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Original Article

Maternal Mortality and Near Misses in the Spectrum of Hypertensive Disorders in Pregnancy at Dr. Kariadi Hospital in 2024

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Abstract

Background : High maternal mortality from hypertension in pregnancy reflects poor early detection and management. Preeclampsia-eclampsia remains a major cause of severe outcomes.
Aims : To analyze the relationship between spectrum of hypertensive disorders in pregnancy and maternal near misses and mortality at Dr. Kariadi Hospital in 2024.
Methods : Cross-sectional study using medical records of pregnant women with hypertensive disorders. All cases were analyzed to assess the relationship between spectrum of hypertension and maternal near miss and maternal death using the chi-square test, in accordance with the ethical approval of KEPK Dr. Kariadi Hospital.
Results : Most pregnant women had preeclampsia/eclampsia (77.3%), followed by superimposed preeclampsia (14.2%). Maternal near miss occurred in 13.3% and mortality in 9.3% of cases, with 206 live births. Organ dysfunction was found in 22.7%, mainly cardiovascular (10.7%), followed by respiratory, coagulation (each 2.2%), and immunological (5.8%). Overall organ dysfunction, especially cardiovascular, respiratory, renal, and coagulation associate with maternal near miss ($p<0.05$). The highest risks were seen in cardiovascular (PR 19.54; CI95% 10.13–37.66), renal (PR 7.96; CI95% 5.63–11.26), respiratory (PR 6.76; CI95% 3.83–11.94), and coagulation dysfunction (PR 4.88; CI95% 2.20–10.86). Immunological dysfunction was strongly associated with maternal mortality and had the highest risk (PR 26.50; CI95% 13.42-52.29).
Conclusion : Preeclampsia/eclampsia is the dominant condition and correlates to maternal near miss and death. Organ dysfunction significantly worsens outcomes.

Keywords : Organ dysfunction, hypertension in pregnancy, maternal mortality, maternal near miss

INTRODUCTION

Maternal mortality remains a global and national challenge. The WHO reported 287,000 maternal deaths in 2020, with hypertension in pregnancy being the leading cause.[1] In Indonesia, the maternal mortality rate decreased from 346 per 100,000 live births (2010) to 189 per 100,000 live births in 2020, but the number of maternal deaths still reached more than 4,000 cases. Hypertension in pregnancy, including chronic hypertension, gestational hypertension, preeclampsia, and eclampsia, is the leading cause of maternal morbidity and mortality, mainly due to suboptimal early detection, inadequate management, and delayed referral.[2]

Near misses and maternal deaths generally occur due to severe complications such as placental abruption, HELLP syndrome, and pulmonary edema, which often arise due to delays in treatment at primary care facilities. An ineffective referral system also increases these risks. Various studies in Indonesia show that mothers with preeclampsia have a higher risk of adverse maternal and perinatal outcomes, and that the quality of antenatal care and the accuracy of referrals play a major role in preventing fatal complications. Optimization of maternal health services is still urgently needed to achieve the targets of the 2024 National Medium-Term Development Plan and the 2030 Sustainable Development Goals.[2,3]

In the city of Semarang, maternal mortality rates have fluctuated over the past three years, and hypertension during pregnancy remains the dominant cause of maternal mortality. Dr. Kariadi Hospital, as the tertiary referral hospital in Central Java, receives many referral cases with severe preeclampsia and records an average case fatality rate of 3.3% for these cases. Given the limited specific data on maternal outcomes in hypertension during pregnancy, an in-depth analysis of maternal near misses and maternal deaths in referral facilities is urgently needed.[4]

This study was conducted to assess the factors of hypertension in pregnancy that affect near misses and maternal mortality, using secondary data from medical records at Dr. Kariadi Hospital in Semarang in 2024 as a basis for evaluation and improvement of obstetric emergency services.

METHODS

The observational analytical design study with a cross-sectional approach was conducted at Dr. Kariadi Hospital in Semarang. The study employed secondary data from the medical records of pregnant women, women in labor, and postpartum women with a spectrum of hypertensive disorders in pregnancy in 2024.

The study population included all pregnant women, women who had given birth, and women in the postpartum period with hypertensive disorders. The sample was obtained using total sampling, covering all cases that met the inclusion criteria, namely patients with preeclampsia/eclampsia, superimposed preeclampsia, gestational hypertension, or chronic hypertension with complete medical records, both without complications and with near miss or maternal mortality. Exclusion criteria included patients with incomplete medical records, as well as patients who were referred out or discharged at their own request.

The independent variable of the study was the spectrum of hypertensive disorders in pregnancy, while the dependent variables were maternal near miss and maternal death. The intermediate variables of the study was the type of organ dysfunction and $MgSO_4$ therapy. Maternal near miss was defined as the occurrence of one or more adverse obstetric conditions such as hypertensive disorders (preeclampsia/eclampsia), hemorrhage, infection, pulmonary edema, shock, gestational diabetes, and critical laboratory values that arise during pregnancy, childbirth, or within 42 days after termination of pregnancy. Maternal death was defined as the death of a mother during pregnancy, childbirth, or within 42 days after termination of pregnancy, which might be caused by the pregnancy process or medical intervention, but not due to incidental events. The type of organ dysfunction, based on Mantell criteria, evaluated the presence of cardiovascular, respiratory, renal, coagulation, uterine, hepatic, neurological, and immunological dysfunctions. $MgSO_4$ therapy was administered in patients with severe preeclampsia, eclampsia, preeclampsia with neurological symptoms (severe headache or visual disturbances), severe gestational hypertension at risk of seizures, and women at risk of preterm delivery for fetal neuroprotection.

Data were collected from medical records using data extraction forms, then tabulated and analyzed. Analysis was performed using SPSS version 29 with Chi-square and Fisher exact tests. Results were considered significant if $p<0.05$.

Ethical approval was obtained from the Medical and Health Research Ethics Committee (KEPK) of Dr. Kariadi General Hospital, Semarang (Ethical Clearance No. 16630/EC/KEPK-RSDK/2025), issued on October 24, 2025.

RESULTS

An evaluation of 225 pregnant women, women who had given birth, and women in the postpartum period at Dr. Kariadi Hospital in Semarang in 2024 found that 174 mothers (77.3%) experienced preeclampsia/eclampsia, 32 mothers (14.2%) experienced superimposed preeclampsia, 7 mothers (3.1%) experienced chronic hypertension, and 12 mothers (5.3%) experienced gestational hypertension. Further analysis yielded the following results.

TABLE 1
Criteria for organ dysfunction based on Mantel

Diagnosis	Criteria
Organ dysfunction based on Mantell	a. Cardiac dysfunction (pulmonary edema or cardiac arrest) b. Vascular dysfunction (hypovolemia necessitating transfusion of ≥5 units of whole blood or packed red cells for resuscitation) c. Immunological dysfunction (requirement for intensive care due to sepsis or emergency hysterectomy secondary to sepsis) d. Respiratory dysfunction (intubation and mechanical ventilation for >60 minutes for reasons other than general anesthesia, oxygen saturation <90% on pulse oximetry persisting for >60 minutes, PaO_2/FiO_2 ratio <300) e. Renal dysfunction (oliguria, urea levels >15 mmol/L, or creatinine >400 mmol/L) f. Hepatic dysfunction (jaundice in the presence of preeclampsia) and metabolic dysfunction (diabetic ketoacidosis or thyroid storm) g. Coagulation dysfunction (acute thrombocytopenia requiring transfusion) h. Cerebral dysfunction (coma lasting >12 hours or subarachnoid/intracerebral hemorrhage) i. Management-based criteria (admission to intensive care, emergency hysterectomy, or anesthesia-related complications such as severe hypotension due to spinal/epidural anesthesia or failed tracheal intubation)

TABLE 2
The relationship between the spectrum of hypertensive disorders, MgSO4 therapy, and organ dysfunction with maternal near miss

Variables	Maternal *Near miss*		*p*	PR (CI95%)
	Yes	No		
Spectrum of hypertensive disorders			0.366[f]	NA
Preeclampsia/eclampsia	27 (90)	147 (75.4)		
Superimposed preeclampsia	3 (10)	29 (14.9)		
Chronic hypertension	0 (0)	7 (3.6)		
Gestational hypertension	0 (0)	12 (6.2)		
MgSO4 therapy			0.092[¶]	2.12 (0.84–5.30)
Yes	25 (83.3)	133 (68.2)		
No	5 (16.7)	62 (31.8)		
Organ dysfunction			<0.001[¶*]	NA
Yes	30 (100)	21 (10.8)		
No	0 (0)	174 (89.2)		
Cardiovascular dysfunction			<0.001[f*]	19.54 (10.13–37.66)
Yes	21 (70)	3 (1.5)		
No	9 (30)	192 (98.5)		
Respiratory dysfunction			<0.001[f*]	6.76 (3.83–11.94)
Yes	4 (13.3)	1 (0.5)		
No	26 (86.7)	194 (99.5)		

TABLE 2. *Continued.*

Variables	Maternal *Near miss*		*p*	PR (CI95%)
	Yes	No		
Renal dysfunction			0.017[f*]	7.96 (5.63–11.26)
Yes	2 (6.7)	0 (0)		
No	28 (93.3)	195 (100)		
Coagulation dysfunction			0.018[f*]	4.88 (2.20–10.86)
Yes	3 (10)	2 (1)		
No	27 (90)	193 (99)		
Uterine dysfunction			1.000[f]	NA
Yes	0 (0)	1 (0.5)		
No	30 (100)	194 (99.5)		
Liver dysfunction			1.000[f]	NA
Yes	0 (0)	0 (0)		
No	30 (100)	195 (100)		
Neurological dysfunction			1.000[f]	NA
Yes	0 (0)	1 (0.5)		
No	30 (100)	194 (99.5)		
Immunological dysfunction			0,225[f]	NA
Yes	0 (0)	13 (6.7)		
No	30 (100)	182 (93.3)		

[¶]Chi-square; [f]Fisher exact; [*]significant $p<0.05$
NA: Not applicable

TABLE 3
The relationship between the spectrum of hypertensive disorders, MgSO4 therapy, and organ dysfunction with maternal death

Variables	Maternal Death		*p*	PR (CI95%)
	Yes	No		
Spectrum of hypertensive disorders			0.127[f]	NA
Preeclampsia/eclampsia	18 (85.7)	156 (76.5)		
Superimposed preeclampsia	1 (4.8)	31 (15.2)		
Chronic hypertension	2 (9.5)	5 (2.5)		
Gestational hypertension	0 (0)	12 (5.9)		
MgSO4 therapy			0.060[¶]	0.46 (0.20–1.04)
Yes	11 (52.4)	133 (68.2)		
No	10 (47.6)	62 (31.8)		
Organ dysfunction			<0.001[f*]	NA
Yes	21 (100)	21 (10.8)		
No	0 (0)	174 (89.2)		

TABLE 3. *Continued.*

Variables	Maternal Death		*p*	PR (CI95%)
	Yes	No		
Cardiovascular dysfunction			0.476[f]	1.39 (0.44–4.39)
Yes	3 (14.3)	21 (10.3)		
No	18 (85.7)	183 (89.7)		
Respiratory dysfunction			0.390[f]	2.20 (0.36–13.33)
Yes	1 (4.8)	4 (2)		
No	20 (95.2)	200 (98)		
Renal dysfunction			1.000[f]	NA
Yes	0 (0)	2 (1)		
No	21 (100)	202 (99)		
Coagulation dysfunction			0.070[f]	4.63 (1.45–14.72)
Yes	2 (9.5)	3 (1.5)		
No	19 (90.5)	201 (98.5)		
Uterine dysfunction			0.093[f]	11.20 (7.37–17.01)
Yes	1 (4.8)	0 (0)		
No	20 (95.2)	204 (100)		
Liver dysfunction			1.000[f]	NA
Yes	0 (0)	0 (0)		
No	21 (100)	204 (100)		
Neurological dysfunction			0.093[f]	11.20 (7.37–17.01)
Yes	1 (4.8)	1 (0.5)		
No	20 (95.2)	204 (100)		
Immunological dysfunction			<0.001[f*]	26.50 (13.42–52.29)
Yes	13 (61.9)	13 (6.7)		
No	8 (38.1)	204 (100)		

[¶]Chi-square; [f]Fisher exact; [*]significant $p<0.05$
NA: Not applicable

The Mantell criteria based on intensive management interventions and organ dysfunction, including cardiovascular, respiratory, renal, coagulation, uterine, hepatic, neurological, and immunological dysfunctions.

The presence of any type of organ dysfunction ($p<0.001$), cardiovascular dysfunction ($p<0.001$), respiratory dysfunction ($p<0.001$), renal dysfunction ($p=0.017$), and coagulation dysfunction ($p=0.018$) significantly influenced the incidence of maternal near misses.

Maternal with cardiovascular dysfunction had a 19.54x higher risk (PR 19.54; CI95% 10.13–37.66) of experiencing maternal near miss events. Maternal respiratory dysfunction was associated with a 6.76-fold higher risk (PR 6.76; 95% CI 3.83–11.94) of maternal near miss events. Maternal with renal dysfunction had a 7.96 times higher risk (PR 7.96; 95% CI 5.63–11.26) of experiencing a maternal near miss event. Maternal with coagulation dysfunction has a 4.88x higher risk (PR 4.88; CI95% 2.20–10.86) of experiencing maternal near miss events.

However, these findings should be interpreted with caution due to the limited sample size and the inclusion of participants from a single healthcare center. This may restrict the external validity and generalizability of the results to broader populations. Therefore, the present study should be regarded as an

TABLE 4
Multivariate analysis of factors influencing maternal near miss

Variables		B	SE	Wald	df	*p*	Exp (B)	CI95%	
								Lower	Upper
Maternal near miss	MgSO4 therapy	-1.993	1.063	3.519	1	.061	.136	.017	1.093
	Organ dysfunction	-.025	4278.531	.000	1	1.000	.975	.000	–
	Cardiovascular dysfunction	23.451	4947.695	.000	1	.996	15299	.000	–
	Respiratory dysfunction	22.756	8765.907	.000	1	.998	76362	.000	–
	Renal dysfunction	43.304	30013.680	.000	1	.999	64105	.000	–
	Coagulation dysfunction	21.550	17070.412	.000	1	.999	22864	.000	–
	Immunological dysfunction	.038	35687.642	.000	1	1.000	1.038	.000	–
	Constant	-199.363	164312.036	.000	1	.999	.000	–	–

Binary logistic regression; *significant $p<0.05$

TABLE 5
Multivariate analysis of factors influencing maternal death

Variables		B	SE	Wald	df	*p*	Exp (B)	CI95%	
								Lower	Upper
Maternal death	Spectrum of hypertensive disorders	-.336	.601	.313	1	.576	.714	.220	2.320
	MgSO4 therapy	1.270	1.052	1.459	1	.227	3.562	.454	27.977
	Organ dysfunction	-1.613	.556	8.426	1	.004*	.199	.067	.592
	Coagulation dysfunction	-1.606	1.933	.690	1	.406	.201	.005	8.873
	Uterine dysfunction	16.710	40192.703	.000	1	1.000	18078	.000	–
	Neurological dysfunction	15.427	40192.934	.000	1	1.000	50082	.000	–
	Immunological dysfunction	13.361	10927.536	.000	1	.999	63462	.000	–
	Constant	-83.200	115763.837	.000	1	.999	.000	–	–

Binary logistic regression; *significant $p<0.05$

exploratory study that provides preliminary evidence of the relationships among the variables, which require confirmation through larger multicenter studies.

The presence of any type of organ dysfunction ($p<0.001$) and immunological dysfunction ($p<0.001$) associated with maternal mortality. Mothers with immunological dysfunction have a 26.50 times higher risk (PR 26.50; CI95% 13.42–52.29) of experiencing maternal mortality. Nevertheless, the results should be interpreted cautiously because the study was conducted in a relatively small sample drawn from a single healthcare institution. Such limitations may reduce the generalizability of the findings to other populations and clinical settings. Consequently, this study is best considered exploratory in nature, providing preliminary insights that warrant further validation in larger, multicenter investigations.

Multivariate logistic regression analysis showed that no variable was significantly associated with near-miss events. $MgSO_4$ therapy demonstrated a trend toward a protective effect against near-miss events (OR=0.136; 95% CI: 0.017–1.093; $p=0.061$), although statistical significance was not achieved. Organ dysfunction, cardiovascular dysfunction, respiratory dysfunction, renal dysfunction, coagulation dysfunction, and immunological dysfunction were not significant

predictors of near-miss events (all $p>0.05$).

Multivariate logistic regression analysis identified organ dysfunction as the only independent factor associated with maternal death (OR=0.199; 95% CI: 0.067–0.592; $p=0.004$). Spectrum of hypertensive disorders, $MgSO_4$ therapy, coagulation dysfunction, uterine dysfunction, neurological dysfunction, and immunological dysfunction were not significantly associated with maternal death after adjustment for other variables (all $p>0.05$). These findings indicated that organ dysfunction remained the most important factor related to maternal mortality in the study population.

DISCUSSION

The evaluation found that 77.3% of mothers experienced preeclampsia/eclampsia, 14.2% experienced superimposed preeclampsia, 3.1% experienced chronic hypertension, and 5.3% experienced gestational hypertension. Maternal near miss events were recorded in 30 subjects (13.3%), while maternal deaths occurred in 21 subjects (9.3%). Meanwhile, live births were found in 206 subjects (91.6%).

A maternal near miss is a pregnancy or delivery that threatens the mother's life but is successfully saved. A maternal near miss is preceded by potentially life-threatening conditions, in the end that can lead to a death, including various complications such as severe bleeding or eclampsia. Therefore, a near miss is the outcome of a serious condition that can be prevented, while potentially life-threatening conditions are the risk factors or causes. According to the WHO, potentially life-threatening conditions include bleeding disorders, placental abruption, and placenta accreta spectrum (accreta, increta, and percreta), as well as ectopic pregnancy, postpartum hemorrhage, uterine rupture, and other systemic conditions, along with complications such as endometritis, pulmonary edema, seizures, sepsis, shock, thrombocytopenia below 100,000, thyroid storm, and hypertensive disorders including severe preeclampsia, eclampsia, severe hypertension, hypertensive encephalopathy, and HELLP syndrome. In addition, the severity may be indicated by management-based criteria such as the need for blood transfusion, central venous access, hysterectomy, intensive care unit (ICU) admission, prolonged postpartum hospitalization exceeding 7 days, non-anesthetic intubation, return to the operating room, and other surgical interventions.[5] The WHO states that there are several conditions in which a mother is said to have experienced a near miss, including based on clinical criteria include acute cyanosis, gasping, respiratory rate >40 or <6 breaths per minute, shock, oliguria unresponsive to fluids or diuretics, coagulation failure, decreased consciousness lasting ≥12 hours, loss of consciousness with absence of pulse or cardiac activity, stroke, uncontrolled or complete paralysis, and jaundice in the presence of preeclampsia; laboratory criteria include oxygen saturation <90% for ≥60 minutes, PaO_2/FiO_2 <200 mmHg, creatinine >300 mmol/L or >3.5 mg/dL, bilirubin >100 mmol/L or >6.0 mg/dL, pH <7.1, lactate >5 mmol/L, loss of consciousness, and the presence of glucose and ketones in the urine; while management criteria include continuous use of vasoactive medications, uterine hemorrhage or infection requiring hysterectomy, transfusion of >5 units of red blood cells, intubation and mechanical ventilation for >60 minutes unrelated to anesthesia, dialysis for acute renal failure, or cardiopulmonary resuscitation.[6]

Eltigani A, *et al*., in a study involving 15,202 mothers, found 339 cases of near miss, 20 cases (5.9%) of preeclampsia, and 12 cases (3.5%) of eclampsia.[7] Tallapureddy S, *et al*., in a study at a tertiary hospital, found that 184 mothers had life-threatening pregnancy conditions, with severe preeclampsia occurring in 50.54% of subjects and eclampsia in 13.59% of subjects. SMO was reported in 38 subjects, consisting of 6 maternal deaths and 32 near-miss events. SMOR was reported at 10.04/1000 live births, MNMR was reported at 8.46/100 live births, maternal near miss mortality ratio was 5.34, and mortality index was 15.79%.[8] Dadhich R, *et al*. In an evaluation of 6,028 mothers, 5,713 live births were recorded. A total of 164 maternal near miss cases and 111 maternal deaths were recorded. The Maternal Near Miss Ratio (MNMR) was 28.70 per 1,000 live births, while the Maternal Near Miss to Maternal Mortality Ratio was 1.46, with a mortality index of 40.36%. The leading cause of near-miss events was pregnancy-induced hypertension (85 cases; 51.82%), followed by hemorrhage (39 cases; 23.78%).[9] Mawarti Y, *et al*., who conducted research at Dr. Sardjito Hospital in Yogyakarta involving 318 subjects, found that maternal deaths occurred in 28 subjects and near misses in 86 subjects. Eclampsia occurred in 30 subjects and severe preeclampsia in 99 subjects. Live births occurred in 303 subjects. The evaluation yielded an SMO of 114 cases, MNMR of 283.17/1000 live births, MMR of 9,240.25/100,000 live births, SMOR of 376.24/1,000 live births, MMI of 24.56%, and FR of 32.56%.[10] Laksana MAC, *et al*. in a study conducted at Dr. Soetomo General Hospital in Surabaya, there were 91 maternal deaths out of 926 deliveries in 2021 and 53 maternal deaths out of 912 deliveries in 2022.[11]

The most reported organ dysfunction in mothers was cardiovascular dysfunction (10.7%), followed by immunological dysfunction (5.8%), respiratory dysfunction (2.2%), and coagulation dysfunction (2.2%). Herklots T, *et al*., in a large-scale study involving 26,842 mothers, found that the most reported organ dysfunction in mothers with poor outcomes was hematological or coagulation dysfunction (52%), cardiovascular dysfunction (46%), and respiratory dysfunction (35%).[12] Drechsel KCE, *et al*., in a study

involving 447 pregnant women with hypertension, found 160 cases of maternal outcomes with poor results. The most commonly reported organ dysfunction was hematological or coagulation dysfunction and respiratory dysfunction, accounting for 59/160 [38.6%] and 23/160 [14.8%], respectively.[13] Eltigani A, *et al*. in a study involving 15,202 mothers found hepatic dysfunction in 9 subjects (2.7%), coagulation dysfunction in 9 subjects (2.7%), renal dysfunction in 8 subjects (2.4%), cardiovascular dysfunction in 4 subjects (1.2%), and respiratory dysfunction in 2 subjects (0.6%).[7]

Preeclampsia and gestational hypertension are among the most common hypertensive disorders in pregnancy, with preeclampsia notably linked to an elevated risk of future cardiovascular disease (CVD). Women who experience gestational hypertension during their first pregnancy have a 1.8-fold increased risk of developing CVD later in life (95% CI, 1.7–2.0) compared to those without pregnancy-related hypertension. This risk rises further, with a hazard ratio of 2.6 (95% CI, 2.3–3.0), when gestational hypertension is accompanied by small-for-gestational-age infants and/or preterm delivery.[14] Cardiovascular dysfunction characterized by pulmonary edema and cardiac arrest in pregnancy with hypertension (preeclampsia) is the result of a combination of endothelial dysfunction, increased systemic vascular resistance, fluid dynamics shifts, and direct cardiac damage.[15] Pulmonary edema, the most common cardiopulmonary complication of preeclampsia, is characterized by the excessive accumulation of fluid within the interstitial and alveolar spaces of the lungs.

Immunological dysfunction was assessed based on the presence of maternal sepsis, with an uncontrolled systemic inflammatory response playing a central role in the pathogenesis of preeclampsia. This condition is characterized by chronic inflammation, including oxidative stress, increased production of pro-inflammatory cytokines, and dysregulated T-cell function. Harrison RK *et al*. reported that the incidence of maternal peripartum infection was significantly higher in women with preeclampsia compared to those without (4.2% vs. 3.8%, p=0.026). Further analysis showed increased rates of wound infection (1.0% vs. 0.5%, p<0.001) and postpartum fever (8.2% vs. 4.4%, p<0.001) among women diagnosed with preeclampsia.[16] Inflammatory dysfunction occurs during preeclampsia, including excessive production of cytokines such as tumor necrosis factor alpha (TNF-a) and interleukin (IL)-6, decreased production of anti-inflammatory cytokines such as IL-4 and IL-10, worsening oxidative stress, and T cell dysregulation.[17,18] An exaggerated inflammatory response plays a key role in both preeclampsia and infection. During infection, similar inflammatory pathways are triggered, including elevated levels of TNF-α and IL-6. The body's physiological response to infection leads to fluid shifting into the interstitial space, resulting in tissue edema and potential organ dysfunction or failure, closely resembling the pathophysiological changes observed in preeclampsia.

Respiratory dysfunction in this study was evaluated based on the presence of respiratory distress/acute respiratory distress syndrome (ARDS), characterized by a PaO2/FiO2 ratio < 300. In this group of patients, intubation was generally required due to the risk of respiratory failure. ARDS is a clinical syndrome characterized by several clinical features and pathological responses that primarily involve the respiratory system. Severe inflammation occurs in the lungs, including injury to the alveolar-capillary barrier, surfactant deficiency, and loss of aerated lung tissue. These inflammatory processes contribute to the development of pulmonary edema, which may result in severe hypoxemia, reduced lung compliance, and increased intrapulmonary shunting and dead space ventilation.[19]

Coagulation dysfunction in pregnant women is assessed based on the presence of severe thrombocytopenia (<50,000) or the need for massive blood transfusions (>5 units of blood products). Thrombocytopenia during pregnancy may arise from obstetric conditions, such as gestational thrombocytopenia and preeclampsia/eclampsia, or occur secondary to systemic disorders, including thrombotic thrombocytopenic purpura and immune thrombocytopenia.[20] Mayama M, *et al*., in a study of 264 mothers, found that severe thrombocytopenia occurred in 24 patients. The estimated relative risk of severe thrombocytopenia was 4.46 [95% confidence interval, 2.59–7.68] for maternal organ damage except thrombocytopenia, 1.61 [1.06–2.45] for preterm delivery <34 weeks of gestation, and 1.35 [1.06–1.73] for admission to the neonatal intensive care unit.[21] Blood coagulation disorders, including thrombocytopenia, are signs of maternal organ damage. Therefore, the presence of thrombocytopenia alone is sufficient to classify a patient as having severe preeclampsia, even in the absence of other manifestations of maternal organ damage.

Mothers with cardiovascular dysfunction have a 19.54 times higher risk of experiencing a maternal near miss. Bashour H *et al*., in a multicenter study, reported that bleeding-related complications were the most frequent conditions among maternal near miss cases across the four hospitals evaluated. Coagulation dysfunction was identified as the most common organ dysfunction (76.1%), followed by cardiovascular dysfunction (33.8%).[22] Cardiovascular factors contribute significantly to severe maternal morbidity (SMM), including conditions such as cardiac arrest, arrhythmias, and acute myocardial infarction. The rising incidence of SMM and its cardiovascular components is associated with increasing maternal age, greater use of assisted

reproductive technologies––often resulting in higher-risk pregnancies––and overall shifts in cardiovascular health among women of reproductive age. Additionally, the growing prevalence of congenital heart disease, diabetes mellitus, pre-pregnancy obesity, and hypertension are key factors leading to obstetric intensive care unit admissions, while smoking, nulliparity, and a history of previous cesarean delivery further elevate the risk of SMM.[23,24] Coexisting metabolic conditions––such as obesity and diabetes mellitus––as well as cardiovascular disorders including hypertension, heart failure, arrhythmias, valvular heart disease, and congenital defects, are associated with an increased risk of severe maternal morbidity (SMM).[25,26]

Maternal patients with respiratory dysfunction have a 6.76 times higher risk of experiencing maternal near misses. Tonyali NV *et al*., in a study of 50 maternal patients treated in the ICU with near misses, found that pulmonary edema occurred in 12 subjects (24%) and ARDS in 4 subjects (8%). Clinical criteria related to respiration in establishing a diagnosis of near miss included acute cyanosis in 13 subjects (39%), gasping in 3 subjects (6%), and respiratory rate >40x or <6x/minute in 33 subjects (66%). Laboratory evaluations related to respiration in the diagnosis of near miss included SpO2 <90% for >60 minutes in 35 subjects (70%), PFR <200 mmHg in 11 subjects (22%), and lactate levels >45 mg/dL in 10 subjects (20%). The types of interventions received by patients included intubation and ventilation >60 minutes in 10 subjects (20%).[27] Acute Respiratory Distress Syndrome (ARDS) causes maternal near miss through severe inflammation and alveolar-capillary membrane disruption, resulting in organ dysfunction, particularly severe hypoxemia and multiple organ failure. ARDS is characterized by a systemic inflammatory response, which can be triggered by various obstetric and non-obstetric complications. The underlying causes (e.g., sepsis, aspiration pneumonia, preeclampsia, or massive transfusion) trigger massive release of inflammatory cytokines. This causes extensive injury to pulmonary endothelial and epithelial cells. The damage compromises the integrity of the alveolar-capillary barrier, leading to increased vascular permeability. Fluid, proteins, and inflammatory cells leak into the alveoli, causing non-cardiogenic pulmonary edema. Fluid accumulation in the alveoli disrupts gas exchange, causing severe hypoxemia (low blood oxygen levels) and an increase in physiological dead space. The lungs become stiff and less elastic (reduced compliance), making breathing difficult and often requiring mechanical ventilation. Ultimately, severe inflammation and hypoxia can lead to systemic inflammatory response syndrome (SIRS) and subsequent dysfunction in other organ systems, such as the kidneys, liver, and cardiovascular system. This multi-organ failure is a key indicator of a near-miss event, where a maternal life is threatened but she survives.[28,29]

Mothers with renal dysfunction have a 7.96 times higher risk of experiencing maternal near misses. Thakur G, *et al*. stated in their study that the incidence of maternal near misses was 43.04 per 1,000 live births. A total of 18.2% of mothers experienced acute kidney injury (AKI). A total of 51.1% experienced AKI during the postpartum period. The most common cause of AKI was bleeding, which occurred in 38.3% of women. The majority of women had serum creatinine levels between 2.1–5 mg/dl, and 44.68% required dialysis.[30] Other studies indicate that preeclampsia and eclampsia are the most common causes of AKI.[31] Renal dysfunction in cases of maternal near miss is mainly a consequence of major obstetric complications. The main mechanisms causing renal dysfunction include bleeding, preeclampsia, and sepsis, which cause AKI through decreased blood flow, direct damage to the kidneys, or systemic inflammatory response. Bleeding is the leading cause of AKI in women with maternal near miss. The mechanism is often prerenal renal failure due to massive blood loss, which causes volume depletion and hypotension, resulting in a significant reduction in blood flow to the kidneys (renal hypoperfusion). If blood flow is not restored promptly, this can lead to acute tubular necrosis and intrinsic renal damage.[30,32]

Mothers with coagulation dysfunction have a 4.88 times higher risk of experiencing maternal near misses. Oliveira LC *et al*., who evaluated 255 cases of maternal near misses in the ICU, found that patient diagnoses were predominantly hypertensive disorders (62.7%), with a substantial proportion complicated by HELLP syndrome (hemolysis, elevated liver enzymes, and low platelet count) (41.2%). Laboratory-based criteria were the most frequently identified indicators of maternal near miss (59.6%), largely driven by the high incidence of acute thrombocytopenia (32.5%). Additionally, 19.2% of patients required transfusion of more than 5 units of blood products.[33] Among the various maternal near miss criteria, acute thrombocytopenia is the most frequently observed, likely reflecting the high prevalence of HELLP syndrome. Acute thrombocytopenia is associated with an increased risk of maternal mortality, and delayed recognition can place the mother in a life-threatening condition.[33] Thrombocytopenia can cause maternal near misses, mainly through severe postpartum hemorrhage (PPH) due to blood clotting disorders. Severe bleeding associated with low platelet counts can cause shock, organ failure (such as kidney failure), and the need for massive blood transfusions, all of which are clinical criteria and management decisions for maternal near misses.[34]

Mothers with immunological dysfunction have a 26.50 times higher risk of maternal mortality. Arora A *et al*. reported that sepsis was the leading cause of near-miss

morbidity, occurring in 54 out of 426 cases (12.7%). Obstetric sepsis was directly identified in 33 cases (61.1%), indirectly in 8 cases (14.8%), and not identified in 13 cases (24.1%). Peritonitis was the most common diagnosis at hospital admission, observed in 27 patients (50%), and 30 patients (55%) required immediate surgical intervention. Notably, approximately 69% of cases had residual morbidity at the time of discharge.[35] Near-miss maternal events due to sepsis involve a complex interaction between maternal infection and an inadequate bodily response, leading to life-threatening organ dysfunction. The main mechanisms include excessive inflammatory response, organ injury, and, often, delayed diagnosis and treatment. Sepsis often originates from bacterial infections, commonly in the uterus, urinary system, or lungs (pneumonia). Complications such as cesarean section wounds, chorioamnionitis, and post-abortion complications are often the entry points for infection. Pregnancy involves natural immunological changes that can mask the typical symptoms of infection, making early detection difficult. When infection occurs, the body's immune response can become overactive or disrupted, causing widespread inflammation that damages the body's own tissues and organs. This widespread inflammation disrupts blood flow and oxygen delivery to vital organs, causing injury or failure of the target organ. Organ dysfunction is the primary diagnostic criterion for severe sepsis and includes conditions such as kidney failure, respiratory distress, and cardiovascular collapse (septic shock).[36,37]

This study has several limitations. First, the cross-sectional design limits the ability to assess the causal relationship between the spectrum of hypertensive disorders in pregnancy, organ dysfunction, and maternal outcomes. Second, the use of secondary medical record data depends on the completeness and accuracy of the records, thus the possibility of misclassification and missing data cannot be avoided. Third, the relatively low number of maternal deaths reduces the power of the analysis to detect significant associations. Fourth, several confounding variables such as age, parity, comorbidities, referral delays, and quality of care cannot be fully controlled and may influence the relationship between the variables studied. Fifth, the evaluation of $MgSO_4$ therapy is also limited because it does not include dose compliance or timing of administration. Sixth, immunological dysfunction representing sepsis-related mechanisms was not supported by additional data, such as microbiological confirmation, source of infection, culture results, or sepsis severity classification. Seventh, the study did not evaluate longer-term neonatal outcomes, including preterm birth, fetal growth restriction, NICU admission, stillbirth, and neonatal mortality.

CONCLUSION

Mothers with cardiovascular dysfunction, respiratory dysfunction, renal dysfunction, or coagulation dysfunction should receive monitoring during more intensive care, such as care in the ICU, because this group is at high risk of maternal near miss.

Early identification of cardiovascular, respiratory, renal, and coagulation dysfunction should be integrated into standardized obstetric screening to enable timely referral and ICU care. Close monitoring and clear clinical protocols are essential to guide intensive management and reduce the risk of maternal near miss.

CONFLICT OF INTEREST

There is no conflict of interest in this research.

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