1 or Norepinephrine<=0.1(microgm/kg)	Dopamine>15 or Epinephrine>0.1 or Norepinephrine>0.1 (microgm/kg)
Central nervous system Glasgow coma scale	15	13-14	10-12	6-9	<6
Renal Creatinine (mg/dl) Urine output (ml/dl)	<1.2	1.2-1.9	2.0-3.4	3.5-4.9 or <500	>5.0 or <200

Apart from this, ICU interventions are done and associated ICU complications were also noted. This SOFA score was a measure of the dysfunction in six organ system viz Respiration, coagulation, liver, cardiovascular, CNS and Renal function. The minimum SOFA Score was 0 and the maximum was 24.

Mean arterial blood pressure was calculated using the following formula.

$$Mean\ Arterial\ Pressure = Diastolic\ Pressure + \left(\frac{1}{3} \times Pulse\ Pressure\right)$$

$$Pulse\ Pressure = Systolic\ Pressure - Diastolic\ Pressure$$

The partial pressure of oxygen was obtained from Arterial blood gas analysis (ABG).

In obstetric ICU of SSG hospital; when nasal cannula was used the formula to calculate Fraction of inspired oxygen was -

FiO2=20+(Flow Rate(L/m) × 4)

The partial pressure of oxygen was obtained from arterial blood gas analysis.

In some cases, evaluation of the neurological system by Glasgow Coma scale scoring was impossible due to the use of continuous sedation. In these situations, the parameters were assumed to be normal and normal values for the variable were used for calculation of the SOFA score.

Ethics Statement: Approved

Institutional Ethics Committee for Human Research (IECHR)

Dated-18/9/2017

EC Reg No.-ECR/85/Inst/GJ/2013/RR-16

Data Analysis

Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. The normality of data was tested by the Kolmogorov-Smirnov test. If the normality was rejected then the non-parametric test was used.

Statistical tests were applied as follows-

01. Quantitative variables were compared using the Independent T-test/Mann-Whitney Test (when the data sets were not normally distributed) between survived and expired.
02. Pearson correlation coefficient was used to assess the correlation of value of parameters with time for each patient so that the time trend of parameters can be calculated.
03. Receiver operating characteristic curve was used to find out cut off point of parameters for predicting mortality.

A p-value of <0.05 was considered statistically significant.

The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

Results

The study was conducted in the Department of Obstetrics and Gynaecology, Medical college and SSG Hospital, Baroda from 1st September 2017 to 31st August 2018. It was a Hospital-based Prospective Study where 100 women were included who were admitted during pregnancy or up to 42 days postpartum in morbid conditions and satisfied the inclusion criteria. SOFA score was calculated at the time of admission, 12 hrs 4after admission and every 24 hours after that till the patient was admitted in ICU. 83% of patients admitted belonged to 20-30 years age group. The mean stay in the ICU was 3.3 ± 1.02 days. The most common indication was Pre-eclampsia and Eclampsia which accounted for 43% of the patients. In this study, among ICU interventions; ventilatory support was required in 72% of patients, blood transfusion in 81% of patients, and hysterectomy was done in 22% of patients. Among medications, antihypertensives, anticonvulsants and inotropes were most commonly used. Overall, 16 patients expired while 84 recovered completely. The SOFA score trend in the patients who recovered showed a significant decrease with time whereas the SOFA score trend in the patients who expired showed a significant increase with respect to time.

Interpretation of the area under the ROC curve showed that the performance of the total SOFA score was excellent (AUC 0.972; 95% CI: 0.917 to 0.995). When the performance for SOFA score was assessed individually for each organ function, the discriminatory power of the respiratory score and cardiovascular score were good; however, no individual score alone had better discriminatory power than the total SOFA score. The respiratory score, CVS score, and total score were 100% sensitive, but the total score had maximum specificity among them.

Respiratory and renal individualized SOFA score trend was 100% sensitive and on the other hand, CVS score and CNS score trend were 100% specific. Though CNS and CVS score had 100% specificity but to predict mortality sensitivity was only 62.5% and 87.5% respectively. Similarly, the sensitivity of the liver score was quite good (93.75%) but its specificity was low i.e. 78.57%. Sensitivity and specificity of coagulation score was 87.5% and 98.81%. The total SOFA score trend was 100% sensitive and 100% specific (Table 2). Thus, according to this study total SOFA score can be used to predict mortality in obstetric ICU and give a prognosis of the patient as an increasing trend of SOFA score indicates a poor prognosis.

Table-2: Sensitivity, specificity, NPV and PPV of SOFA score trend for predicting mortality.

Sofa score trend	SN	95% CI	SP	95% CI	PPV	95% CI	NPV	95% CI
Respiratory trend	100	79.4-100	95.24	88.3-98.7	80	56.3-94.3	100	95.5-100
Coagulation trend	87.5	61.7-98.4	98.81	93.5-100	93.3	68.1-99.8	97.6	91.8-99.7
Liver trend	93.75	69.8-99.8	78.57	68.3-86.8	45.5	28.1-63.6	98.5	92.0-100
CVS trend	87.5	61.7-98.4	100	95.7-100	100	76.8-100	97.7	91.9-99.7
CNS trend	62.5	35.4-84.8	100	95.7-100	100	69.2-100	93.3	86.1-97.5
Renal trend	100	79.4-100	72.62	61.8-81.8	41	25.6-57.9	100	94.1-100
Total trend	100	79.4-100	100	95.7-100	100	79.4-100	100	95.7-100

SN: Sensitivity, SP: Specificity

Discussion

Maternal death is an important health indicator of the country. The study of near-miss cases is used to evaluate the quality of obstetrical health care systems. In order to reduce maternal morbidity and mortality; early recognition of obstetric complications and referral of these patients to higher centers is required. Apart from this access to safe, affordable and both basic and emergency obstetric care is needed.

The challenge of predicting severe morbidity and mortality in the obstetric population is that different patients tend to develop different patterns of organ dysfunction. Thus, an ideal scoring system should allow the prediction of mortality and quantification of the severity of illness during hospitalization. The scoring system should also help in predicting morbidity and degree of success achieved by treatment. This study was conducted over a period of one year in a tertiary care centre which receives a large number of referred cases.

This study evaluated the performance of the total SOFA score and showed that the score had a good performance. Assessment of the SOFA scores has potential utility in cases of obstetrics patients admitted in ICU. Very high scores are suggestive of very severe organ/system dysfunction. These results were similar to studies done in Brazil [10] and Mexico [11] which concluded similar results.

The APACHE II and SAPS II scores which are usually used in obstetrics population tends to overestimate severity and maternal mortality ratios. Physiological changes in pregnancy and different patterns of obstetric morbidities are the factors that lead to this overestimation. A study conducted to evaluate these various scoring systems concluded that SOFA score was easier to calculate as compared to other scores [8].

Organ-specific-based scoring systems such as the SOFA are superior to diagnosis-based systems for several reasons[9]. As seen in this study many patients had multiple organs/system dysfunction or failure simultaneously with severe obstetric illness. Secondly, obstetric patients had multiple clinical diagnoses at admission or during hospitalization.

Furthermore, severity scoring systems such as the SOFA generates an overall score based on the severity of the condition of the patient thus deciding ICU admission. Apart from this SOFA score can easily be calculated on a daily basis as parameters required are simple. These daily scores help in comparison and thus in knowing about the response to treatment and predicting morbidity or mortality of the patient. In addition, the SOFA could be also be used as a tool to audit the quality of care [12].

The SOFA score of individual organ system showed the maximum degree of alteration in the given organ system at that point of time and the trend of SOFA score gives us an idea of the degree of alteration in organ function at different moments in ICU as seen in this study. These findings were similar to a study by Antonio et al [10].

SOFA Score was also excellent in predicting mortality as of 100 patients taken for study, 16 patients who expired had high total SOFA score just before death. These results were similar to studies [3,13] which concluded that total SOFA score had the best discriminative value for predicting mortality.

Limitations of Study- There are some limitations to this study.

First, In this study data collection was performed manually by reviewing the case sheets and reports of the patient admitted in ICU. Secondly, due to relatively less number of deaths i.e. 16 deaths out of 100 in this study, evaluation of the performance of scores may have been affected. Third, the study was done in a tertiary care hospital which was a referral center leading to a large number of complicated cases being referred. Thus, these results may not be the projection of the general obstetric patient population.

Conclusion

A scoring system for critically ill obstetric patients could lead to better monitoring in these patients and help in assessing response to treatment.

The scoring system like SOFA Score can easily be adopted as it is easy to use, requires simple parameters to calculate score and hence should be practised and be incorporated into guidelines.

The SOFA score was able to predict outcome in obstetric ICU patients. The trend of SOFA score was progressively declining in survivors while non-survivors had higher scores. The study shows that the total SOFA score had good predictive and discriminative value for survival or death in critically ill obstetric patients.

What does the study add to the existing knowledge?

The SOFA scoring system can thus help the obstetricians in admitting patients, monitoring the clinical course, assessment of organ dysfunction, predicting mortality, and for transferring patients out from the ICU and thus in proper utilization of ICU resources also in developing countries like ours, where the resources are limited.

Author's contribution

Dr. Nupur Anand: Study design, Concept

Dr. A V. Gokhale: Manuscript preparation

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