Int. j. adv. multidisc. res. stud. 2023; 3(1):521-527

Received: 06-12-2022
Accepted: 16-01-2023

International Journal of Advanced Multidisciplinary Research and Studies

ISSN: 2583-049X

Developing a Feasible Scoring System for Critically Ill Obstetric Patients in Intensive Care Units in Resource Limited Settings

[1] Fagbohun AO, [2] Adebowale AA, [3] Smith SK

[1, 2, 3] Consultant Anaesthetist, Department of Anaesthesia, Lagos State University Teaching Hospital, Lasuth, Ikeja, Lagos, Nigeria

Corresponding Author: **Fagbohun AO**

Abstract

Background: Maternal mortality is a challenge to the health care system especially in developing countries. One of the strategies of reducing maternal mortality is the care of the critically ill obstetric patients in the Intensive Care Unit (ICU). The clinical state of these patients at admission remains a major determinant of their outcome.

Evidence based assessment tools such as the Acute Physiologic Assessment and Chronic Health Evaluation 11 (APACHE 11) and the Sequential Organ Failure Assessment (SOFA) scores have been used to stratify and prognosticate obstetric patients in the ICU but are limited by some shortfalls. The Modified Obstetric Early Warning Signs scoring system (MOEWS) has been suggested to serve this purpose devoid of the shortfalls.

Objective: This study retrospectively compared the MOEWS to the APACHE II and SOFA scores in predicting the outcome of critically ill obstetric patients in the ICU with the aim of developing a scoring tool adaptable to a resource limited setting.

Method: An evaluation of the scoring systems as prognostic tools was done. The primary outcome was the predicted maternal mortality by the scoring tools as against the actual maternal mortality observed while the secondary outcomes were mechanical ventilation, use of vasopressors and length of ICU stay.

Results: The area under receiver operator characteristic (AUROC) curve of MOEWS, SOFA, and APACHE II for prediction of maternal mortality was 0.794 (95% CI, 0.649–0.818), 0.684 (95% CI, 0.594–0.772), and 0.724 (95% CI, 0.641–0.828), respectively.

The standardized mortality rate (SMR) indicated that all the three scoring systems were comparable in predicting maternal mortality. The MOEWS correlated more significantly with the length of ICU stay ($p = 0.029$, $R = 0.138$) and number of hours on ventilation ($p = 0.025$, $R = 0.228$). Statistical Analysis of ICU parameters showed that hospital stay ($p = 0.011$), and ventilation days ($p = 0.014$) were significant predictors of maternal outcome. Age ($p = 0.789$) and ICU stay ($p = 0.701$) were not significant.

Conclusion: The MOEWS scoring system which is comparable to other commonly used scoring systems will be of value in resource limited settings in developing management protocols for obstetric patients in the ICU.

Keywords: Critically Ill Obstetric Patients, Intensive Care Units**,** Maternal Mortality Rate, Predictive Scoring Models, Clinical Outcomes

1. Introduction

Maternal mortality is a challenge to the health care system especially in the developing countries where more than 99% of the worldwide maternal mortality occurs. Sub-Saharan Africa and South Asia account for 86% of maternal deaths worldwide. Nigeria and India account for about 34% of global maternal deaths [1, 2]. As at 2020, Maternal Mortality Rate (MMR) in Nigeria was 814 deaths /100,000 live births compared to 23.8 deaths /100,000 live births in the United States of America, USA. The USA has the highest maternal mortality rate of the developed countries [1, 2]. One of the targeted goals at reducing maternal mortality is the care of the critically ill obstetric patients in the Intensive Care Unit (ICU). The mortality rate of obstetric patients admitted into the ICU in developing countries is higher compared with their counterparts in the developed world [3, 4]. Several factors have been cited for this high disparity which includes poor education of the pregnant women on the importance of antenatal care, low socioeconomic status of these women, lack of accessible and affordable well-staffed and equipped antenatal care services, delayed referral, poor education of health care providers attending to these women on early diagnosis of critically ill mothers so that appropriate and prompt intervention can be instituted, delayed referral to point of care where required facilities for needed interventions are available, lack of adequate dedicated and affordable intensive care facilities and

lack of health care personals proficient in the knowledge and required skill in the ICU [5, 6]. The single most important factor that has been observed is the clinical state of the critically ill obstetric patients at admission into the ICU. This remains the major determinant of the outcome of ICU care [4, 6, 7]. Therefore, identifying the need for ICU care early and commencing prompt and appropriate targeted care will improve patients' outcome in the ICU [4, 6].

The use of evidence-based assessment tools for risk stratification and prognostication of these patients from the point of admission into the ICU, has been suggested to reduce mortality among obstetric patients in the intensive care unit as it will assist the intensivist to stratify patients according to needs, predict prognosis and commence early appropriate care of these patients [8]. Stratification and prognostication allow for development of protocols for immediate deployment of needed human and material resources as appropriate and also helps in giving informed counseling to the patients and their family with regards prognosis and cost of care [9, 10, 11].

The APACHE and SOFA scoring systems have been modified for use in obstetric patients in the ICU with their major shortfall being that they cannot be fully administered at the point of admission into the ICU as laboratory results will be required and also physiological changes in the pregnant woman may yield high APACHE or SOFA scores thus over predicting mortality. The MOEW score has also been used in some studies and its benefits includes its non-requirement of laboratory results at the point of admission as it is based on clinical parameters only, it considers the physiological changes in pregnancy and it is less cumbersome and simple to calculate [12].

This study compared the MOEWS to the APACHE II and SOFA scores in predicting the outcome of critically ill obstetric patients in the ICU with the aim of developing a scoring tool adaptable to a resource limited setting.

2. Methodology

This retrospective cross-sectional study was conducted in our ten bedded multi-specialty ICU at the Lagos State University Teaching Hospital (LASUTH). Study subjects included all obstetric patients admitted to the ICU between January 2020 and January 2022, a period of 24 months. The admissions comprised inpatients on admission within the hospital whose clinical states deteriorated and outpatients referred from private clinics and other public hospitals to the LASUTH obstetrics and gynaecology emergency department and thereafter to the ICU for further care. The inclusion criteria included all obstetrics patient admitted into the ICU during pregnancy or within 42 days of the termination of pregnancy. These obstetrics patients must have their complete management data available for review to be included in the study.

During the period under review, 62 patients were admitted into the ICU. Records of 4 of the patients could not be traced hence were excluded from the study. Data from 58 participants were analyzed. Eight (13%) of them were booked patients within the facility while the remaining 50 (86.2%) were obstetric patients referred from other private and public facilities for critical care. The socio-demographic, obstetric and ICU related data were retrieved. Demographic data included the patient's age, presence of comorbidities, date of admission to the hospital, antenatal status (booked/unbooked). Obstetrical data included the parity, mode of delivery, complications related to pregnancy and maternal outcome. The date of admission into the ICU and ICU interventions such as mechanical ventilation, hemodialysis, and the use of vasopressors were recorded. The patient's disease severity was measured by APACHE II, SOFA and MOEWS scoring systems using data within 24 hours of admission into the ICU to predict their prognosis as recorded in their folders.

The primary outcome of the study was to compare the maternal mortality as predicted by the APACHE 11, SOFA and MOEWS against the actual maternal mortality observed while secondary outcome was to analyze the need for mechanical ventilation, use of vasopressors and length of ICU stay. Categorical data were expressed as percentages. Continuous data were reported as mean ± SD. Data were analyzed by SPSS version 26. An Area under receiver operator characteristic Curve, (AUROC) was generated for PMR of all the scores.

3. Results

During the period under review, a total of 345 patients were admitted into the ICU. 62 of these patients (17.97%) were critically obstetric patients. Records of 4 of the patients could not be traced hence they were excluded from the study. Data from 58 participants were analyzed. Eight (13%) of the patients were booked patients within the facility while the remaining 50 (86.2%) were unbooked. (Table 1) This table showed that 8 patients were admitted with comorbidities and the mean age of admission was 25.54 ± 4.24 years.

Table two depicted the obstetric data. 32 patients (55.17%) were admitted in the post natal period while 26 patients (44.82%) were admitted in the antenatal period. Many of the patients had low parity. Table 3 showed the causes of maternal deaths.18 (31%) of the 58 patients admitted died. All the six patients that died from haemorrhage and the four from sepsis were all unbooked. The commonest causes of admission into the ICU were haemorrhage (51.7%), hypertensive disorders (13%) and sepsis (12%). (Fig 1) Of the 30 patients (51.7%) admitted secondary to haemorrhage, post-partum haemorrhage accounted for 60%, abruption placenta 13%, placenta praevia, uterine rupture and ruptured ectopic each accounted for 6.66%. five (62.5%) of the hypertensive patients had eclampsia while three (37.5%) had HELLP syndrome.

In table 5, the age of the mothers and length of ICU stay were not significant in predicting maternal outcome. (p value 0.789 and 09.701 respectively) while the ventilation and hospital stay were significant in predicting maternal outcome (p value0.011 and 0.014 respectively)

Table six showed MOEWS having the highest Standardized Mortality Ratio. The correlation of the scoring models with secondary maternal outcome was displayed in table seven with MOEWS correlating more with length of ICU stay and number of hours on the ventilator. The Area under receiver operator characteristic curve, (AUROC), sensitivity, specificity, positive predictive value and negative predictive value of the scoring models for prediction of maternal mortality were displayed in table eight.

Table 1: Demographic Data

S. No	Characteristics	No	Percentage (%)
1	**Age mean ± SD** 25.54 ± 4.24	58	
2	**Medical History** Diabetes Cardiac disease Hepatitis B/C Bronchial Asthma	 2 3 1 2	 3.44 6.80 1.70 3.44
3	**Antenatal** Booked Unbooked	 8 50	 13 86.2

Table 2: Obstetric Data

S. No	Characteristics	No (58)	Percentage (%)
1	**Antenatal Admissions** Parity Gravida1 Gravida2 ≥Gravida3	26 12 8 6	44.82 46.1 30.77 23.07
2	**Postnatal Admissions** Parity Para1 Para2 ≥Para3	32 15 10 7	55.1 46.88 31.25 21.88
3	**Gestation in Weeks** First Trimester Second Trimester Third Trimester Post-Partum	 6 7 10 35	 10.34 12.06 17.24 60.34
4	**Mode Of Delivery** Normal Vaginal delivery Emergency LSCS Ex Lap	 9 11 25	 15.51 18.96 43.10
5	**Medically managed cases**	5	8.62

Table 3: Causes of Maternal Deaths

S. No	Cause of Death	Frequency n=18	% Booked	% Unbooked
1	Haemorrhage	6	0	6
2	Sepsis	4	0	4
3	Eclampsia	2	1	1
dxed4	Acute Kidney injury	3	0	3
5	Cardiac related (Cardiomyopathy)	2	1	1
6	Congestive Cardiac failure	1	0	1

Table 4: Statistical Analysis of ICU Parameters

Variable	Mean +SD Survival	Mean + SD Death	P Value
Age	24.24 ±0.622	24.36 ± 0.144	0.789
ICU stay	6.62 ± 0.52	3.48 ± 1.20	0.701
Hospital Stay	9.61 ± 0.512	5.82 ± 1.19	0.011
Ventilation (Days)	2.38 ± 0.42	4.82 ± 1.21	0.014
APACHE II Score	12.68±6.09	35.72 ± 1.66	0.000
SOFA Score	6.62 ± 0.82	15.4 ± 1.748	0.000
MOEWS Score	7.55 ± 3.58	13.55 ± 4.87	0.000
Numbers of hours on Vasopressors	48.68 ±27.60	52.45±22.72	0.607
Number of Dialysis Session	23.50 ± 2.00	36.40±18.64	0.720

Table 5: Clinical Characteristics and Laboratory Parameters

Parameter	Mean +SD	Interquartile Range
Heart Rate (bpm)	115 ± 18.40	101 – 124
Respiratory rate	23.65 ± 6.53	16 – 29
Temperature	38.5 ± 1.60	37 – 39
Systolic Blood Pressure	105.5 ± 28.5	76 – 122
Diastolic Blood Pressure	63 ± 22.5	63 – 90
Oxygen required to maintain SPO2 at 96%	85.6 ± 20.7	85 – 95
Fraction of inspired oxygen (FIO2)	0.45 ± 0.18	0.2 – 0.4
Serum potassium (meq/L)	3.82 ± 0.8	3.3 – 4.5
Serum Creatinine (mg/dl)	1.72 ± 1.95	0.75 – 2.0
Serum Sodium (meq/L)	135.72 ± 8.52	135 – 145
Serum Billirubin	1.58 ± 1.74	0.9 – 2.1
Hematocrit %	25.65 ± 5.58	19 – 32
WBC Cells/Ul	17,000 ± 5,000	12,800 – 22, 500
Platelet count U/l	225,000 ± 115,000	120,000 – 300,000
Glasgow Coma Scale	12.05 ± 2.07	10 – 15

Table 6: Standardized Mortality Ratio of Apache II, Moews, and Sofa Scores

Score	Observed maternal mortality (%)	Predicted maternal mortality (%)	Standardized mortality ratio (%)
Apache II score	31.00	47.50	67.42
Moews score	31.00	38.30	68.95
Sofa score	31.00	42.70	63.40

Table 7: Correlation of Apache II Moews and Sofa Scores with Secondary Material Outcomes

Secondary Outcome		Apache II	Moews	Sofa
Length of stay in the ICU in days	Correlation coefficient	0.080	0.25	0.095
	P Value	0.12	0.039	0.16
	N	58	58	58
Numbers of hours on vasopressors	Correlation Coefficient	0.14	0.07	0.04
	P Value	0.22	0.61	0.84
	N	13	13	13
Numbers of hours on ventilation	Correlation Coefficient	0.20	0.32	0.07
	P Value	0.05	0.025	0.54
	N	16	16	16

Table 8: Area under Receiver Operator Characteristic Curve, (Auroc), Sensitivity, Specificity, Positive Predictive Value and Negative Predictive Value of Apache Ii, Moews, and Sofa Scores for Prediction of Maternal Mortality

Scores	AUROC	p value	Cutoff	Sensitivity	Specificity	Positive predictive value	Negative predictive value
APACHE II	0.724 (95% CI-0.641 to 0.288)	<0.0001	>10	92.65 (95% CI = 85–95.5)	79.16 (95% CI = 73.4–86.4)	66.7 (95% CI = 54.4–7625)	95.3 (95% CI = 93.6–97.2)
MOEWS	0.794 (95% CI = 0.649–0.878)	<0.0001	>8	93.87 (95% CI = 83–97.2)	85.92 (95% CI = 79.3–83.6)	74.2 (95% CI = 52.8–65)	97.2 (95% CI = 92.4–96.5)
SOFA	0.684 (95% CI = 0.594–0.772)	<0.0001	>6	91.31 (95% CI = 81–95.5)	76.22 (96% CI = 66.6–84.7)	59.6(95% CI = 54.3–63.8)	92.5 (95% CI = 89.4–96.9

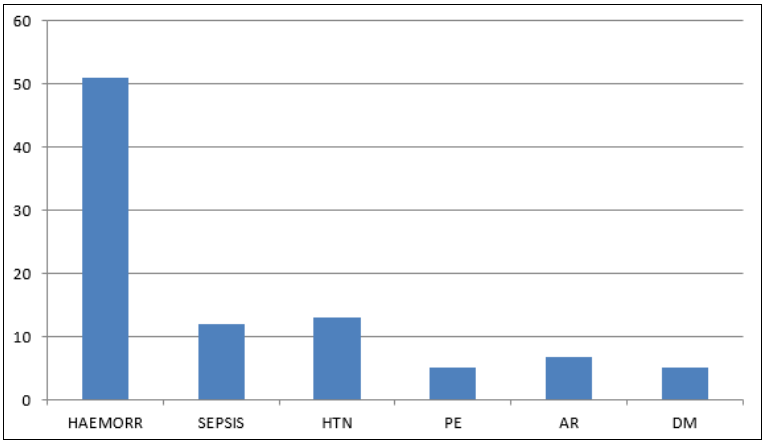

Fig 1: Incidence of ICU Admissions

Vertical axis: Frequency of admission in percentage
Horizontal axis: Causes of ICU admissions

Key:
Haemorr: Haemorrhage
HTN: Hypertensive Disorders
PE: Pulmonary embolism
AR: Anaesthesia related
DM: Diabetes Melithus

4. Discussion

Sixty-two critically ill obstetric patients were admitted into the ICU during the period under review. This represents 17.97% of the total ICU admissions. This is comparable to the findings of Embu and colleagues who observed that their obstetric admissions were 17.29% of their total ICU admissions (13). The mean distribution of age of obstetric ICU patients in the index study was 25.54 ± 4.24 years which is similar to what has been observed in other studies within Nigeria and other low to middle income countries [13, 14]. This is in contrast to findings from studies from developed countries which reported a relatively higher maternal age [15, 16]. The disparity in age distribution can be attributed to the younger age of marriage and subsequently early pregnancy seen in our environment in contrast to the culture of early exposure to contraceptive techniques and the ease of assessment of these contraceptive methods in the developed countries [17].

Eight (13.79%) of the patients admitted into the ICU had associated co-morbidities (table 1). Hypertension was the most common medical condition existing pre-morbidly in this population (6.8%). The gestational age of critically ill obstetric patients may reflect the indication for ICU admission and this has varied in different reports. ICUs with postpartum hemorrhage being the main indication for admissions reported a higher gestational age of more than 34 weeks, while ICUs with most patients presenting with pregnancy induced hypertension, PIH have a relatively lower gestational age [18-20]. in the current study, haemorrhage was the most prominent indication for ICU admission (51.7%, Fig 1) and our patients presented with a higher gestational age (table 2). In contrast, Kumar *et al*. [14] reported more patients with PIH than hemorrhage and their patients had lower gestational ages. While some earlier studies have suggested higher maternal mortality in women with three or more parity [21-24] this was not the case in our study. Higher parity did not impact on the maternal outcome significantly.

Kumar *et al*. reported less ICU admissions secondary to haemorrhage as most of their deliveries were adequately supervised by appropriately trained personnel. In our situation, most of our bleeding patients were referred from peripheral centers. The six patients that died from haemorrhage were all unbooked, referred from other centers in critical conditions as at the time of admission into the ICU as evidenced by the scoring systems. Similar pattern was observed by Adeniran and colleagues [3] who documented that clinical condition of critically ill patients at admission into the ICU is a major determinant of their outcome. Another common cause of ICU admission are complications from elevated blood pressure [21]. In this study, 8 patients (13%, patients were reported to have hypertensive related disorders. 5 of them had eclampsia with 3 subsequently developing HELLP syndrome and 2 dying thereafter (table 3). Seven of our patients (12%) presented with sepsis. Some of the patients that presented with sepsis had surgical interventions before they were referred from their primary facilities. All the four mortalities from sepsis were unbooked patients referred to our center. They arrived at the ICU in very poor clinical conditions and often beyond the golden sepsis hour. This may explain the associated maternal mortality which occurred in these patients who had presented in septic shock. Although more patients were admitted into the ICU secondary to hemorrhage, many survived as blood and blood products are available in our institution being a tertiary facility. Hence, we had less mortality from haemorrhage. Certain parameters and ICU interventions are said to influence the pattern of outcome of critically ill obstetric patients. These include the age of the patient, duration of ventilation, duration on vasopressors, length of ICU stay and hospital stay. (4, 6, 7). In the index study, statistical Analysis of ICU parameters showed that hospital stay ($p = 0.011$), and ventilation days ($p = 0.014$) were significant predictors of maternal outcome. Age ($p = 0.789$) and ICU stay ($p = 0.701$) did not affect maternal mortality significantly.

Despite ICU care, 18 of our patients (31%) died. This corresponds to the finding from other studies done in various ICU facilities across the country who had also recorded high mortality rates in their ICU [3-5]. The maternal mortality rate reported in ICUs in developing countries is higher than that reported from developed nations. While some studies have reported zero mortality, [22] the mortality rate was consistently below 5% in other reports from ICUs of developed countries [23]. The high mortality rate in the developing countries can be attributed to the late presentation of these patients and delay in diagnosis of their rapidly deteriorating clinical conditions which would have triggered earlier needed ICU interventions.

In our experience, a higher severity of illness score at admission, requirement for ventilator support**,** number of days on ventilation, ($p = 0.014$) and the length of hospital stay, ($p = 0.011$) all predisposed these patients to a poorer outcome. We observed that mortality was higher in patients with higher scores in all the scoring models assessed including the MOEWS. Critically ill obstetric patients with normal values of Modified Obstetric Early Warning Score had lower mortality rate, while those with high Modified Obstetric Early Warning Score values had poorer outcome. The age of patient, need for inotropic support and length of ICU stay have also been identified as predictors of poor maternal outcomes [21]. However, in the index study, age, ($p = 0.789$), inotropic support ($p = 0.607$) and length of ICU stay, ($p = 0.701$) did not predict maternal outcome. The MOEWS correlated more significantly with length of ICU stay ($p = 0.039$) and the number of hours on ventilation ($p = 0.025$). This was not the case with APACHE II and SOFA scores.

In this study, the MOEWS was statistically significantly comparable with the APACHE 11 and SOFA scoring models in predicting maternal mortality. The standard mortality ratio was highest in MOEWS. (MOEWS had the value closest to one, table 6). This suggests that the MOEWS had the best predictive value compared to APACHE 11 and SOFA scores. Furthermore, The MOEWS had a moderate cut-off threshold of >8 compared to >10 and > 6 for APACHE and SOFA respectively. The cut off value is the dividing point on a measuring scalar. If the

score is excessively high, it predisposes to fewer prediction of false negative outcomes (mortality rate) but more false positive survival rate. Similarly, the MOEWS had a sensitivity of 93.87% and a specificity of 85.92% in predicting maternal mortality thus it has a lesser tendency for predicting false survival and false mortality respectively. (25) The AUROC (table 8) of the MOEWS was higher compared to that of APACHE 11 and SOFA scores also suggesting that the MOEWS is a better performance model. These findings correlates with that observed in a retrospective cohort study performed by Khergade *et al*. [12] Unlike the APACHE 11 and SOFA scoring systems that did not put into consideration the physiological changes in pregnancy which could predispose to a falsely elevated estimated maternal mortality rate, the MOEWS model considers the physiological changes observed in pregnant women. Another benefit observed with the MOEWS is that it is less cumbersome, easier to calculate and does not require laboratory parameters which may be an added advantage in resource limited settings.

5. Conclusion

The MOEWS scoring system which is comparable to other commonly used scoring systems will be of value in resource limited settings in developing management protocols for obstetric patients in the intensive care unit.

6. References

1. World Health Organization. Trends in Maternal Mortality: 1990 to 2015: Estimates Developed by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division. Accessed December 19, 2019. https://reliefweb.int/report/world/trends-maternal-mortality-1990-2015-estimates-who-unicef-unfpa-world-bank-group
2. World Health Organization, UNICEF, United Nations Population Fund and the World Bank, Trends in Maternal Mortality: 2000 to 2017 WHO, Geneva, 2019k.
3. Faponle AF, Adenekan AT. Obstetric admissions into the Intensive Care Unit in a Sub-urban university teaching hospital. Niger J Obestet Gynaecol. 2011; 6:33-36. [Google Scholar]
4. Adeniran AS, Bolaji BO, Fawole AA, Oyedepo OO. Predictors of maternal mortality among critically ill obstetric patients. Malawi Medical Journal. 2015; 27(1):16-19.
5. Okafor VU, Efetie ER, Amucheazi A. Risk factors for maternal deaths in unplanned obstetric admissions to the intensive care unit- Lessons for sub-Saharan Africa. Afr J Reprod Health. 2011; 15(4):51-54.
6. Karnad DR, Lapsia V, Krishnan A, Salvi VS. Prognostic factors in obstetric patients admitted into an Indian intensive care unit. Crit Care Med. 2004; 32(6):1294-1299.
7. Ozumba BC, Ajah LO, Obi VO, Umeh UA, Enebe JT, Obioha KC. Pattern and Outcome of Obstetric Admissions into the Intensive Care Unit of a Southeast Nigerian Hospital. Indian J Crit Care Med. 2018; 22(1):16-19. Doi: 10.4103/ijccm.IJCCM_297_17. PMID: 29422727; PMCID: PMC5793016.
8. Fadiloglu E, Bulut Yuksel ND, Unal C, Ocal S, Akinci SB, Topeli A, *et al*. Characteristics of obstetric admissions to intensive care unit: APACHE II, SOFA and the Glasgow Coma Scale. J Perinat Med. 2019; 47(9):947-957. Doi: 10.1515/jpm-2019-0125. PMID: 31603858
9. Vincent JL, Moreno R, Takala J, Takala J, Willatts S, De Mendonça A, *et al*. The SOFA (sepsis-related organ failure assessment) score to describe organ dysfunction/failure. Intensive Care Med. 1996; 22(7):707-710. Doi: 10.1007/BF01709751. DOI: [PubMed] [Google Scholar]
10. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: A severity of disease classification system. Crit Care Med. 1985; 13(10):818-829. Doi: 10.1097/00003246-198510000-00009. [PubMed] [CrossRef]
11. Carle C, Alexander P, Columb M, Johal J. Design and internal validation of an obstetric early warning score: secondary analysis of the intensive care national audit and research centre case mix programme database. Anaesthesia. 2013; 68(4):354-367. Doi: 10.1111/anae.12180. [PubMed]
12. Khergade M, Suri J, Bharti R, Pandey D, Bachani S, Mittal P. Obstetric Early Warning Score for Prognostication of Critically Ill Obstetric Patient. Indian J Crit Care Med. 2020; 24(6):398-403.
13. Embu HY, Isamade ES, Nuhu SI, Oyebode TA, Kahansim ML. Obstetric admissions in a general intensive care unit in north-central Nigeria. Trop J Obs Gynaecol. 2016; 33:14-20. [Google Scholar]
14. Kumar R, Gupta A, Suri T, Suri J, Mittal P *et.al*. Determinants of maternal mortality in a critical care unit: A prospective analysis Lung India. 2022; 39(1):44-50.
15. Sriram S, Robertson MS. Critically ill obstetric patients in Australia: A retrospective audit of 8 years' experience in a tertiary intensive care unit. Crit Care Resusc. 2008; 10:124.
16. Togal T, Yucel N, Gedik E, Gulhas N, Toprak HI, Ersoy MO. Obstetric admissions to the intensive care unit in a tertiary referral hospital. J Crit Care. 2010; 25:628-633.
17. Vera Sagalova, Siméon Nanama, Noel Marie Zagre, Sebastian Vollmer. Long-term consequences of early marriage and maternity in West and Central Africa: Wealth, education, and fertility JoGH, 2021.
18. DN, Estenssoro E, Canales HS, Reina R, Saenz MG, Das Neves AV, *et al*. Clinical characteristics and outcomes of obstetric patients requiring ICU admission. Chest. 2007; 131:718-724.
19. Kilpatrick SJ, Matthay MA. Obstetric patients requiring critical care. A five-year review. Chest. 1992; 101:1407-1412.
20. Lapinsky SE, Kruczynski K, Seaward GR, Farine D, Grossman RF. Critical care management of the obstetric patient. Can J Anaesth. 1997; 44:325-329.
21. Osinaike B, Amanor Boadu S, Sanusi A. Obstetric intensive care: A developing country experience. Internet J Anesthesiol. 2006; 10:2.
22. Togal T, Yucel N, Gedik E, Gulhas N, Toprak HI, Ersoy MO. Obstetric admissions to the intensive care unit in a tertiary referral hospital. J Crit Care. 2010; 25:628-633.
23. Zwart JJ, Dupuis JR, Richters A, Ory F, van Roosmalen J. Obstetric intensive care unit admission: A 2-year

nationwide population-based cohort study. Intensive Care Med. 2010; 36:256-263.
24. Mantel GD, Buchmann E, Rees H, Pattinson RC. Severe acute maternal morbidity: A pilot study of a defnition for a near-miss. Br J Obstet Gynaecol. 1998; 105:985-990.
25. Abdul Ghaaliq Lalkhen, MB ChB FRCA, Anthony McCluskey, BSc MB ChB FRCA, Clinical tests: Sensitivity and specificity, Continuing Education in Anaesthesia Critical Care & Pain. 2008; 8(6):221-223. Doi: https://doi.org/10.1093/bjaceaccp/mkn041