Research Article

Sensitivity and Specificity of the Modified Early Obstetric Warning Score (MEOWS) and Maternal Early Warning Criteria (MEWC) for Predicting Maternal Morbidity: A Retrospective Cohort Study in Pregnant Women with COVID-19

Dinda Desti Cahyani[1,2], Heru Priyanto[1], Alfun Dhiya An[2], Supriyatiningsih[2]

[1]Department of Obstetrics and Gynecology Dr Moewardi Hospital, Faculty of Medicine Universitas Sebelas Maret Solo
[2]Department of Obstetrics and Gynecology, Faculty of Medicine and Health Science, Universitas Muhammadiyah Yogyakarta

Abstract

Objective: To compare the sensitivity, specificity, and predictive value of the Modified Early Obstetric Warning Score (MEOWS) and Maternal Early Warning Criteria (MEWC) in predicting morbidity among pregnant patients infected with COVID-19. This research aims to assess the use of these tools as screening methods for determining the appropriate level of care for pregnant COVID-19 patients.

Methods: A retrospective cohort study was conducted on 89 pregnant women with COVID-19 admitted to Bantul Regional General Hospital between January and December 2021.Data analysis was done using the ROC curve to compare sensitivity, specificity, and predictive values of MEOWS and MEWC.

Results: MEWC is better than MEOWS in predicting the morbidity of pregnant patients COVID-19 infection. The MEWC showed better sensitivity (78,3%) and PPV value (78%) compared to MEOWS, though it had a lower specificity (81.8%) and negative predictive value (NPV, 82%). MEOWS had a higher specificity (97.1%) but lower sensitivity. The ROC curve analysis yielded an area under the curve (AUC) of 74.9% for MEOWS and 80% for MEWC.

Discussion: MEWC has a better sensitivity indicating that patients who do not trigger MEWC criteria will have a low risk of experiencing maternal morbidity. Screening tools will prioritize the sensitivity value compared to the specificity value of the instrument used. A screening tool will have a lower positive predictive value if the study population has a lower prevalence of morbidity. Based on the comparison of the predictive value, sensitivity, and specificity of the MEWC and MEOWS instruments, it can be concluded that MEWC is associated with maternal morbidity with a higher sensitivity than MEOWS, although it has a lower specificity. High sensitivity values will result in screening tools with consistent results. The ROC curve can also show that MEWC has a higher sensitivity value by looking at the Y-coordinate, which is higher than the Y-coordinate of MEOWS. MEWC has a better Receiver Operator Curve (ROC) intersection point than MEOWS, where the MEWC intersection point has the furthest point on the upper left of the ROC diagonal line.

Conclusion: MEWC has a higher sensitivity compared to MEOWS, even though it has a lower specificity. High sensitivity values will produce screening tools with consistent results.

Keywords: MEWC, maternal early warning system, maternal morbidity, MEOWS.

Correspondence author. Dinda D. Cahyani. Department of Obstetrics and Gynecology Dr Moewardi Hospital. Sebelas Maret University. Solo. Email; dindadesti2312@gmail.com

INTRODUCTION

The World Health Organization declared COVID-19, a disease caused by the SARS-CoV-2 virus, a global pandemic on March 11, 2020[1]. This global pandemic has ushered in various impacts on aspects of life, particularly in healthcare systems around the world. One population of significant concern has been pregnant women[2]. In Indonesia, data collected from the Indonesian Obstetrics and Gynecology Association found that 20% of maternal deaths during the first 17 months of the pandemic were among pregnant women who tested positive for COVID-19. This

surge in maternal mortality peaked in July 2021, with death rates tripling compared to earlier in the pandemic[3]. According to data from the Ministry of Health, there were 7,389 maternal deaths in Indonesia in 2021a 56.69% increase compared to 2020, which saw 4,627 deaths. COVID-19 accounted for 2,982 of these deaths. Other significant causes included hemorrhage (1,320 deaths), hypertension during pregnancy (1,077 deaths), and heart disease (335 deaths). In addition to that, there were 207 maternal deaths due to infection; 80 due to metabolic disorders; 65 due to circulatory system disorders; 14 due to abortion; and 1,309 due to other causes[3].

Based on data from The American College of Obstetricians and Gynecologists shows that that pregnant women infected with SARS-CoV-2 are at increased risk of mortality and morbidity due to obstetric complications compared to those not infected with the virus[4]. *The Centers for Disease Control* reported a significant increase in cases of the SARS-COV 2 virus variant, the Delta variant, in late July 2021, with a more contagious character and a worse impact compared to the previous SARS-COV 2 variant. Meanwhile, pregnant women who have received full vaccination as of November 20, 2021, are only around 35%, so data shows that the occurrence of severe maternal morbidity in pregnant women is increasing during the period when the Delta variant attacked the world compared to when the previous SARS-COV 2 variant[5]. Another study found that during the Delta variant period, the risk of pregnant women being admitted to intensive care units increased by 66%, the risk of needing mechanical ventilation rose by 63%, and the risk of death was more than twice as high compared to infections from earlier SARS-CoV-2 variants[6].

The increased risks predominantly due to physiological and immunological changes experienced by pregnant women, particularly when infected with COVID-192. Physiological parameters such as blood pressure, heart rate, respiratory rate, temperature, and mental status can serve as early indicators of critical conditions across various populations, including obstetric patients. These parameters form the foundation of early warning scoring systems for obstetric patients[7]. This early warning system requires periodic monitoring of a patient's vital signs to allow for continuous assessment of their clinical condition. By detecting any deterioration early, timely interventions can be administered, improving the likelihood of positive outcomes[8].

Countries around the world employ various types of Modified Early Warning Systems, including the Modified Early Obstetric Warning Score (MEOWS), Maternal Early Warning Criteria (MEWC), and Maternal Early Warning Trigger (MEWT). The Confidential Enquiry into Maternal and Child Health (CEMACH) recommends the use of MEOWS, though research on its application as an early warning system for obstetric patients remains limited in developing countries, particularly during the ongoing pandemic. A prospective study conducted by Anju Singh and his team in 2016 evaluated the MEOWS scoring system's ability to predict morbidity in obstetric patients. The study found that MEOWS is sensitive in predicting maternal morbidity, with a sensitivity of 86.4% and a specificity of 85.2%. Furthermore, the researchers observed a correlation between the parameters used in MEOWS and obstetric morbidity[10,11]. Anju Singh and his team proved that tool is highly effective for monitoring treatment and predicting obstetric morbidity, and they strongly recommend its implementation in all obstetric units. At the conclusion of the study, Singh also called for further research on the MEOWS instrument in different clinical settings[7].

Another early warning system recommended by the National Partnership for Maternal Safety (NPMS) is the Maternal Early Warning Criteria (MEWC), designed to identify patients at risk of morbidity and mortality. MEWC provides an alert if even a single parameter falls outside the normal range, making it simpler compared to the Modified Early Obstetric Warning Score (MEOWS), which requires the calculation of a severity score based on 11 parameters[12,9]. MEWC, developed through consensus by experts in the United States[13] is recommended for use in all hospitals providing obstetric services by the American College of Obstetricians and Gynecologists (ACOG) District II's Safe Motherhood Initiative. This initiative aims to improve maternal health outcomes in New York, a state with one of the highest maternal mortality rates[14]. Research conducted by David E. Arnolds and his team in Chicago found that there was an association between MEWC and maternal morbidity, showing that MEWC demonstrated high sensitivity and negative predictive values (NPV), but lower specificity and positive predictive values (PPV). While MEWC's high sensitivity aligns with its role as a screening tool, it is recommended because it serves as an early warning system, prompting the need for diagnostic or therapeutic interventions

in women at risk of morbidity. A robust early warning system is believed to be a crucial tool in reducing maternal morbidity and mortality[10].

The purpose of this study is to compare the sensitivity and specificity of MEOWS and MEWC in predicting morbidity in pregnant patients infected with COVID-19. This research could serve as a screening method to help determine the appropriate level of care for pregnant patients with COVID-19.

METHODS

This quantitative research is conducted using a retrospective cohort method. Data collection is performed through the extraction of medical records from Bantul Regional General Hospital. The study was carried out at Panembahan Senopati Bantul Regional General Hospital, with data collected from medical records of pregnant inpatients infected with COVID-19 between November 7, 2022, and December 1, 2022. Based on the results of the medical record analysis, a comparison between the MEOWS and MEWC early warning systems in predicting patient morbidity will be evaluated. The control group consists of pregnant patients with confirmed COVID-19 infection who were monitored using standard care protocols without the implementation of the MEOWS or MEWC early warning systems.

The research has been carried out in the medical record room of the Bantul Regional General Hospital. The study population consisted of inpatient pregnant patients who were confirmed with COVID-19 infection. Samples are determined through total sampling which aims to obtain a more comprehensive and thorough sample type. Samples were taken through medical records by taking into account the patient's MEOWS sheet, the initial assessment sheet of hospitalization, CPPT (Integrated Patient Development Record) sheet for inpatient care, the patient's entry and exit summary sheet, and the PCR swab laboratory result sheet in the patient's medical record.

Univariate analysis analyses each research variable descriptively by calculating the frequency distribution of the variables and research subjects based on age, gravida status, and gestational age. In this study, univariate analysis was conducted using frequency analysis[15]. Bivariate analysis, or correlation analysis, was used to examine the relationship between two variables: the relationship between MEOWS and MEWC and morbidity and mortality in pregnant patients infected with COVID-19. The statistical technique employed was the Chi-Square test, with a significance level (p-value) of 0.05, as the data is nominally categorical. Receiver Operating Curve (ROC) analysis was also performed to compare the area under the curve (AUC), sensitivity, and specificity of the two maternal early warning systems.

In this study, the population was pregnant women with COVID-19. This study compares MEOWS and MEWC in the early detection of complications in pregnant women with COVID-19 and assesses whether MEWC is better than MEOWS in predicting morbidity in pregnant patients with COVID-19 infection. For this purpose, predictive value analysis, accompanied by sensitivity and specificity value analysis, was carried out to assess the comparison between the two early warning scores. Predictive value, sensitivity, and specificity were analysed with a 95% CI.

RESULTS

The study included a total of 89 pregnant patients infected with COVID-19 who were admitted to Bantul Regional General Hospital. The sample characteristics based on age, gestational age, and gravida status are as follows.

Table 1. Sample Characteristics of Pregnant Patients Infected with COVID-19 in Bantul Regional General Hospital

Sample Characteristics		
	Frequency (n)	**Percentage (%)**
Age		
Reproductive (20-35)	77	86.5
Risk (< 20 and > 35)	12	13.5
Gestational Age (weeks)		
< 37	31	34.8
37-42	57	64.0
> 42	1	1.1
Gravida		
Primigravida	35	39.3
Multigravida	54	60.7

Based on Table 1, it can be observed that the study sample was predominantly composed of pregnant patients infected with COVID-19 within the reproductive age range (20-35 years), accounting for 77 patients (86.5%). Most of the patients had a gestational age of 37-42 weeks, with 57 patients (64.0%), and the majority were multigravida pregnancies, comprising 54 patients (60.0%) of the total study sample, with a 95% Confidence Interval (CI). The following are the

results of the data analysis on the correlation and comparison of MEOWS and MEWC in pregnant patients infected with COVID-19 at Bantul Regional General Hospital. Based on Table 1, it can be observed that the study sample was predominantly composed of pregnant patients infected with COVID-19 within the reproductive age range (20-35 years), accounting for 77 patients (86.5%). Most of the patients had a gestational age of 37-42 weeks, with 57 patients (64.0%), and the majority were multigravida pregnancies, comprising 54 patients (60.0%) of the total study sample, with a 95% Confidence Interval (CI). The following are the results of the data analysis on the correlation and comparison of MEOWS and MEWC in pregnant patients infected with COVID-19 at Bantul Regional General Hospital.

Table 2. Relationship of MEOWS with Morbidity in Pregnant Patients Infected with COVID-19 at Bantul Regional General Hospital

MEOWS	**Morbidity**		***P-value***
	non-morbidity (n)	**morbidity (n)**	
Normal	33 (37.1)	1 (1.1)	21.132
Trigger	26 (29.2)	29 (32.6)	(0.000)
Total	59	30	

Table 2 shows that a sample of pregnant patients infected with COVID-19 with a "normal" category MEOWS score and experienced Non-Morbidity was 33 (37,1%) samples. Based on the calculation results of *Chi-Square*, p-value = 0.000 < α = 0.05 (*p-value value* smaller than α = 0.05 with 95% Confidential Interval (CI)). This means that there is a significant association between the MEOWS and the incidence of morbidity in pregnant patients infected with COVID-19 at the Bantul Regional General Hospital.

Table 3. Relationship of MEWC with Morbidity in Pregnant Patients Infected with COVID-19 at Bantul Regional General Hospital

MEOWS	**Morbidity**		***P-value***
	non-Morbidity (n)	**Morbidity (n)**	
Normal	54 (60.7)	12 (13.5)	24.928
Trigger	5 (5.6)	18 (20.2)	(0.000)
Total	59	30	

Table 3 showed that the majority of the sample of pregnant patients infected with COVID-19 with a normal MEWC score and experienced Non-Morbidity was 54 (60.7%) patients. Based on the calculation results of *Chi-Square*, p-value = 0.000 < α = 0.05 (*p-value value* smaller than α = 0.05 with 95% Confidential Interval (CI)). This means that there is a significant relationship between MEWC and the incidence of morbidity in pregnant patients infected with COVID-19 at Bantul Regional General Hospital.

Table 4. Comparison of Sensitivity and Specificity of MEWC and MEOWS in Pregnant Patients with COVID-19 at Bantul Regional General Hospital

	MEOWS	**MEWC**
AUC	74.9	80
Sensitivity	52.7	78.3
1-Specificity	2.9	18.2
PPV	53	78
NPV	97	82
Odds Ratio	36.808	16.200
Chi Square	21.132	24.928

Table 4 shows that MEWC has a better value sensitivity (78.3%) compared to MEOWS (52.7%), even though MEWC's specification value (81.8%) is lower than MEOWS (97.1%) with 95% Confidential Interval (CI). So the results of the data analysis on MEWC's ability to show truly morbidity individuals from the total morbidity population and the value of the proportion of patients with negative tests who really do not experience morbidity are better than MEOWS' ability. showed that the ability of MEWC to detect an early morbid condition or the possibility of a positive result when performed on a group of subjects at risk of experiencing morbidity is better than the ability of MEOWS. Meanwhile, the ability of MEWC to determine that the subject is not sick or the possibility of a negative result if it is performed on a group of healthy subjects is lower than that of MEOWS.

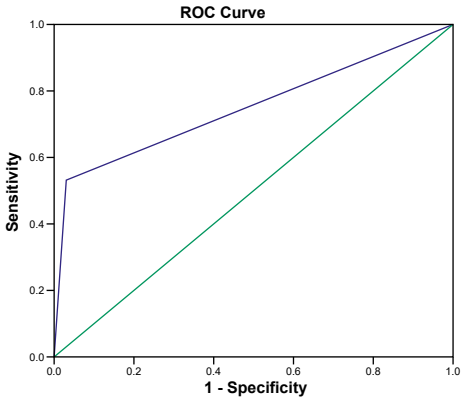

Figure 1. Receiver operator curve MEOWS

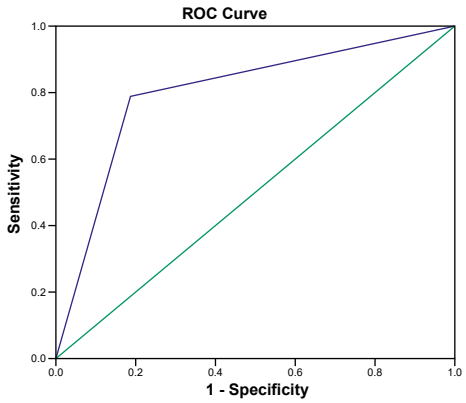

Figure 2. Receiver operator curve MEWC

Figure 1 and 2 shows that MEWC has a bigger area under curve than MEOWS. The results of MEOWS and MEWC data analysis using ROC produce an area under the curve for MEOWS of 0,749 (74,9%) while for MEWC of 0,800 (80%, with 95% Confidential Interval (CI)) so we can see that MEWC has a better ROC intersection point than MEOWS, where the MEWC intersection point has the furthest point on the upper left of the ROC diagonal line. The ROC curve can also show that MEWC has a higher sensitivity value by looking at the Y-coordinate, which is higher than the Y-coordinate of MEOWS.

DISCUSSION

The results of the analysis showed that a large portion of the sample was aged 20-35 years, accounting for 86.5% or 77 patients. This indicates that most pregnant patients infected with COVID-19 at Bantul Regional General Hospital were within the reproductive age group. These findings align with data reported by the CDC, based on the largest sample of pregnant patients in the United States. A Morbidity and Mortality Weekly Report covering the period from January 22 to June 7, 2020, found that 8,207 of the total 326,335 confirmed COVID-19 cases in women of reproductive age were pregnant. The dominance of this age group can be attributed to the fact that women of reproductive age are more likely to conceive, have more frequent interactions with the healthcare system, and exhibit higher mobility compared to other age groups[16].

The data collected in this study found that most of the sample of pregnant women confirmed with COVID-19 was within 37-42 weeks of pregnancy, namely 57 (64.0%) patients. This shows that pregnant women infected with COVID-19 at the Bantul Regional General Hospital are mostly at gestational age in the third trimester. Several studies have found a predominance of pregnant women in the third trimester in pregnant patients with confirmed COVID-19. Although until now the cause is not known for certain, there is a suspicion that there is a possibility of patients undergoing swab tests at the same time as when they come to the hospital with increased obstetric complaints in that trimester[13].

The results of patient data collection in this study found that a large percentage of patients were multigravida, accounting for 60.0% (54) of the total sample. This indicates that, in terms of parity status, most pregnant patients confirmed with COVID-19 at Bantul Regional General Hospital had been pregnant two or more times. Primigravida refers to a woman who is pregnant for the first time, whereas multigravida refers to a woman who has been pregnant more than once. According to findings reported by the CDC and several previous studies, higher parity levels are often associated with older maternal age and larger family size, which may be among the risk factors for the transmission of the SARS-CoV-2 virus[13].

Maternal Early Warning Criteria (MEWC)

Sixty-six or 74.2%, of pregnant patients infected with COVID-19 at the Bantul Regional General Hospital had MEWC assessment results in the "Normal" (non-trigger) category. According to research by David Arnold and his team in Chicago, women who did not trigger criteria (Normal) on the MEWC assessment had a low risk of experiencing morbidity. An increased risk of morbidity can still occur due to physiological and immunological changes experienced by pregnant women, especially when infected with COVID-19[2]. Changes in vital signs such as blood pressure, heart rate, respiratory rate, and body temperature can be used as parameters to predict the onset of morbidity or mortality in various populations, including the obstetric population This forms the basis for the development of maternal early warning systems. This early warning system requires periodic measurement of the patient's vital signs so that the patient's clinical condition can be monitored optimally and any worsening of the patient's condition can be detected earlier so that the intervention given is not too late for better outcomes[7]. The MEWC is a simplified version of the MEOWS early warning system.[9]. The primary difference between the two systems lies

in the number of abnormal parameters needed to activate the warning. In MEWC, an immediate warning is triggered when a single parameter falls outside the normal range. The MEWC system uses parameters based on reviews of various cases of maternal morbidity and mortality, although the effectiveness of the system relies heavily on how well it is implemented by each healthcare provider[11].

Modified Early Obstetric Warning Score (MEOWS)

Table 2 indicates that a significant proportion of pregnant patients with COVID-19 at Bantul Regional General Hospital, assessed using MEOWS, fell into the 'Normal' category, accounting for 38.2% (n=34) of respondents. Previous research indicates that MEOWS can be effectively used to predict obstetric morbidity and serves as a practical bedside screening tool. It meets most of the criteria for ideal screening in pregnant patients, allowing for early recognition of life-threatening situations, which can help reduce maternal morbidity and mortality[7]. However, there has been limited research on the use of MEOWS as a maternal early warning system in developing countries, despite the urgent need for its implementation, especially under current conditions[8]. The escalation protocol used in the MEOWS early warning system is based on parameter score values outside the normal limits, where the warning will be active when the total parameter score is more than equal to 7 or is in the red alert zone (high risk), so that an examination of the patient's condition is needed to determine whether intensive care is needed for the patient[9].

Relationship of Maternal Early Warning Criteria (MEWC) and Modified Early Obstetric Warning Score (MEOWS) with Morbidity Maternal

The chi square continuity correction yielded MEWC and MEOWS scores of 24.928 and 21.132, respectively, with a p-value $<\alpha = 0.05$, indicating a significant relationship between MEWC and MEOWS with the incidence of morbidity in pregnant patients with COVID-19 at Bantul Regional General Hospital. This means that the MEWC and MEOWS scores can predict the incidence of morbidity in pregnant patients infected with COVID-19. The results of this study were supported by the study which showed that the parameters used in MEOWS had a significant correlation with maternal morbidity[7]. In addition, researchers also found MEOWS to be sensitive in predicting maternal morbidity, with a sensitivity value of 86.4% and a specificity value of 85.2%[7]. Research also proves that the MEOWS instrument is very useful as a treatment monitoring tool in predicting obstetric morbidity and highly recommends its use for all maternity care units everywhere7. The results of this who stated that the sensitivity of the maternal early warning system reached a proportion of 89% and a specificity of 85% for predicting morbidity[17]. The results of this study also confirmed a significant relationship between MEWC and maternal morbidity. It was found that MEWC has excellent sensitivity and a high negative predictive value, demonstrating that women who do not trigger criteria in MEWC have a low risk of experiencing maternal morbidity[10]. MEWC's sensitivity is comparable to that of the maternal early warning system recommended by the British Confidential Inquiry into Maternal and Child Health[10]. Its high sensitivity makes it an effective screening tool. MEWC is recommended for its role not only as a screening tool but also as a reminder for the need for early diagnostic or therapeutic intervention in women at risk of morbidity. A strong early warning system is considered a vital tool in reducing maternal morbidity and mortality[10]. The results of this study indirectly support the recommendations issued by the NPMS regarding the use of MEWC to assist health workers in the early identification of obstetric patients who are at risk of experiencing maternal morbidity[10]. The findings of this study are further supported by evidence showing that the MEOWS early warning system, when simplified, becomes more sensitive and useful. The analysis also concluded that simplifying early warning system parameters can reduce the complexity of managing triggered warnings and decrease the overall workload, without diminishing the potential benefits of early warning systems as a patient safety tool. Based on the results of this analysis, it can be concluded that the MEWC is more effective than MEOWS in predicting morbidity in pregnant patients with COVID-19 infection.

Comparison of Predictive Value, Sensitivity, and Specificity of MEWC and MEOWS

Screening tools will prioritize the sensitivity value compared to the specificity value of the

instrument used. Previous studies have found that MEWC has a very good sensitivity (97%) and negative predictive value (97%), thus indicating that patients who do not trigger MEWC criteria will have a low risk of experiencing maternal morbidity[10]. The findings in this study are in line with Arnold and his team's research, which found a MEWC sensitivity value of 78.3%. Although the specificity value of MEWC (81.8%) when compared to MEOWS (97.1%) does have a lower specificity value, This is because all screening tools, including maternal early warning systems with high sensitivity, tend to sacrifice specificity[10]. The definition of maternal morbidity in each study will also influence the performance of any screening method[18]. The positive and negative predictive values of a screening tool will tend to depend on the prevalence of morbidity, so they are highly individual for each study population. A screening tool will have a lower positive predictive value if the study population has a lower prevalence of morbidity[10]. Based on the comparison of the predictive value, sensitivity, and specificity of the MEWC and MEOWS instruments, it can be concluded that MEWC is associated with maternal morbidity with a higher sensitivity than MEOWS, although it has a lower specificity. High sensitivity values will result in screening tools with consistent results.

Comparison Area under Curve (Receiver Operator Curve) of MEWC and MEOWS

MEWC has a bigger area under curve than MEOWS. Receiver Operator Curve (ROC) is a way of determining the cut-off point of a diagnostic test in the form of a graph that illustrates the trade-off between sensitivity and specificity. Assessment of the ability of a test is done by AUC. AUC values range from 0–1, where the ability of a test is declared good if the AUC is 0.7[19]. Sensitivity is described in the Y-ordinate, while 1-specificity is described in the X abscissa, so that the higher the sensitivity, the lower the specificity, and vice versa. The diagonal line on the ROC shows a line consisting of points with a sensitivity equal to 1, so the closer the ROC curve is to the diagonal line, the worse the result[12]. The best point of intersection is the point farthest to the upper left of the diagonal line. The results of MEOWS and MEWC data analysis using ROC produce an area under the curve for MEOWS of 0,749 (74,9%) while for MEWC of 0,800 (80%) so we can see that MEWC has a better Receiver Operator Curve (ROC) intersection point than MEOWS, where the MEWC intersection point has the furthest point on the upper left of the ROC diagonal line. The ROC curve can also show that MEWC has a higher sensitivity value by looking at the Y-coordinate, which is higher than the Y-coordinate of MEOWS[20].

CONCLUSION

Our study suggests that MEWC outperforms MEOWS in predicting morbidity, due to its superior sensitivity, PPV, and AUC value. While MEWC exhibits a lower specificity and NPV value, the high sensitivity ensures consistent results in identifying patients at risk. It is important to note that this research has limitations because it was conducted quantitatively, so researchers do not yet know in depth the perceptions of health workers regarding the use of MEWC and MEOWS in maternal unit services. Future research could explore ways to deepen this research through qualitative research to reveal the perceptions of health workers so that the barriers and conveniences of each instrument can be identified. Future researchers are also advised to use different methods, such as prospective cohorts. This research is also still being carried out centrally in one hospital, so multicenter research is needed to see more comprehensive results.

ACKNOWLEDGEMENT

The author would like to thank the director of Bantul Regional General Hospital (RSUD Panembahan Senopati) who has supported the implementation of this project.

REFERENCES

1. Brahmana, Ivanna Beru, & Rosa, Elsye Maria. Factors Influencing Covid-19 Transmission to Patients at the Obstetrics and Gynecology Polyclinic. J Medicoeticolegal Manajemen Rumah Sakit. 2020; 9(3): 207–15. https://doi.org/10.18196/jmmr.93132
2. Qeadan, Fares, Mensah, Nana A., Tingey, Benjamin, & Stanford, Joseph B. The risk of clinical complications and death among pregnant women with COVID-19 in the Cerner COVID-19 cohort: a retrospective analysis. BMC Preg Childbirth. 2021;21(1):1–14. https://doi.org/10.1186/s12884-021-03772-y
3. POGI. POGI: 20 Persen Kematian Ibu Hamil Akibat Positif Covid-19. CNN Indonesia.Com. 2021: 1.

4. Metz, Torri D., Clifton, Rebecca G., Hughes, Brenna L., Sandoval, Grecio J., Grobman, William A., Saade, George R., Manuck, Tracy A., Longo, Monica, Sowles, Amber, Clark, Kelly, Simhan, Hyagriv N., Rouse, Dwight J., Mendez-Figueroa, Hector, Gyamfi-Bannerman, Cynthia, Bailit, Jennifer L., Costantine, Maged M., Sehdev, Harish M., Tita, Alan T. N., Macones, George A. Association of SARS-CoV-2 Infection With Serious Maternal Morbidity and Mortality From Obstetric Complications. National Institute of Child Health and Human Development Maternal-Fetal Medicine Units (MFMU) Network. Jama. 2022. https://doi.org/10.1001/jama.2022.1190
5. DeSisto, Carla L., Wallace, Bailey, Simeone, Regina M., Polen, Kara, Ko, Jean Y., Meaney-Delman, Dana, & Ellington, Sascha R. Risk for Stillbirth Among Women With and Without COVID-19 at Delivery Hospitalization United States, March 2020–September 2021. MMWR. Morbidity Mortality Weekly Report. 2021;70:1640–45. https://doi.org/10.15585/mmwr.mm7047e1
6. States, Status United, Strid, Penelope, Zambrano, Laura D., Woodworth, Kate R., & Ellington, Sascha R. COVID-19 Severity among Women of Reproductive Age with Symptomatic Laboratory-Confirmed SARS-CoV-2 by Pregnancy. 2021:1–15.
7. Yadav, P., & Sinha, R. (2023). Validating the Performance of Modified Early Obstetrics Warning Score (MEOWS) for Prediction of Obstetrics Morbidity: A Prospective Observational Study in a Tertiary Care Institute in East India. J Obstet Gynecol Ind. 2023; 73(Suppl 2): 227–33. https://doi.org/10.1007/s13224-023-01855-8
8. Singh, Anju, Guleria, Kiran, Vaid, Neelam B., & Jain, Sandhya. Evaluation of maternal early obstetric warning system (MEOWS chart) as a predictor of obstetric morbidity: a prospective observational study. Eur J Obstet Gynecol Reprod Biol. 2016;207:11–7. https://doi.org/10.1016/j.ejogrb.2016.09.014
9. Blumenthal, Elizabeth A., Hooshvar, Nina, McQuade, Miriam, & McNulty, Jennifer. A Validation Study of Maternal Early Warning Systems: A Retrospective Cohort Study. Am J Perinatol. 2019; 36(11): 1106–14. https://doi.org/10.1055/s-0039-1681097
10. Kaur, J., Thompson, C., McLeod, S., & Varner, C. Application of the Modified Early Obstetrical Warning System (MEOWS) in postpartum patients in the emergency department. CJEM. 2023; 25(6): 481–8. https://doi.org/10.1007/s43678-023-00500-7
11. Xu, Y., Zhu, S., Song, H., Lian, X., Zeng, M., He, J., Shu, L., Xue, X., & Xiao, F.. A new modified obstetric early warning score for prognostication of severe maternal morbidity. BMC Preg Childbirth. 2022;22(1): 901. https://doi.org/10.1186/s12884-022-05216-7
12. Kumala Fajar Apsari, Ratih. Deteksi Pasien Obstetrik Kritis dengan Maternal Early Warning System. Jur Anest Obstet Indones.2020;2(1):63–70. https://doi.org/10.47507/obstetri.v2i1.35
13. Arnolds, David E., Smith, Aaron, Banayan, Jennifer M., Holt, Roxane, & Scavone, Barbara M. (2019). National Partnership for Maternal Safety Recommended Maternal Early Warning Criteria Are Associated with Maternal Morbidity. Anest Anal. 2019;129(6):1621–6. https://doi.org/10.1213/ANE.0000000000003889
14. Friedman, Alexander M. Maternal Early Warning Systems. Obstet Gynecol Clin North America. 2015; 42(2): 289–98. https://doi.org/10.1016/j.ogc.2015.01.006
15. Sugiyono. Metode penelitian kuantitatif kualitatif dan r&d. intro (PDFDrive).pdf. Bandung Alf. 2011: 143.
16. Overton, Eve E., Goffman, Dena, & Friedman, Alexander M. The Epidemiology of COVID-19 in Pregnancy. Clin Obstet Gynecol. 2022;65(1):110–22. https://doi.org/10.1097/GRF.0000000000000674
17. Umar, Aminu, Ameh, Charles A., Muriithi, Francis, & Mathai, Matthews. Early warning systems in obstetrics: A systematic literature review. PLoS ONE. 2019;14(5). https://doi.org/10.1371/journal.pone.0217864
18. Singhal, S., Acharya, N., Madaan, S., Mohammad, S., & Acharya, S. Use of the modified early obstetric warning system chart as a predictor of peri-partum obstetric morbidity in a rural teaching institute: A two-year cross-sectional study. J Fam Med Prim Care. 2022; 11(12): 7644–51. https://doi.org/10.4103/jfmpc.jfmpc_320_22
19. Tamara, Yosi, Lutfi, Muhammad, & Prawitasari, Shinta. Hubungan Maternal Early Obstetric Warning Score (MEOWS) dengan Perawatan di Intensive Care Unit pada Pasien Preeklamsia Berat di RSUP DR. Sardjito. Jur Kes Reprod. 2019;6(3):79. https://doi.org/10.22146/jkr.49330
20. Arnolds, D. E., Carey, K. A., Braginsky, L., Holt, R., Edelson, D. P., Scavone, B. M., & Churpek, M. Comparison of early warning scores for predicting clinical deterioration and infection in obstetric patients. BMC Preg Childbirth. 2022; 22(1):295. https://doi.org/10.1186/s12884-022-04631-0