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Effective application of midwifery early warning in predicting adverse obstetric outcomes and reducing obstetric morbidity in hospitals: A systematic literature review

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Abstract

Background: Several iterations of Early Warning Systems used in the birthing domain for the purpose of identifying and addressing early clinical hazards aim to prevent morbidity and mortality. The potential of early warning systems lies in their ability to improve the quality of health care and reduce the likelihood of maternal death.

Purpose: To validate the effectiveness, accuracy and sensitivity of implementing different obstetric early warning systems and physiological triggers to predict morbidity in postnatal wards in high-risk women.

Method: A systematic review was conducted in accordance with PRISMA guidelines to identify peer-reviewed studies on obstetric Early Warning Systems published between 2016 and 2023. The search spanned multiple databases, including Scopus, ScienceDirect, Research Rabbit, Google Scholar, and PubMed, and was supplemented by a review of relevant reference lists and professional organization websites. The review focused on studies evaluating the effectiveness, accuracy, and sensitivity of MEOWS, MEWC, OEWS, SMO, and SMS in predicting clinical deterioration and improving outcomes in hospitalized maternity patients. Studies involving pediatric or non-obstetric populations and qualitative designs were excluded. Due to heterogeneous findings, a narrative synthesis was applied.

Results: Out of 1,152 identified articles, 20 met the inclusion criteria. These studies examined the predictive accuracy and sensitivity of midwifery Early Warning Systems (EWS) in relation to maternal morbidity and mortality. Eight studies focused on the systems' effectiveness in improving clinical outcomes, while one addressed both aspects. Eight versions of the midwifery EWS were analyzed, most of which incorporated six core clinical parameters: pulse, respiratory rate, temperature, blood pressure, and level of consciousness. Eleven studies specifically evaluated the accuracy of these systems in enhancing clinical outcomes. Additionally, researchers contributed to the development of midwifery-specific EWS tools.

Conclusion: The maternal early warning system has shown effectiveness in predicting severe morbidity among obstetric patients and mortality in critically ill cases. These systems hold promise for enhancing service quality, preventing the progression of maternal complications, and improving overall health outcomes. However, current evidence on their impact in reducing maternal mortality across all populations remains limited. Additionally, most versions rely on clinical parameters routinely collected from constrained resources, which may contribute to less-than-optimal outcomes.

Suggestion: A validated and standardized national obstetric early warning tool will enable the consistency and uniform approach needed in the assessment and management of potentially deteriorating conditions of pregnant women and compliance of health workers in implementing obstetric early warning tools according to standards.

Keywords: Modified Early Obstetric Warning System (MEOWS); Morbidity; Mortality.

INTRODUCTION

Maternal and perinatal mortality rates serve as critical indicators of a nation's healthcare quality. Approximately 99% of maternal deaths and 98% of perinatal deaths occur in developing countries, with around 830 women dying daily from preventable causes. A significant contributor to these deaths is the delay in recognizing the severity and complications of obstetric conditions (Gupta, Suri, Bachani, Bharti, Pandey, & Mittal, 2023). To address this, various severity prediction models originally designed for the general population have been adapted for use in obstetric care. These scoring systems aim to identify critically ill patients and categorize them for appropriate levels of care—ranging from standard wards to high-dependency units or intensive care. However, due to the unique physiological changes in pregnancy, general scoring systems often yield inaccurate assessments, prompting the development of obstetric-specific tools (Khergade, Suri, Bharti, Pandey, Bachani, & Mittal, 2020).

In some healthcare settings, rapid response systems incorporating Early Warning Scores (EWS) have been implemented. These tools support healthcare providers—nurses, midwives, and physicians—in the early recognition and efficient management of clinical deterioration. EWS evaluates deviations in vital signs to determine the urgency of response and whether to activate a rapid response team (Escobar-Vidarte, Suso, Echavarría, Hincapié, Nasner, & Carvajal, 2020). Timely identification of abnormal physiological parameters, combined with prompt intervention, plays a crucial role in preventing adverse outcomes (Tanhapour & Kalhori, 2022). In response to rising maternal mortality rates, researchers have developed obstetric-specific EWS aimed at detecting early signs of potentially life-threatening pregnancy complications. These systems use thresholds for vital signs to trigger early intervention, thereby reducing maternal morbidity and mortality (Umar, Manu, Mathai, & Ameh, 2020). Evidence indicates that obstetric EWS enhances the detection of severe complications and contributes to lowering maternal mortality in the facilities where it is implemented (Zuckerwise & Lipkind, 2017).

RESEARCH METHOD

This systematic review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The review process began with the formulation of clinically meaningful research questions. To define the scope and set eligibility parameters for study inclusion, the authors applied the PICOS framework, which encompasses: P (Population/Problem), I (Intervention or Exposure), C (Comparison or Control), O (Outcome), and S (Study Design). For this review, the PICOS elements were defined as follows: Population (P): Pregnant women in labor, those experiencing illness at any stage of pregnancy, and women up to six weeks postpartum, all of whom were admitted to hospital units, including intensive care and high-dependency units. Intervention (I): Implementation of obstetric Early Warning Systems (EWS), including both paper-based and electronic monitoring tools. Comparison (C): Use of non-obstetric EWS. Outcome (O): Clinical outcomes such as maternal mortality, non-severe maternal morbidity, potentially life-threatening conditions, maternal near-miss events, and intensive care unit admissions. Study Design (S): Prospective studies, retrospective longitudinal studies, case-control studies, observational cohort studies, cross-sectional studies, phased trials, and randomized controlled trials.

An initial literature search was conducted using three databases from the Centre for Reviews and Dissemination, including the Database of Abstracts of Reviews of Effects (DARE) and the Turning Research Into Practice (TRIP) database, along with databases listing ongoing reviews. The primary search strategy targeted PubMed, Google Scholar, Scopus, and ScienceDirect, employing a combination of relevant keywords and synonyms related to the interventions and outcomes of interest. Additionally, reference lists from selected articles and websites of professional organizations—such as the World Health Organization (WHO), the Royal College of Obstetricians and Gynaecologists (RCOG), and the American College of Obstetricians and Gynecologists (ACOG)—were reviewed for pertinent literature.

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Studies published between January 2016 and 2023, in any language, were considered for inclusion. Two reviewers independently screened all potentially relevant titles, with selection carried out in two phases: initial screening based on titles, followed by full-text evaluation. Only studies meeting the predefined inclusion criteria were retained.

Exclusion criteria encompassed studies involving pediatric or non-obstetric populations, those using

qualitative methods, as well as editorials, commentaries, and letters to the editor.

The initial search yielded 1,152 articles (PubMed = 213, ScienceDirect = 534, Research Rabbit = 22, Google Scholar = 103, Scopus = 270, and other sources = 10). After applying the inclusion and exclusion criteria through a structured screening process, a total of 20 studies were selected for final analysis.

RESEARCH RESULTS

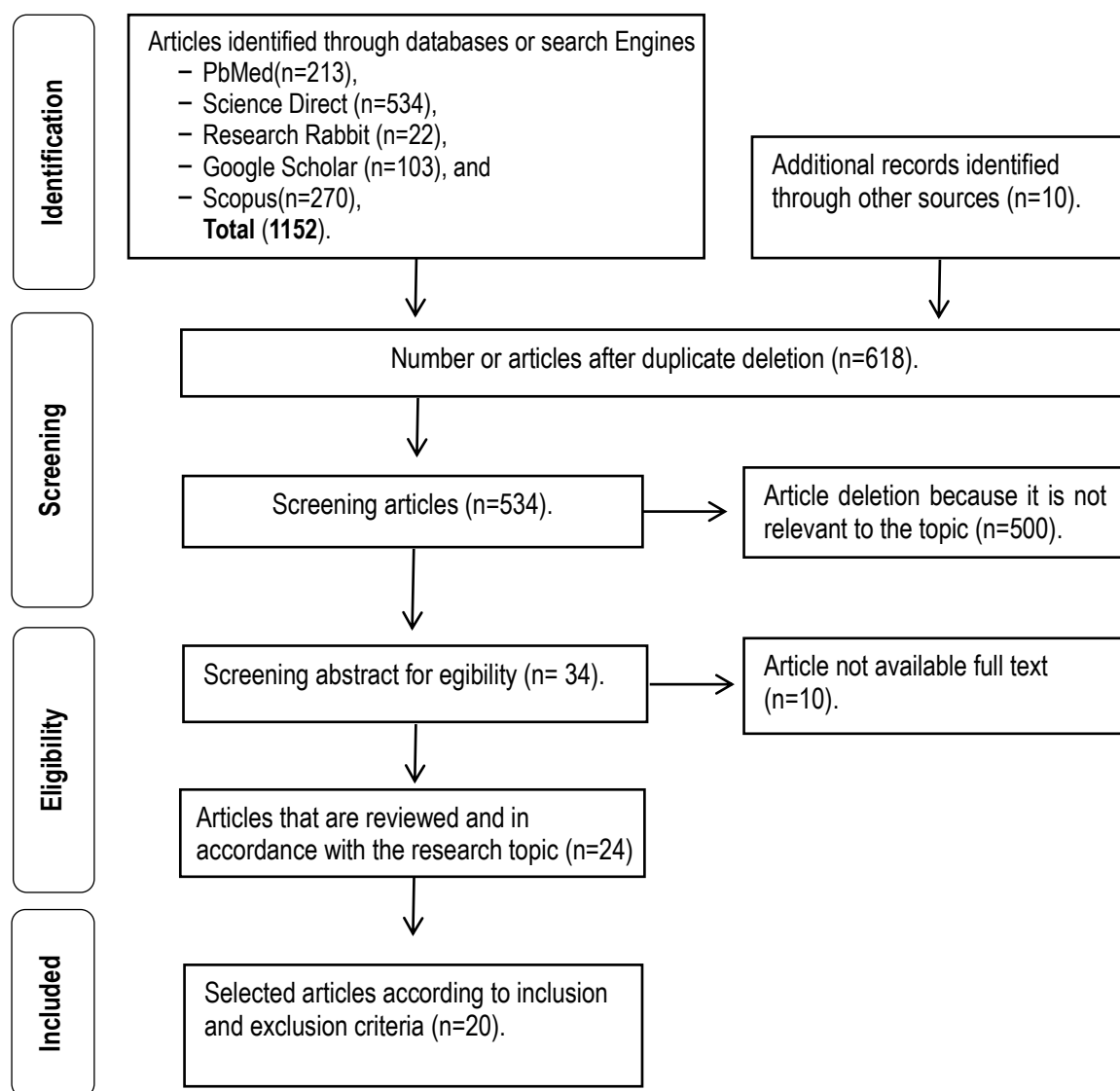


Figure PRISMA Flow Diagram

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Table The Main Characteristics of Included Studies

(Author, Year) (Country)	Purpose	Method	Results
(Hannola et al., 2021) (Finland)	To detect deterioration of the patient and to enable timely intervention to prevent possible severe illness.	An 18-month prospective cohort study was carried out at a tertiary referral hospital in Finland with roughly 5,000 deliveries annually between November 2016 and April 2018. The public health care system includes the hospital.	At its peak, the obstetric early warning system's sensitivity was 50% for infection, 25% for postpartum hemorrhage, and 72% for pre-eclampsia. In every outcome examined, there was a substantial correlation between morbidity and the red triggers. Pre-eclampsia, systolic blood pressure (OR 2.7, 95% CI 1.4-5.6), heart rate (OR 3.6, 95% CI 1.7-7.6) with postpartum hemorrhage, and heart rate (OR 3.3, 1.0-10.3) with infection were all independently linked to the red triggers of systolic blood pressure (OR 25.7, 95% CI 13.2-50.1) and diastolic blood pressure (OR 22.1, 95% CI 11.3-43.0).
(Gangwar et al., 2023) (India)	To compare three maternal early warning Systems (EWS).	The purpose of this prospective observational study was to assess the many obstetric early warning systems that have been proposed in the literature for predicting maternal morbidity and death as well as high-risk clinical situations. The sensitivity, specificity, and predictive value of the Modified Obstetric Early Warning System (MEOWS), Midwifery Early Warning Criteria (MEWC), and Save the Mother Score (SMS) as bedside screening techniques were evaluated in order to facilitate the early identification of physical deterioration in obstetric patients by tracking their physiological parameters.	The majority of the 496 patients (40.9%) were between the ages of 21 and 25. Out of 496 patients, 75 (15.1%) were under the age of 20, 196 (39.5%) had P1 parity, 177 (35.7%) had P2 parity, 70 (14.1%) had P3 parity, and 53 (10.7%) had P4 and above parity. The majority of these patients were from the IV (Upper Lower) and V (Lower) SES groups. Out of 496 patients, 291 (58.6%) were in the no alert zone, 129 (26.0%) were in the yellow alert zone, and 76 (15.3%) were in the red alert zone on admission and during follow-up until discharge, according to the evaluation of participants' MEOWS scores. Out of 496 patients, 205 (41.4%) were in the red zone and 291 (58.6%) were in the MEWC score. Out of the 496 patients whose MEOWS scores were evaluated, 291 (58.6%) were in the no alert zone, 129 (26.0%) were in the yellow alert zone,

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			and 76 (15.3%) were in the red alert zone. These alert zones were activated both at the time of admission and during the follow-up period until release. Out of 496 patients, 205 (41.4%) were in the red zone and 291 (58.6%) were not in the red zone when calculating the MEWC score. Out of 496 patients, 289 (58.3%) were in the green zone, 132 (26.6%) were in the orange zone, and 75 (15.1%) were in the red zone, per SAVING MOTHERS SCORE. MEOWS showed 87.1% sensitivity, 92.7% specificity, 89.7% PPV, and 90.8% NPV. Whereas the sensitivity in SMS was 87.1%, specificity was 91.6%, PPV was 88.3%, and NPV was 90.7%, the sensitivity, specificity, and PPV in MEWC were 86.1%, 92%, 88.7%, and 90.1%, respectively.
(Xu et al., 2022) (China)	To determine whether severe maternal morbidity is effectively predicted by a newly proposed Modified Obstetric Early Warning Score (MOEWS) in the setting of an obstetric intensive care unit.	The highest score was used as the final value in a retrospective analysis of pregnant women admitted to the intensive care unit (ICU) from MOEWS. The calculations were made 24 hours prior to and 24 hours following the admission. The poorest value before to admission was gathered for women who were admitted straight from the emergency room. The Acute Physiology and Chronic Health Evaluation II (APACHE II) score was compared with MOEWS's overall performance in predicting critical illness in pregnant women.	Out of the 352 pregnant women that were included, 290 (82.4%) had severe maternal morbidity, and two (0.6%) of them passed away. Women who experienced substantial obstetric complications had significantly greater MOEWSs than women who did not [8(6, 10) vs. 4(2, 4.25), $z = -10.347$, $P < 0.001$]. Compared to MOEWSs conducted 24 hours prior to ICU admission, MOEWSs conducted 24 hours after ICU admission exhibited superior sensitivity, specificity, and AUROC. Positive predictive value (PPV) was 95.1% (95% CI: 92–97), negative predictive value (NPV) was 95.9% (95% CI: 86–100), specificity was 75.8% (95% CI: 63–86), and sensitivity was 99.3% (95% CI: 98–100) when the two MOEWSs were combined. The APACHE II score's areas

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			under the MOEWS receiver operator characteristic (ROC) curves were 0.70 (95% CI: 0.63–0.76) and 0.92 (95% CI: 0.88–0.96).
(Friedman et al., 2018) (New York)	To explore early warning implementation across a wide range of hospital settings.	Prospective study, Limited data available for MEOWS and MERC early warning systems. MEWT tool showed significant reduction in severe maternal morbidity.	Overall, MEOWS had a 39% positive predictive value, 89% sensitivity, and 79% specificity. Compared to MEOWS, the screen positive rate with MEWT was significantly lower (2.3%).
(Tuyishime, et al., 2020) (East Africa)	To determine if the use of the RI and MEOWS tool is feasible in DHs in Rwanda and to determine the role of the RI and MEOWS tool in predicting morbidity.	Parturients hospitalized to four district hospitals between April and July 2019 were included in a cross-sectional study. Data on the prediction of morbidity (pre-eclampsia, infection, and bleeding) and completeness rate (feasibility) to the RI and MEOWS tools were gathered.	75.9% of the 478 RI and MEOWS forms that were used were completed completely, indicating sufficient viability. Furthermore, the RI and MEOWS tool demonstrated a 4.1 (95% Confidential Interval (CI), 2.4–7.1) relative risk, a sensitivity of 28.9%, a specificity of 93.5%, a PPV of 36.1%, an NPV of 91.1%, an accuracy of 86.2%, and a relative risk of 4.1. The majority of respondents stated that the RI and MEOWS tool was lengthy, that there was a poor staff-to-patient ratio, that the English language was a barrier, and that printed forms were occasionally unavailable when questioned about difficulties they had using the tool.
(Arnolds et al., 2022) (USA)	To compare early warning scores for predicting clinical deterioration and infection in obstetric patients	Patients admitted to obstetric wards at the University of Chicago between November 2008 and December 2018 were part of this observational cohort study. In order to predict ward to intensive care unit (ICU) transfer, death, and new infection, the area under the receiver operating characteristic score (AUC) was used to compare obstetric	In all, 19,611 patients were included; 43 (0.2%) had deterioration (death or transfer to the intensive care unit) and 88 (0.4%) had an infection. With an AUC of 0.86, eCART exhibited the strongest discrimination for deterioration ($p < 0.05$ for all comparisons). MEOWS (0.74), NEWS (0.72), MEWC (0.71), MEWS (0.70), and MEWT (0.65) were next in

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		scores (modified early obstetric warning system (MEOWS), maternal early warning criteria (MEWC), and maternal early warning trigger (MEWT), paper-based general scores (Modified Early Warning Score (MEWS) and National Early Warning Score (NEWS), and a general score created using machine learning (electronic Cardiac Arrest Risk Triage (eCART) score).	line. At certain cut-off thresholds, MEWC, MEWT, and MEOWS were less accurate than eCART but more accurate than MEWS and NEWS. When it came to infection prediction, eCART exhibited the highest discrimination (AUC 0.77).
(Umar et al., 2020). (Nigeria)	To report on the development and validation of a simple prediction model for obstetric morbidity and mortality in resource-limited settings	Using a retrospective case-control analysis of secondary data with clinical indices predictive of severe maternal outcome (SMO), we conducted a multivariate logistic regression analysis. 500 cases were chosen at random from among 4360 women with SMO diagnoses in 42 hospitals for design and validation. One thousand obstetric admissions without an SMO diagnosis served as the controls. For cases, we used clinical observations made within 24 hours of the incidence of SMO, and for controls, we used normal deliveries. Two controls per case were included in the combined dataset, which we then randomly divided into development (n = 600) and validation (n = 900) datasets. We evaluated the model's overall effectiveness in predicting SMO using receiver operator characteristic (ROC) curves, as well as its validity using sensitivity and specificity metrics. After that, we evaluated the performance of the final developmental model by fitting it to the validation dataset. Utilizing the reference range suggested in the Confidential Enquiry into Maternal and	Abnormal systolic blood pressure (SBP > 140 mmHg or < 90 mmHg), high diastolic blood pressure (DBP > 90 mmHg), respiration rate (RR > 40/min), temperature (> 38 °C), pulse rate (PR > 120/min), cesarean delivery, and the number of prior caesarean deliveries were all included in the final developmental model. With an area under the ROC of 92% (95% CI 90–95%), the model predicted SMO with 86% (95% CI 81–90) sensitivity and 92%-95% CI 89–94) specificity. With the exception of DBP, every parameter in the validation model was important. The model exhibited acceptable screening characteristics and retained good discriminatory power in the validation (n = 900) dataset (AUC 92, 95% CI 88–94%). SMO was strongly predicted with low urine output (300 ml/24 h) and conscious level (long unconsciousness-GCS < 8/15) in the univariate analysis.

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		Child Health 2007 report from the United Kingdom, we transformed the model into a straightforward score-based obstetric EWS algorithm.	
(Ibáñez-Lorente et al., 2021) (Spain)	to assess how well a tertiary level hospital is monitoring patients in the first two hours following birth using a maternal early warning system (MEWS).	1166 patients had their use of the criteria assessed between March 15 and September 15, 2018. Systolic and diastolic blood pressure, heart rate, oxygen saturation, urine production, uterine involution, and hemorrhage were among the parameters that were gathered. Any of these measures that were out of range prompted a caution, and the patient was examined by an obstetrician. At that point, the obstetrician made the decision to summon the anesthesiologist. We conducted a multivariate analysis of the parameters associated with the development of potentially fatal disorders (PFD), reintervention, critical care admission, and stay, as well as a sensitivity-specificity investigation of triggers.	In 75 patients, the MEWS was triggered (6.43%). Eleven patients had a PFD, and the leading trigger was changed systolic blood pressure in 32 patients (42.7%). There were twenty-eight false negative triggers. The system's sensitivity was 0.28 (0.15, 0.45) and its specificity was 0.94 (0.93, 0.96). Trigger activation and PFD were found to be correlated by the multivariate analysis.
(Gupta et al., 2023) (India)	To evaluate Carle's OEWS and its components to predict admission to the obstetric critical care unit (OCCU). Maternal near-miss and death were secondary outcomes.	Over the course of 18 months, a prospective observational study was carried out on 1250 pregnant patients admitted to the labor wards of a tertiary center with a gestational period of at least 28 weeks. At admission and at regular intervals after that, until discharge or OCCU admission, the physiological parameters of OEWS were documented, and an aggregate score was computed.	For all outcomes, the OEWS area under the receiver operating characteristic (ROC) curve was significant and was 0.975 for OCCU admission prediction, 0.971 for near-miss prediction, and 0.996 for maternal mortality prediction. With the exception of diastolic blood pressure, every individual measure had a substantial relative risk of predicting the need for OCCU care.

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(Author, Year) (Country)	Purpose	Method	Results
(Kizito et al., 2018) (Uganda)	To determine the sensitivity, specificity and predictive values of Modified Early Obstetric Warning System (MEOWS) in correctly identifying women at risk of developing obstetric morbidity.	The study was a prospective cohort study conducted at St. Francis Hospital Nsambya, maternity ward, from January to February 2016. MEOWS monitoring tool was used alongside with questionnaires.	502 respondent mothers were enrolled in the study. 160 patients (31.9%) triggered and of which: 11.5% of them had obstetric morbidity which included postpartum haemorrhage-35.5%, preeclampsia-26.3%, suspected infection-22.4%, third degree perineum tear-5.3%, anaesthetic complications-4% and prolong hospital stay-7%. MEOWS was 81.7% sensitive (95% CI 80-94%), 76.3% specific (95% CI 74-81%), with a positive predictive value 36.3% (95% CI 31-44%) and negative predictive value of 96.2% (95% CI 94-99%).
(Raiji et al., 2018) (Afrika)	To determine the influence of modified early obstetrics warning signs chart in identifying obstetric crises early.	The study design method that was employed was cross-sectional. The focus was on all labor and delivery ward nurses and midwives. 42 respondents in all were enlisted, and information was gathered from them using a standardized questionnaire. 321 files containing the MEOWS graphic were obtained through systematic random sampling. The study included two main informants. The Statistical Package for Social Sciences (SPSS) was used to examine the data, primarily using descriptive statistics. Mode, mean, median, and standard deviation were examples of descriptive statistics. Tables, pie charts, and graphs were used to display the data.	The majority of respondents agreed that the MEOWS chart makes it possible to identify obstetric warning symptoms early. Additionally, the majority of users reported that color coding warns them of potential degradation. The majority of respondents also concurred that the chart offers precise guidelines for treatment priority and escalation. However, doctors' responses to escalations within ten minutes were not consistently followed. The charts' findings showed that early warning sign triggering and prompt escalation depended on the documenting of physiological parameters and observable variable changes.
(Xie et al., 2018) (China)	To ascertain the ideal cut-off value for predicting in-hospital mortality and to validate the Modified Early Warning	A single-center, prospective observational cohort study. 383 patients who were 18 years of age or older and who arrived at the emergency room between May 17 and September 27, 2017, and were classified as category 1, 2,	This study had 383 patients in total. Transfer to the intensive care unit was 21.7% (83/383), while in-hospital mortality was 13.6% (52/383). For the purpose of predicting in-hospital mortality, the area under the MEWS receiver operating

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	Score's (MEWS) performance in a Chinese emergency room.	or 3, were included in the study. A combination of in-hospital mortality and intensive care unit admission served as the main outcome. Using MEWS to forecast hospitalized and released patients was the secondary outcome.	characteristic curve was 0.83 (95% CI 0.786 to 0.881). With a cut-off point of 3.5 for in-hospital mortality prediction, 158 patients had MEWS >3.5, with 66% specificity, 87% sensitivity, 69% accuracy, 28% positive predictive value, and 97% negative predictive value, respectively.
(Moore et al., 2019) (Ethopia)	The report of the UK Confidential Enquiry into Maternal and Child Health recommends the use of modified versions in the obstetric population.	For parturients who had undergone surgery at Felege Hiwot Referral Hospital, a tertiary facility in Bahir Dar, Ethiopia, a modified obstetric early warning system (MOEWS) was implemented. Along with healthcare worker training, a guideline was created to go along with the MOEWS. Before it was introduced, a retrospective case note review was used to evaluate the quality of postoperative surveillance. This was reviewed with an evaluation of the response to "triggers" at 8 and 11 months after introduction. A survey and qualitative interviews were conducted to find out how healthcare professionals felt about its usefulness and acceptance.	According to this study, the implementation of a MOEWS in a referral hospital in Ethiopia seemed to enhance postoperative patient monitoring. The early warning score is a workable and acceptable instrument to meet the particular demands in this low-resource setting, provided it is modified to fit the situation, senior clinicians are involved, and ongoing training is provided.
(Rudakemwa et al., 2021) (USA)	To assess reasons for admission and accuracy of prediction models for mortality of obstetric patients admitted to ICUs of two public tertiary hospitals in Rwanda.	In order to determine the reasons for admission, demographic and clinical characteristics, outcome, including death, and its predictability by both the Modified Early Obstetric Warning Score (MEOWS) and quick Sequential Organ Failure Assessment (qSOFA), data from all obstetric patients admitted to the intensive care units (ICUs) of Rwanda's two public tertiary hospitals was prospectively gathered between March 2017 and February	Obstetric patients (n = 94) accounted for 12.8% of all ICU admissions, or 1.8% of all 4.999 women admitted for labor or pregnancy. The two most frequent causes of ICU admission were obstetric hemorrhage (n = 24; 25.5%) and sepsis (n = 30; 31.9%). The average duration of stay for obstetric patients was 6.6 ± 7.525 days, and the overall ICU death rate was 54.3% (n = 51). With an adjusted AUROC of 0.773 (95 % CI 0.67–0.88) and 0.764 (95 % CI 0.65–0.87), the MEOWS and

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		2018. Using logistic regression to account for mortality-related covariates, we evaluated the accuracy of mortality prediction models by MEOWS or qSOFA. The forecasting ability of each separate instrument is displayed using the area under the Receiver Operating characteristic (AUROC) curves.	qSOFA scores were both independent predictors of mortality (adjusted (a)OR 1.25; 95 % CI 1.07–1.46) and showed fair accuracy for ICU mortality prediction in these settings.
(Abraham et al., 2023) (Saudi Arabia)	To evaluate the effectiveness of implementing maternal early warning signs to identify maternal deterioration and reduce maternal transfer to the Intensive Care Unit (ICU).	This quantitative action research study employs a cross-sectional design. The information gathered pertains to the number of mothers who were admitted to the intensive care unit (ICU) between October 2017 and October 2018 without receiving any kind of educational instruction on the MEOWS tool inside the healthcare system. Data on the number of women admitted to the intensive care unit following the full implementation of the MEOWS tool in June 2019 through July 2020 was compared with data on the number of mothers transferred to the ICU as a result of deterioration. Thirty-three (N = 33) nurses in all took part in the survey and passed the maternal warning sign tests.	With a mean score of 1.98 (SD = 0.402), more than three-quarters of them demonstrate good awareness of early warning signals of mothers. Their mean score of 1.99 (SD = 0.179) indicates a positive attitude toward the practice (mean score = 2.00; SD = 0.000). However, the findings demonstrated that their degree of proficiency in recognizing maternal impairment using MEOWS was not significantly correlated with any of the investigated variables, including age, highest qualification, marital status, and years of work experience.
(Schuler et al., 2019) (Brazil)	To assess postpartum women's modified early obstetric warning system (MEOWS) in a Brazilian tertiary hospital.	705 hospitalized women participated in a descriptive research. Vital indicators, including temperature, heart rate, respiration rate, systolic and diastolic blood pressure, and lochia, were recorded in medical records and entered into the MEOWS chart of physiological parameters. Severe abnormalities were shown in red on this graphic chart, while mild abnormalities were shown with yellow	Only three patients (0.8%) had a medical evaluation requested, despite the fact that anomalies were discovered in the physiological parameters of 49.8% of the women who were identified from MEOWS triggers.

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(Author, Year) (Country)	Purpose	Method	Results
		alerts. At least one red warning or two yellow alerts were activated to signal that a medical assessment was necessary.	
(Kaur, et al., 2023) (Canada)	To determine if MEOWS could accurately identify patients at risk of severe maternal morbidity and mortality in the ED setting.	This study reviewed the charts of patients who, between May 2020 and March 2022, presented with a postpartum complaint within six weeks of giving birth at an academic tertiary care center (annual ED census 65,000). One very aberrant (red) or two somewhat aberrant (yellow) physiological measurements during the ED visit were considered triggers, and their presence was the exposure. Sensitivity, specificity, positive predictive value, and negative predictive value were calculated to determine the diagnostic accuracy of the instrument to identify patients at risk of severe maternal morbidity or mortality.	Twenty-one (7.9%) of the 267 patients who were included satisfied the requirements for severe maternal morbidity. No maternal fatalities occurred. With a sensitivity of 85.7% (95% CI 63.7–97.0%), specificity of 67.9% (95% CI 61.7–73.7%), positive predictive value of 18.6% (95% CI 15.1–22.7%), and negative predictive value of 98.2% (95% CI 95.1–99.4%), the MEOWS tool performed well overall. With 16 (76.2%) cases, severe preeclampsia and eclampsia were the most frequent outcome category of severe maternal morbidity. 90.0% of patients did not return within 30 days, and the majority of patients (86.5%) were released straight from the emergency department.
(Putri et al., 2023) (Indonesia)	To determine the cut-off, point of the Modified Early Obstetric Warning System (MEOWS) scores for severe preeclampsia patients to enhance clinical surveillance and responsiveness for determining the appropriate level of care.	A retrospective cross-sectional study design was used, with 282 samples drawn from research participants' medical records at Pekanbaru's Arifin Achmad Hospital. The MEOWS score, the place of care, and preeclampsia (PEB) were among the research variables. Two groups were created from the research sample: those with low MEOWS scores (MEOWS < 8) and those with high MEOWS scores (MEOWS ≥ 8). SPSS was used to process and statistically analyze the data, and the Receiver Operating Characteristic (ROC) curve was used to determine sensitivity and specificity.	The MEOWS score cutoff for the two groups differed statistically significantly. The MEOWS score cut-off point, rounded to the nearest eight, was found to be 7.57. MEOWS scores ≥ 8 were significantly associated with both the risk of Intrauterine Fetal Demise (IUFD) (RR 1.04; 95% CI 1.02–1.06) and the need for Intensive Care Unit (ICU) care (Relative Risk [RR] 0.35; 95% Confidence Interval [CI]: 0.157–0.788; p = 0.009).

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Effective application of midwifery early warning in predicting adverse obstetric outcomes and reducing obstetric morbidity in hospitals: A systematic literature review

(Author, Year) (Country)	Purpose	Method	Results
(Xu et al., 2024) (China)	To validate the accuracy of four early warning scores for early identification of women at risk.	An analysis of pregnant patients who were admitted to the obstetric critical care unit (ICU) in the past. The ability of the Maternal Early Obstetric Warning System (MEOWS chart), Maternal Early Warning Trigger (MEWT), ICNARC Obstetric Early Warning Score (OEWS), and Modified Obstetric Early Warning Score (MOEWS) to predict severe maternal morbidity was compared. The scoring system's predictive performance was assessed using the area under the receiver operator characteristic (AUROC) curve.	290 pregnant women with significant maternal morbidity were found out of the 352 pregnant women that were included. Compared to MEOWS chart, ICNARC OEWS, and MEWT, MOEWS was more sensitive (96.9% vs. 83.4%, 66.6%, and 44.8%). The MEOWS chart (48.4%), MOEWS (83.9%), ICNARC OEWS (75.8%), and MEWT showed the best specificity (98.4%). For predicting maternal mortality, the AUROC of MOEWS, ICNARC OEWS, MEOWS chart, and MEWT were, respectively, 0.91 (95% CI: 0.874–0.945), 0.765 (95% CI: 0.71–0.82), 0.657 (95% CI: 0.577–0.738), and 0.716 (95% CI: 0.659–0.773). When it came to the discriminating of major complications in maternal hemorrhage, infection, cardiovascular illness, and hypertensive diseases, MOEWS had the highest AUCs. Peripheral oxygen saturation (SPO ₂), maximum respiratory rate (RR), maximum diastolic blood pressure (DBP), and maximum systolic blood pressure (SBP) all showed better predictive power for individual vital signs.
(Polprasarn et al., 2023) (Thailand)	To evaluate the application of Modified Early Obstetric Warning Criteria (MEOWC) in the immediate postpartum period and to generate an first predictive model for maternal morbidity following childbirth.	Conducted a retrospective case-control research between January 2017 and January 2020. Over the course of the trial, 2,762 births took place. A general hospital's obstetrics unit in Thailand's Nakhon Si Thammarat Province.	200 control cases and 100 cases of maternal morbidity that happened in the first several days after giving birth were matched. Compared to women lacking the criterion, those who had MEOWC in the immediate postpartum period had a much higher chance of developing postpartum maternal morbidity later on. The postpartum maternal morbidity was moderately predicted by MEOWC.

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DISCUSSION

The Modified Early Obstetric Warning System (MEOWS) functions as a structured checklist incorporating two tiers of vital sign thresholds: one representing a “yellow alert” for moderately concerning values and another indicating a “red alert” for more critical deviations. The parameters monitored include respiratory rate, oxygen saturation, temperature, systolic and diastolic blood pressure, heart rate, pain score, and neurological response. Clinical intervention is mandated if either one red alert or two yellow alerts are present. The core physiological parameters routinely recorded on the MEOWS chart encompass respiratory rate, oxygen saturation, temperature, systolic blood pressure, heart rate, and level of consciousness, which constitute the minimum standard for routine physiological monitoring.

Additional maternal-specific indicators such as diastolic blood pressure, pain severity, pre-delivery vaginal discharge and/or lochia, and postnatal proteinuria are also documented (Friedman, Campbell, Kline, Wiesner, D'Alton, & Shields, 2018). Other commonly monitored variables include pulse, temperature, and urine output (ml/hr), while specific parameters like blood loss characteristics, urine protein content, and cardiotocography (CTG) baseline are either integrated into the score or recorded via electronic health record systems such as BESTCare. Color-coded responses guide clinical action: grey (normal) requires no response; yellow (mild) prompts the primary nurse to notify the team leader; orange (moderate) necessitates a response from a senior nurse or physician; and red (severe) demands activation of the critical care response team (Abraham, Bakar, Al Aaly, Moustafa, & Kudus, 2023).

The QUADAS-2 tool was used to assess study quality, including the risk of bias and applicability concerns. The majority of studies were rated as having a low risk of bias in terms of patient selection (73%), index test (82%), and participant flow (80%). The most frequent sources of bias were the absence of a reference standard (three studies) and issues related to participant attrition (three studies). Approximately 20% of studies presented an unclear risk of bias in relation to the reference standard. Overall study quality was classified as good if low

bias and low concern were present across all four domains; medium if no more than one domain was unclear and none high; and poor if multiple domains were unclear or high risk. Most studies investigating MEOWS efficacy met the threshold for moderate to high quality. All studies utilized MEOWS adapted for obstetric populations. Two versions were developed specifically from a multi-country cohort of preeclamptic patients and may have limited generalizability to broader obstetric populations or resource-limited settings.

Diagnostic accuracy assessments involved a cohort of 352 pregnant women, among whom 290 (82.4%) were identified with severe maternal morbidity, and two fatalities (0.6%) were recorded. MEOWS scores were significantly elevated in women experiencing serious obstetric complications compared to those without [8 (6–10) vs. 4 (2–4.25), $z = -10.347$, $p < 0.001$]. MEOWS applied 24 hours post-ICU admission demonstrated superior sensitivity, specificity, and area under the receiver operating characteristic curve (AUROC) compared to pre-admission scores. When both MEOWS scores were combined, sensitivity reached 99.3% (95% CI: 98–100), specificity 75.8% (95% CI: 63–86), positive predictive value (PPV) 95.1% (95% CI: 92–97), and negative predictive value (NPV) 95.9% (95% CI: 86–100). The AUROC for MEOWS was 0.92 (95% CI: 0.88–0.96), outperforming the APACHE II score at 0.70 (95% CI: 0.63–0.76), indicating MEOWS as a more effective tool for early identification of critical maternal illness (Xu, Zhu, Song, Lian, Zeng, He, & Xiao, 2022).

Among the 15 studies evaluating MEOWS effectiveness in predicting obstetric morbidity and mortality, 11 focused specifically on mortality as the primary outcome. Two retrospective studies of good or moderate quality involved obstetric ICU admissions and reported high predictive accuracy of MEOWS for mortality (AUROC > 0.80) in critically ill obstetric patients. The application of Early Warning Systems has proven effective in the timely identification of severe morbidity. This represents the first documented evaluation of MEOWS performance both 24 hours before and after ICU admission, underscoring its potential to facilitate early screening

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and establish a strong correlation with severe maternal morbidity.

Preeclampsia was the most common indication for ICU admission (Xu et al., 2022), whereas in Rwanda, primary causes included obstetric hemorrhagic shock, sepsis, and septic shock. ICU mortality rates among obstetric patients remain alarmingly high. Scoring tools such as MEOWS and the quick Sequential Organ Failure Assessment (qSOFA) have demonstrated acceptable predictive accuracy for ICU mortality (Rudakemwa, Cassidy, & Twagirumugabe, 2021). Additionally, the combined predictive accuracy of the Rapid Index (RI) and MEOWS reached 86.2% (Tuyishime, Ingabire, Mvukiyehe, Durieux, & Twagirumugabe, 2020). Compared to APACHE II, MEOWS consistently exhibited superior sensitivity (99.3%), specificity (75.8%), and diagnostic precision, reinforcing its utility in enhancing maternal health outcomes (Xu et al., 2022).

The effectiveness of the Modified Early Obstetric Warning System (MEOWS) in enhancing sensitivity for predicting maternal morbidity has been reported at 72.91%, with a specificity of 91.87%. The tool also demonstrated a positive predictive value (PPV) of 85.96% and a negative predictive value (NPV) of 83.24%. Regarding maternal mortality prediction, the MEOWS achieved an area under the receiver operating characteristic (AUROC) curve of 0.79 (95% CI: 0.75–0.82). MEOWS enables the early identification of obstetric morbidity, often before clinical symptoms become apparent, positioning it as a valuable predictive tool for adverse maternal outcomes (Yadav & Sinha, 2023).

Three studies investigated the effectiveness of Early Warning Systems (EWS) in improving outcomes in general obstetric populations. These studies assessed both clinical outcomes—including morbidity, maternal mortality, and ICU admissions—and trigger system metrics, such as the frequency of vital sign recordings, time lag between alert and intervention, preoperative stabilization, specialist consultation rates, and referral frequency (Ibáñez-Lorente, Casans-Francés, Bellas-Cotán, & Muñoz-Alameda, 2021; Tamara, Lutfi, & Prawitasari, 2019).

In terms of maternal morbidity, mortality, and ICU admission, only one pre-post intervention study involving cesarean section patients evaluated

maternal mortality. However, disparities in the comparison groups limited the clarity of conclusions regarding sample adequacy and statistical power. Notably, a significant reduction in postpartum hemorrhage (PPH)-related complications was observed following the implementation of MEOWS (Ibáñez-Lorente et al., 2021). Although ICU admissions and severity of obstetric complications did not decrease significantly, the improved outcomes were attributed to earlier recognition and more timely interventions (Schuler, Katz, Melo, & Coutinho, 2019).

MEOWS demonstrated a discriminatory capacity of 0.74 for predicting clinical deterioration and outperformed other systems such as the Modified Early Warning Score (MEWS) and National Early Warning Score (NEWS). It yielded a sensitivity of 61% and specificity of 87%, while showing 28.9% sensitivity, 93.5% specificity, 36.1% PPV, 91.1% NPV, and an overall accuracy of 86.2% in predicting morbidity (Arnolds, Carey, Braginsky, Holt, Edelson, Scavone, & Churpek, 2022). The emphasis across studies remains on the prognostic effectiveness of MEOWS and similar tools in identifying and preventing maternal morbidity and mortality, rather than detailing physiological characteristics of the patient populations (Tuyishime et al., 2020).

As a bedside screening instrument, MEOWS has shown robust performance, with sensitivity at 87.1%, specificity at 92.7%, PPV of 89.7%, and NPV of 90.8%. Given these figures, it is recommended that MEOWS be routinely implemented across obstetric units for the early detection of adverse maternal outcomes (Gangwar, Kansal, Agarwal, & Bansal, 2023).

The Modified Obstetric Early Warning Score (MOEWS) also plays a crucial role in detecting potential postoperative complications and facilitating prompt intervention. The monitoring protocol includes vital sign assessments every 15 minutes for the first two hours, followed by hourly evaluations for the next four hours. Parameters include appearance, respiratory rate, heart rate, blood pressure, consciousness level, temperature, oxygen saturation, pain score, and urine output. Critical values falling within the red zone prompt immediate medical review, while yellow zone readings necessitate more frequent monitoring. Progressive

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deterioration across observations similarly indicates the need for clinical reassessment. In one study, 22.5% of recorded cases were triggered in recovery, with red zone alerts in 15% and yellow in 7.5% of patients. Clinical action followed in 55.6% of these cases, though direct medical intervention occurred in only 22% (Moore, Thomson, Pimentil, Fekad, & Graham, 2019).

Higher referral rates are also associated with MEOWS use, supporting its foundational role in identifying early signs of clinical deterioration and initiating review or referral. As the MEOWS score increases, reflecting worsening physiological status, timely responses are more likely, thereby enhancing patient safety and reducing preventable adverse outcomes. Notably, 94.87% of respondents in one study agreed that MEOWS charts assist in the early recognition of warning signs, with healthcare providers affirming its utility in identifying deteriorating patients and expediting ICU referrals (Raiji, Karonjo, Mwend, & Obura, 2018).

MEOWS has shown high sensitivity and specificity in predicting obstetric morbidity and ICU admissions. Although its PPV remains relatively modest, this does not detract from its utility as an effective bedside screening tool for general obstetric populations. While early warning systems demonstrate strong predictive value for maternal mortality in critically ill patients, evidence supporting their capacity to reduce maternal death remains limited (Polprasarn & Thongwon, 2023). Nevertheless, MEOWS contributes to more frequent and timely monitoring of vital signs and facilitates quicker clinical responses to patient deterioration, thereby potentially improving maternal care and reducing obstetric complications. Most obstetric EWS models rely on routinely collected clinical data, making them viable even in resource-limited settings. Further rigorous research is warranted to validate their effectiveness in reducing maternal mortality (Rudakemwa et al., 2021).

CONCLUSION

Obstetric Early Warning Systems (EWS) have shown effectiveness in detecting life-threatening complications and reducing maternal mortality within specific healthcare settings. They are particularly reliable in predicting severe morbidity among obstetric patients and mortality in critically ill cases.

These systems hold potential for enhancing care quality and preventing the progression of maternal morbidity. However, evidence supporting their impact on reducing maternal mortality across broader populations remains limited. Additionally, reliance on routinely collected clinical parameters in resource-constrained settings may contribute to suboptimal outcomes.

SUGGESTION

A national obstetric early warning tool that has been validated and standardized will allow for the uniformity and consistency required in the evaluation and treatment of pregnant women's potentially worsening conditions, as well as health workers' adherence to standards when using obstetric early warning tools.

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