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Maternal near miss: A comprehensive analysis of severe maternal morbidity and mortality at a tertiary referral center

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Abstract

Aim: Our aim is to evaluate the cases that are followed in our hospital and meet the maternal near miss (MNM) criteria and to contribute to the management of these cases in the light of this information.

Materials and Methods: Our study was conducted retrospectively. Data of 50 pregnant women who were treated in intensive care between 2022 and 2024 and met the MNM criteria of the World Health Organization (WHO) were collected from the hospital registry system. Information about the cases, laboratory results, clinical follow-up data and newborn data were obtained from the hospital registry system. Descriptive statistics were used to evaluate the cases.

Results: The mean maternal age was 30.55 ± 5.95 years, with a median BMI of 28 (IQR: 7). Most of the MNM cases occurred antenatally (46%) or intrapartum (34%). Hypertensive disorders, including gestational hypertension (42%), preeclampsia (40%), and HELLP syndrome (14%), were the leading causes of MNM, followed by hemorrhagic disorders such as postpartum atony (12%) and placenta previa (10%). Medical conditions, such as cardiovascular disease (18%) and diabetes (14%), were also significant contributors. Overall, 64% of patients recovered without sequelae, while 28% experienced long-term effects, and 3 patients (6%) died. The maternal mortality ratio (MMR) was 12.23 per 100,000 live births, and the maternal near miss ratio (MNMR) was 2.04 per 1,000 live births, with a mortality index of 5.66%.

Conclusion: Consistent with previous results, hypertensive and hemorrhagic diseases were shown to be the most important causes of maternal near miss events. Maternal morbidity was also increasingly influenced by chronic medical disorders. However, high MNMR and mortality index indicate the need for effective management of serious maternal complications. The study underscores the importance of early detection, timely intervention, and multidisciplinary care in managing maternal near miss cases. To enhance maternal health outcomes, more work must be done.

Introduction

Pregnancy and pregnancy-related complications and maternal deaths is one of the most important problems encountered in the healthcare system. Approximately 295,000 maternal deaths were reported to have occurred during or after birth in 2017 [1]. Of these deaths, 94% happened in low-resource environments and were mostly avoidable [2]. Working on this issue, the World Health Organization published a statement in 2004 emphasizing why maternal losses occur and how they can be prevented [3]. In 2011, it defined the concept of Maternal near miss to evaluate the quality of maternal care [4]. According to WHO maternal near miss (MNM) is a term that refers to the survival of a pregnant woman despite encountering life-threatening complications during pregnancy, birth or within 42 days after birth [5]. Today, MNM is accepted as an indicator of the quality of maternal care. Although worldwide efforts have greatly lowered maternal mortality rates, especially with programs like the Sustainable Development Goals (SDGs) aiming at maternal health (SDG 3.1), MNM instances remain a crucial indicator for even bettering maternal outcomes [6]. The purpose of WHO's definition is to address the causes and management of maternal losses and to determine the measures required to prevent these losses [7]. The main pathologies that con-

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tribute to MNM cases in studies are; bleeding, hypertensive disorders of pregnancy, postpartum sepsis, obstructed labor, uterine rupture, abortion and anemia [8].

Particularly in high-risk settings like emergency departments, near-miss detection is crucial in healthcare to help prevent adverse outcomes [9,10]. Standard reporting systems may be inadequate to interpret these often overlooked events. Identifying and analyzing MNM cases helps improve maternal health, making these data a valuable tool to improve the quality of maternal care [11].

In this study, we aimed to evaluate MNM cases in our hospital, a tertiary healthcare institution, and to identify the main factors contributing to this condition. With our findings, we aim to provide insight into the effectiveness of clinical management strategies and contribute to studies aiming to improve the quality of maternal care in high-risk pregnancies. This retrospective study aims to analyze 50 cases of maternal near miss cases treated at the Perinatology Clinic of Etlik City Hospital between September 2022 and June 2024.

Materials and Methods

This retrospective study was conducted in Perinatology Clinic of Etlik City Hospital between September 2022 and June 2024. Cases in intensive care were evaluated and 50 cases that met WHO MNM criteria were included in the study [5]. Ethical approval was obtained from the Ankara Etlik City Hospital No. 1 Clinical Research Ethics Committee (approval number: AEŞH-BADEK-2024-914). The study was conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all participants, and their clinical data were used with their permission.

This study was planned as a single-center, descriptive study in which all cases that met the World Health Organization's MNM criteria were included in a certain time period. Initially, all pregnant women and women who gave birth until the 42nd postpartum day, who were admitted to the intensive care unit of our hospital were identified through the hospital data system. Approximately 210 cases were reached. Each case was then evaluated individually according to the WHO MNM criteria, and 50 cases meeting these criteria were included in the study. The exclusion criteria included any pregnant or postpartum women within the first 42 days after birth admitted to intensive care but not meeting the MNM criteria.

Our sample size was thus determined by analyzing all cases that met the criteria within the selected time frame. Given that similar single-center studies are limited, we evaluated the adequacy of our sample size by referencing studies like those by Verma et al. [12], Jabir et al. [13] and Kachale et al. [14].

Data were collected from the hospital's electronic medical records. Patients' demographic characteristics (age, parity, gravidity, body mass index), obstetric history, chronic illnesses, pregnancy characteristics, laboratory results, clinical management of complications, maternal outcomes and fetal outcomes were documented.

Statistical analysis

The SPSS 22.0 (SPSS Inc.; Chicago, IL, USA) software was used for all statistical analyses. Descriptive statistics were used to summarize the data, including means, medians, and standard deviations for continuous variables and categorical variables are expressed as frequencies and percentages. Kolmogorov-Smirnov test was applied to evaluate normality. Our study is a descriptive analysis and no comparative hypothesis testing was performed.

Results

In this study of maternal near miss cases, the mean maternal age was 30.55 ± 5.95 years, and the median BMI was 28 (IQR: 7). The mean gestational age at the time of MNM events was 32.19 ± 6.85 weeks and most of the cases occurred antenatally (46%) or intrapartum (34%). The majority of participants were multiparous (median parity: 2.0), and caesarean sections were dominant mode of delivery (88.9%). The most common comorbid conditions were maternal anemia (56%), fetal growth restriction (50%) with preeclampsia (22.2%), and chronic hypertension (16%). Educational levels varied; 38% had completed secondary school and 4% had no school education. The rates of premature birth (66.7%) and stillbirth (8.89%) were also quite high (Table 1).

Gestational hypertension was seen in 21 instances (42.0%), pre-eclampsia in 20 cases (40.0%), and HELLP syndrome in 7 cases (14.0%), hypertensive diseases were the main cause of maternal near misses. Among haemorrhagic disorders, postpartum atony was seen in 6 cases (12.0%), followed by placenta previa (5 cases, 10.0%). Medical disorders, particularly heart disease (9 cases, 18.0%) and diabetes (7 cases, 14.0%), were also significant contributors to morbidity. While 32 of 50 patients (64%) experienced improvement without sequelae, 14 patients (28%) experienced improvement with sequelae (Table 2).

The most frequent complication was hemorrhage exceeding 1000 mL, affecting 62% of patients. Acute kidney injury (AKI) and shock each occurred in 32% of cases, while relaparotomy and sepsis were noted in 28%. Pulmonary edema was present in 24% of patients, and disseminated intravascular coagulation (DIC) affected 18%. Other frequently observed complications are shown in Table 3.

Clinical criteria were met by 84% of women, with respiratory rate abnormalities (66%), oliguria non-responsive to treatment (60%), and acute cyanosis (39%) being the most frequent. Laboratory abnormalities were present in 82%; they predominantly included prolonged oxygen saturation below 90% (70%) and impaired gas exchange (PaO_2/FiO_2 $<$ 200 mmHg) in 22%. Management-based interventions were followed in 80% of cases, most commonly the use of vasoactive medications (34%) and transfusion of more than 5 units of red blood cells (44%) (Table 4).

During the study period, there were 50 maternal near-miss cases and 3 maternal deaths among 24,526 live births. The maternal mortality ratio (MMR) was calculated as 12.23 per 100,000 live births. The maternal near miss ratio (MNMR) was 2.04 per 1,000 live births, indicating that maternal near miss cases occurred relatively frequently in comparison to maternal deaths. The mortality index (the

Table 1. Sociodemographic characteristics among women with maternal near miss.

Characteristic	n = 50	95% CI
Maternal age, mean ± SD	30.55 ± 5.95	28.75-32.13
BMI, median (IQR)	28 (7)	26.10-31.42
Gestational age, mean ± SD	32.19 ± 6.85	30.24-34.13
Ultrasound measurement, mean ± SD	31.42 ± 6.80	29.49-33.35
Timing of MNM events, no. (%)		
Antenatal	23 (46)	
Intrapartum	17 (34)	
Postpartum	10 (20)	
Gravidity, median (IQR)	2.0 (3.0)	1.75-5.85
Parity, median (IQR)	2.0 (2.0)	1.43-3.64
Living children, median (IQR)	2.0 (2.0)	1.32-3.35
Abortions, median (IQR)	0.0 (1.0)	0.12-1.04
DC, median (IQR)	0.0 (0.0)	0.01-0.13
Education level, no. (%)		
Primary school dropout	4 (8)	
Primary school graduate	11 (22)	
Middle school graduate	19 (38)	
High school graduate	14 (28)	
University graduate	2 (4)	
Pregnancy without antenatal care, no. (%)	2 (4)	
Number of abortions, no. (%)	5 (10)	
Mode of delivery, no. (%)		
Vaginal delivery	5 (11.1)	
Caesarean section	40 (88.9)	
Timing of delivery, no. (%)		
Extreme preterm (≤28 weeks)	5 (11.1)	
Very preterm (28-32 weeks)	8 (17.8)	
Preterm (34-37 weeks)	17 (37.8)	
Term (≥37 weeks)	15 (33.3)	
Anemia, no. (%)	28 (56)	
Stillbirth, no. (%)	4 (8.89)	
Fetal growth restriction (FGR), no. (%)	10 (22.2)	
Diabetes mellitus (DM), no. (%)	10 (20)	
Gestational diabetes mellitus (GDM), no. (%)	4 (8)	
Placenta previa, no. (%)	5 (10)	
Chronic hypertension, no. (%)	8 (16)	
Preeclampsia, no. (%)	25 (50)	
HELLP syndrome, no. (%)	7 (14)	
Cardiac disease, no. (%)	4 (8)	
Hospital stay duration, median (IQR)	11.25 (11)	13.02-24.56

CI: Confidence Interval, SD: Standard Deviation, BMI: Body Mass Index, IQR: Interquartile Range, MNM: Maternal Near Miss, DC: Dilatation and Curettage, DM: Diabetes Mellitus, GDM: Gestational Diabetes Mellitus, HELLP: Hemolysis, Elevated Liver Enzymes, Low Platelet Count.

Table 2. Distribution of maternal pathologies contributing to maternal near miss.

Condition	No. (%)
Hypertensive disorders	61
Gestational hypertension	21
Pre-eclampsia	20
HELLP syndrome	7
Chronic hypertension	8
Eclampsia	5
Haemorrhage disorder	20
Postpartum atony	6
Placenta previa	5
Morbidly adherent placenta	3
Placental abruption	3
Ruptured uterus	2
ITP	1
Medical disorders	29
Heart disease	9
Diabetes	7
Asthma	4
Epilepsy	2
Thalassemia	1
Malignancy	1
Sepsis	3
Pulmonary hypertension	1
Pulmonary embolism	1

ITP: Immune Thrombocytopenic Purpura, HELLP: Hemolysis, Elevated Liver Enzymes, Low Platelet Count.

Table 3. Complication frequency in near miss cases.

Complication	n (%)
Acute Kidney Injury (AKI)	16 (32)
Shock	16 (32)
Relaparotomy	14 (28)
Sepsis	14 (28)
Pulmonary Edema	12 (24)
Disseminated Intravascular Coagulation (DIC)	9 (18)
Acute Cardiac Failure	5 (10)
Stroke (Cerebrovascular Event)	4 (8)
Acute Respiratory Distress Syndrome (ARDS)	4 (8)
Pulmonary Embolism	1 (2)
Acute Myocardial Infarction	1 (2)
Hemorrhage > 1000 mL	31 (62)
Chorioamnionitis	3 (6)
Uterine Atony	5 (10)
Maternal Death	4 (8)

proportion of maternal deaths among total severe maternal outcomes) was calculated to be approximately 5.66%.

Discussion

As a result of our study, the mean maternal age for MNM cases was 30.55 ± 5.95 and the mean gestational age was 32.19 ± 6.85. 46% of MNM cases were in the antenatal period, 30% were during birth and 24% were in the postnatal period. While 88.9% of births occurred by cesarean section, 66.7% occurred in the preterm period. Our stillbirth rate was 8.89% and 22.2% of the cases were complicated by fetal growth restriction (FGR). When we look at the accompanying maternal morbidities, the largest part was pre-pregnancy and pregnancy-related hypertensive disorders.

Table 4. Clinical, laboratory, and management-based criteria in maternal near miss cases.

Criterion	No (%)
Clinical	
Overall	42 (84)
Acute cyanosis	13 (39)
Gasping	3 (6)
Respiratory rate > 40 or < 6 / minute	33 (66)
Shock	15 (30)
Oliguria, non-responsive to fluids or diuretics	30 (60)
Clotting failure	3 (6)
Loss of consciousness lasting $\geq$ 12 hours	10 (20)
Cardiac arrest	9 (18)
Stroke	2 (4)
Uncontrollable fit/ Total paralysis	3 (6)
Jaundice in the presence of pre-eclampsia	6 (12)
Laboratory	
Overall	41 (82)
Oxygen saturation < 90% for > 60 minutes	35 (70)
pH < 7.1	10 (20)
PaO_2/FiO_2 < 200 mmHg	11 (22)
Lactate > 5 mmol/L or > 45.0 mg/dL	10 (20)
Creatinine > 300 mmol/L or > 3.5 mg/dL	6 (12)
Acute severe thrombocytopenia (< 50 000 platelets)	10 (20)
Bilirubin > 100 mmol/L or > 6.0 mg/dL	4 (8)
Management based	
Overall	40 (80)
Use of continuous vasoactive drugs	17 (34)
Intubation and ventilation for > 60 minutes not related to anaesthesia	10 (20)
Hysterectomy following infection or haemorrhage	8 (16)
Transfusion of > 5 units red cell transfusion	22 (44)
Dialysis for acute renal failure	5 (10)
Cardiopulmonary resuscitation	3 (6)

PaO_2/FiO_2: Partial Pressure of Arterial Oxygen/Fraction of Inspired Oxygen, ITP: Immune Thrombocytopenic Purpura, HELLP: Hemolysis, Elevated Liver Enzymes, Low Platelet Count.

The World Health Organization (WHO) defines MNM concept as "a woman who, near death, survives a complication arising during pregnancy, delivery, or within postpartum 42 days" [5]. WHO criteria are consisting of a combination of a number of parameters including clinical features, laboratory findings, and management practices. Due to the physiological characteristics of pregnancy itself, existing scoring systems are insufficient to reflect the seriousness of the situation in the presence of pregnancy complications [15,16].

In our study, chronic hypertension and pregnancy-related hypertensive disorders were the most important causes of morbidity. Gestational hypertension was detected in 42%, preeclampsia in 40%, HELLP syndrome in 14% and eclampsia in 10%. In the study of Verma et al. published in 2023, the majority of MNM cases (38.46%) were hypertensive disorders, as in our study [11]. In many other studies, hypertensive disorders are the leading causes of maternal morbidity and mortality [1, 2, 13]. In the study of Rulisa et al., the most common cause of MNM was found to be peritonitis, unlike many other studies [14]. Hypertensive disorders and hemorrhagic diseases have been shown to be the main causes after peritonitis.

Following hypertensive disorders, the second most common condition we observed was obstetric hemorrhage. Almost 20% of MNM cases had hemorrhagic abnormalities. Postpartum atony (12%) and placenta previa (10%) were the main causes of obstetric hemorrhage. In 2017, Witteveen and colleagues evaluated pregnancy outcomes according to WHO MNM criteria using three cohort studies. In this study, the most common comorbidity in all 3 cohort groups was postpartum hemorrhage (PPH) [17]. In the study of Verma et al. in 2023, the majority of the conditions contributing to MNM were bleeding during pregnancy and the postpartum period [12]. In this study they reported that 44% of MNM patients required more than five units of blood transfusion. We think that the lower bleeding rates in our study are due to the close monitoring of bleeding cases in our clinic and timely blood transfusions.

Diabetes (14%) and cardiovascular diseases (18%) were factors contributing to significant maternal morbidity in the study group. These findings may be due to the shift of pregnancy to advanced ages, especially in developed countries. The fact that the mean maternal age in our study was 30.55 $\pm$ 5.95 also supports this view. Akın Evsen et al.'s retrospective study also emphasized that cardiovascular dysfunction and other systemic diseases play an important role in MNM cases [18]. Specifically, systemic complications such as shock, cardiac arrest, and respiratory system diseases were found to critically affect maternal outcomes. Also in this study, they emphasized that the incidence of MNM was significantly higher if the patients transferred from other health institutions without adequate interventions [18]. These findings highlight the importance of early diagnosis of chronic health problems during pregnancy and suggest that delay in treatment or management can worsen these problems. Approximately 56% of our cases were anemic. This rate is higher than the 30% anemia rate in healthy pregnant women in Turkey [16]. The relationship between anemia and poor pregnancy outcomes has been demonstrated. These results become more evident in women with hemoglobin levels below 70 g/L [19,20]. Therefore, it is important to prevent medical conditions such as anemia during pregnancy. The World Health Organization (WHO) aims to reduce the rate of anemia in women of reproductive age by 50% by 2025 [18].

The high rate of recovery without sequelae (64%) is a positive indicator of the effectiveness of the clinical interventions employed. However the 28% of women who recovered with sequelae highlight the long-lasting effects of severe maternal morbidity on women's health. The clinical severity of MNM cases, evidenced by elevated rates of organ dysfunction and the requirement for critical care measures such as vasoactive agents and blood transfusions, underscores the imperative for timely, multidisciplinary intervention to enhance outcomes.

WHO criteria are quite strict and are primarily valid in hospital settings with close follow-up and good record-keeping systems [18]. In our study group, clinical criteria were followed most frequently (84%). However, the fre-

quency of laboratory (82%) and management-based (80%) criteria was also similar. The most frequently affected systems were the respiratory system and the urinary system. The study conducted by Visi and Akoijam in North East India in 2021 examined MNM cases according to WHO criteria. This study emphasizes that criteria such as cardiovascular dysfunction (especially shock and cardiac arrest) carry a higher risk of mortality compared to other organ dysfunctions [21]. In their meta-analysis, Pattinson et al. (2009) stated that cases of multi-organ failure and requiring cardiovascular support are in the highest risk group and that these cases are of critical importance in evaluating the quality of maternal care [22].

Deciding which set of criteria to use has been a matter of difficult discussion in many studies. In these studies, it was stated that intervention and laboratory-based criteria were more applicable in institutions with better intensive care conditions, such as our hospital, rather than in low-resource countries. Say et al. (2009) evaluated the applicability of WHO's maternal near-miss criteria in low- and middle-income countries [5]. The study noted that it may be appropriate to supplement these criteria with management-based criteria (e.g., intensive care unit admission or massive transfusion) rather than organ dysfunction-based criteria, especially where resources are limited. It has been emphasized that clinical and intervention-based criteria are more practical due to the limitations of laboratory tests in such countries.

The maternal mortality rate (MMR) in our study was 12.23 per 100,000 live births. In the study conducted by Mansuri and Mall, MMR was found to be 367 per 100,000 in Ahmedabad [23,24]. Nelissen et al. in 2013, 32 maternal deaths were reported in 216 MNM cases in a 2-year period [22, 23] According to this study, the MNM incidence rate is 23.6 per 1000 live births and the overall case fatality rate is 12.9%. The reason for the better results in our study may be due to the fact that the health system in our country is at a higher level than in the countries where reference studies were conducted. Additionally, complicated cases are referred less frequently in our country. Our study's maternal near miss ratio (MNMR) of 2.04 per 1,000 live births and mortality index of 5.66% highlight the frequency of severe maternal complications. Nayana reported an MNMR of 30.45 per 1,000 live births and a mortality index of 6.95% in India [27]. A study in Tanzania found an MNMR of 32.9 per 1,000 live births, with a mortality index of 1.67%. The relatively low mortality index indicates that, despite the high rate of near-miss events, the obstetric care provided was effective in preventing fatalities [28].

When maternal deaths in our group are examined, the complexity of MNM management becomes more evident. Two of the 3 cases with maternal loss had preeclampsia. Deep vein thrombosis developed in one of these cases, and acute respiratory distress syndrome (ARDS) due to pneumonia developed in the other. The third case came to our hospital unconscious and as a result of the examinations; the patient was diagnosed with meningitis. These cases highlight the significance of early management in high-risk pregnancies and the necessity of recognizing unusual presentations, such as meningitis, in pregnant women to enhance outcomes.

Our study also found that the peripartum hysterectomy rate in MNM cases (16%) was significantly higher than the national average of 0.32%. This difference arises from the fact that our hospital is a reference center where placental invasion defects are frequently operated on. A previous study by Evsen et al. reported that 68.3% of MNM patients underwent peripartum hysterectomy, with 50.7% exhibiting placental invasion anomalies [18].

Our study has some limitations. First, including only 50 MNM cases limits generalizability, which may limit the accuracy of the findings. The retrospective nature of the study and the fact that it was conducted in a single center may cause bias and make it difficult to generalize the results to other centers with different health systems. Finally, clinical and management-based standards in the WHO criteria vary between centers, which may make it difficult to compare MNM cases in different centers.

Conclusion

In conclusion, hypertensive and hemorrhagic disorders, alongside chronic medical conditions, remain significant contributors to maternal near-miss cases. These findings highlight the ongoing need for preventive strategies, early detection, and comprehensive management to reduce maternal morbidity and mortality. Improving access to multidisciplinary treatment, especially in high-risk pregnancies, and enhancing maternal near-miss tracking systems are crucial measures for maximizing maternal outcomes.

Ethical approval

Ethical approval was obtained from the Ankara Etlik City Hospital No. 1 Clinical Research Ethics Committee (approval number: AEŞH-BADEK-2024-914).

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