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ORIGINAL RESEARCH

Epidemiological Risk Factor Analysis for Maternal Mortality Associated with Eclampsia: A Single-Center Study from Tertiary Hospital Garut

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Background: Maternal mortality remains a major global health challenge, particularly in low- and middle-income countries. Eclampsia, a severe complication of hypertensive disorders in pregnancy, continues to contribute substantially to maternal and perinatal deaths despite advances in obstetric care. Previous studies have highlighted the role of clinical and laboratory abnormalities in worsening outcomes; however, evidence from developing settings remains limited. A clearer understanding of maternal mortality risk factors in eclampsia is essential to improve early detection, risk stratification, and clinical management.

Objective: To identify maternal mortality risk factors associated with eclampsia based on patient characteristics, clinical presentation, and laboratory findings.

Methods: A retrospective observational study was conducted using medical records of pregnant women diagnosed with eclampsia between January 2022 and March 2024 at a tertiary referral hospital. Demographic data, clinical features, and laboratory parameters were extracted systematically. Statistical analysis included univariate and bivariate analyses using the Chi-square test to assess associations between variables and maternal mortality. Multivariate logistic regression analysis was performed to determine independent risk factors and estimate odds ratios (OR) with corresponding p-values. Statistical significance was set at $p \leq 0.05$.

Results: A total of 112 patients met the inclusion criteria. The eclampsia case fatality rate was 20.54%. Laboratory parameters demonstrated significant associations with maternal mortality. Severe proteinuria (+3) was associated with increased mortality risk (OR = 1.67; p = 0.05). Anemia, defined as hematocrit <35%, showed a strong association with maternal death (OR = 2.25; p = 0.001). Additionally, HELLP syndrome significantly increased the risk of maternal mortality (OR = 2.82).

Conclusion: Laboratory abnormalities are key predictors of maternal mortality in eclampsia. Severe proteinuria, anemia, and HELLP syndrome should be promptly identified and managed to reduce adverse maternal outcomes.

Keywords: epidemiology, case fatality rate, eclampsia, risk factors

Introduction

Maternal mortality remains a critical indicator of health system performance, particularly in low- and middle-income countries. The World Health Organization defines maternal death as the death of a woman during pregnancy or within 42 days after the termination of pregnancy due to causes related to or aggravated by pregnancy.[1] Despite global efforts to reduce maternal mortality, hypertensive disorders of pregnancy, especially preeclampsia and eclampsia, continue to be leading causes of maternal death worldwide.[2,3]

In Indonesia, maternal mortality has declined over recent decades; however, the burden remains substantial. A systematic review by Syairaji et al in 2024 reported a national maternal mortality ratio of 249 per 100,000 live births

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between 2016 and 2020, representing a 45% reduction compared to 1990.[4] Importantly, the pattern of maternal death has shifted. While obstetric hemorrhage was previously the predominant cause, hypertensive disorders and non-obstetric complications now account for a large proportion of maternal deaths. Preeclampsia, eclampsia, and HELLP syndrome together contributed 14.6% of the maternal fatalities in Indonesia.[4]

Eclampsia is a severe and life-threatening pregnancy complication characterized by generalized tonic clonic seizures in women with hypertensive disorders of pregnancy.[5] Although its incidence has decreased in high-income countries, eclampsia remains common in low-resource settings, with reported incidence rates ranging from 50 to 151 per 10,000 deliveries.[6] Maternal mortality associated with preeclampsia and eclampsia remains high, with reported fatality rates of 5 to 20%, particularly among young women.[7]

Previous studies have identified several factors associated with increased mortality in eclampsia, including HELLP syndrome, disseminated intravascular coagulation, acute kidney injury, pulmonary edema, acute respiratory distress syndrome, and central nervous system hemorrhage.[5,8] Laboratory abnormalities such as severe proteinuria, anemia, thrombocytopenia, and liver dysfunction have also been associated with poor maternal outcomes.[9] However, the relative contribution of these factors may vary across institutions due to differences in patient characteristics, referral patterns, and available resources.

Given the persistent contribution of eclampsia to maternal mortality in Indonesia, evaluating institution-specific risk factors is essential. This study aims to examine epidemiological, clinical, and laboratory risk factors associated with maternal death due to eclampsia at our institution to support earlier risk identification and improved clinical management strategies.

Materials and Methods

Study Design and Setting

This study employed an observational analytic design with a cross-sectional approach. The study was conducted at Dr. Slamet Garut Regional General Hospital. Data were collected retrospectively from medical records of patients treated between January 2022 and March 2024.

Study Population

The study population consisted of pregnant women diagnosed with eclampsia who were treated at the emergency maternal unit of Dr. Slamet Garut Regional General Hospital during the study period. Total sampling was applied to include all eligible cases that met the predefined inclusion criteria. The target population comprised all pregnant women attending the hospital, while the accessible population included patients with a confirmed diagnosis of eclampsia managed at the emergency maternal unit.

Inclusion and Exclusion Criteria

Inclusion criteria were pregnant women referred to or treated at Dr. Slamet Garut Regional General Hospital between 2022 and 2024 with a clinical diagnosis of eclampsia. Exclusion criteria included incomplete medical records, multiple pregnancies, seizures attributed to epilepsy, and patients with documented pre-existing neurological disorders prior to pregnancy.

Data Collection and Statistical Analysis

Data were extracted systematically from medical records and included patient demographic characteristics, clinical findings, and laboratory parameters. Data processing involved data editing to ensure completeness and accuracy, coding of variables, data entry into a master database, and tabulation. Statistical analysis was performed using IBM SPSS Statistics version 29.0.1.0. Univariate analysis was conducted to describe variable distributions. Bivariate analysis using the chi-square test was applied to assess associations between independent variables and maternal mortality. Multivariate logistic regression analysis was performed to identify independent risk factors and calculate odds ratios. Statistical significance was defined as a p value of 0.05 or less. Results are presented as proportions, odds ratios, p values, and tables.

Result

Table 1 presents the demographic and clinical characteristics of the study population. Most participants were aged 20–30 years (66.1%), and a large proportion were overweight or obese (78.5%). More than half of the participants were at a gestational age of ≥34 weeks (58.0%), while 15.2% were in the postpartum period. Primiparous women constituted 53.6% of the study population, and the majority had fewer than six antenatal care visits (63.4%). In terms of educational background, most participants had completed senior high school or lower (98.2%).

Table 2 summarizes the clinical symptoms and blood pressure characteristics of the participants. Edema was present in 35.7% of cases, headache in 66.1%, upper abdominal pain in 33.0%, and blurred vision in 40.2%. Elevated systolic blood pressure (≥140 mmHg) was observed in 97.3% of participants, while diastolic blood pressure ≥90 mmHg was recorded in 93.8%, indicating a high prevalence of hypertension-related clinical features in the study population.

Table 1 Demographic and Clinical Characteristics of the Study Population

Variable		N	%
Age	< 20 years old	16	14.30%
	20 - 30 years old	74	66.10%
	> 30 years old	22	19.60%
Body Mass Index (BMI)	Normoweight	24	21.40%
	Overweight	51	45.50%
	Obese	37	33.00%
Gestational Age	≤ 34 weeks	30	26.80%
	≥ 34 weeks	65	58.00%
	Postpartum	17	15.20%
Parity	Primiparous	60	53.60%
	Multiparous	52	46.40%
Frequency of Antenatal Care (ANC)	≥ 6 times	41	36.60%
	< 6 times	71	63.40%
Last educational status	Elementary school	14	12.50%
	Junior high school	41	36.60%
	Senior highschool	55	49.10%
	Bachelor degree or above	2	1.80%

Table 2 Clinical Symptoms and Blood Pressure Characteristics of Study Participants

Variable		N	%
Edema	Lower limb	37	33.00%
	Generalized	3	2.70%
	None	72	64.30%
Headache	Present	74	66.10%
	Absent	38	33.90%
Upper abdominal pain	Present	37	33.00%
	Absent	75	67.00%
Blurred vision	Present	45	40.20%
	Absent	67	59.80%
Systolic blood pressure	< 140	3	2.70%
	140 - 160	61	54.50%
	> 160	48	42.90%
Diastolic blood pressure	< 90	7	6.30%
	90 - 110	70	62.50%
	≥ 110	35	31.30%

Table 3 presents laboratory findings and the prevalence of HELLP syndrome among study participants. Proteinuria was detected at varying degrees, with 17% having 1+, 40.2% showing 2+, and 42.9% presenting with ≥3+. Hemoglobin levels were distributed almost equally, with 45.5% having levels ≥11 g/dL, while 54.5% had levels below 11 g/dL.

Regarding hematocrit levels, 58.9% of participants had values below 35, whereas 41.1% had levels ≥35. Serum creatinine levels were predominantly below 1.13 mg/dL (79.5%), with 20.5% having elevated levels (≥1.13 mg/dL). Additionally, HELLP syndrome was identified in 33% of participants, while 67% did not exhibit this condition.

Table 4 shows the case fatality rate of eclampsia among study participants. A total of 112 cases of eclampsia were recorded, with 23 deaths attributed to the condition. This results in a case fatality rate of 20.54%, indicating that approximately one in five patients with eclampsia did not survive. These findings highlight the significant mortality risk associated with eclampsia and underscore the importance of timely medical intervention and management to improve patient outcomes.

Table 5 shows that several maternal factors are associated with perinatal mortality risk. The table presents a comparative analysis between deceased and surviving cases based on maternal age, body mass index (BMI), gestational age, parity, antenatal care visits, and education level. The odds ratio (OR) and p-value for each variable indicate the strength and significance of these associations.

Younger mothers (<20 years) had a higher odds ratio (OR = 2.7) for mortality compared to older age groups, although the association was not statistically significant (p = 0.192). Regarding BMI, obese mothers had a lower odds ratio (OR = 0.182) compared to normoweight mothers, but this relationship was also not significant (p = 0.869). Gestational age at delivery did not show a significant impact on mortality outcomes (p = 0.247).

Table 5 also shows that antenatal care is an important factor in reducing mortality risk. Women who had fewer than six antenatal visits had a higher mortality rate (78.3%) than those with more visits (21.7%). The odds ratio for this variable (OR = 0.409) suggests a potential protective effect, with a borderline p-value (0.097). The last education status variable produced a p-value of 0.351 > 0.05, indicating no association between the last education status and eclampsia case mortality.

Table 3 Laboratory Parameters and HELLP Syndrome in Study Participants

Variable		N	%
Proteinuria	1+	19	17.00%
	2+	45	40.20%
	≥3+	48	42.90%
Hemoglobin	≥ 11	51	45.50%
	< 11	61	54.50%
Hematocrite	< 35	66	58.90%
	≥ 35	46	41.10%
Creatinine levels	< 1.13 mg/dl	89	79.50%
	≥ 1.13 mg/dl	23	20.50%
HELLP syndrome	Present	37	33.00%
	Absent	75	67.00%

Notes: 1+ (Proteinuria): Mild proteinuria detected on urine dipstick (approximately 30 mg/dL), indicating a small amount of protein in the urine. 2+ (Proteinuria): Moderate proteinuria on urine dipstick (approximately 100 mg/dL), indicating a higher level of urinary protein excretion. ≥3+ (Proteinuria): Severe proteinuria on urine dipstick (approximately ≥300 mg/dL), suggesting marked protein loss in the urine and clinically significant proteinuria.

Table 4 Case Fatality Rate of Eclampsia Cases

Variable	N	Total Eclampsia Cases	Case Fatality Rate
Number of deaths	23	112	20.54%

Table 5 Maternal Risk Factors Based on Demographic and Clinical Characteristics

Variable		Maternal Death				Odds Ratio (OR)	*P value*
		Yes		No			
		N	%	N	%		
Age	< 20 years old	6	26.10%	10	11.20%	2.7	0.192
	20 - 30 years old	13	56.50%	61	68.50%	0.959	
	> 30 years old	4	17.40%	18	20.20%	0.221	
Body Mass Index (BMI)	Normoweight	4	17.40%	20	22.50%	0.725	0.869
	Overweight	11	47.80%	40	44.90%	0.997	
	Obese	8	34.80%	29	32.60%	0.182	
Gestational Age	≤ 34 weeks	6	26.10%	24	27.00%	0.458	0.247
	≥ 34 weeks	11	47.80%	54	60.70%	0.373	
	Postpartum	6	26.10%	11	12.40%	0.423	
Parity	Primiparous	12	52.20%	48	53.90%	0.932	0.880
	Multiparous	11	47.80%	41	46.10%		
Frequency of Antenatal Care (ANC)	≥ 6 times	5	21.70%	36	40.40%	0.409	0.097
	< 6 times	18	78.30%	53	59.60%		
Last educational status	Elementary school	4	17.40%	10	11.20%	0.563	0.351
	Junior high school	11	47.80%	30	33.70%	0.917	
	Senior highschool	8	34.80%	47	52.80%	0.426	
	Bachelor degree or above	0	0.00%	2	2.20%	0.001	

Table 6 Clinical Symptoms and Blood Pressure as Risk Factors for Maternal Mortality

Variable		Maternal Death				Odds Ratio (OR)	*P value*
		Yes		Yes			
		N	%	N	%		
Edema	Lower limb	7	30.40%	30	33.70%	0.887	0.833
	Generalized	1	4.30%	2	2.20%	1.900	
	None	15	65.20%	57	64.00%	0.673	
Headache	Present	18	78.30%	56	62.90%	2.121	0.166
	Absent	5	21.70%	33	37.10%		
Upper abdominal pain	Present	10	43.50%	27	30.30%	1.766	0.232
	Absent	13	56.50%	62	69.70%		
Blurred vision	Present	12	52.20%	33	37.10%	1.851	0.188
	Absent	11	47.80%	56	62.90%		

(*Continued*)

Table 6 (Continued).

Variable		Maternal Death				Odds Ratio (OR)	*P value*
		Yes		Yes			
		N	%	N	%		
Systolic blood pressure	< 140	1	4.30%	2	2.20%	0.573	0.034*
	140 - 160	7	30.40%	54	60.70%	0.285	
	> 160	15	65.20%	33	37.10%	1.100	
Diastolic blood pressure	< 90	1	4.30%	6	6.70%	0.364	0.156
	90 - 110	11	47.80%	59	66.30%	0.407	
	≥ 110	11	47.80%	24	27.00%	1.273	

Note: *statistically significant result, p<0.05.

Table 6 shows that clinical symptoms such as edema, headache, upper abdominal pain, blurred vision, and blood pressure levels were analyzed as potential risk factors for mortality in eclampsia cases. The table presents the frequency and percentage of mortality cases in relation to these factors, along with the odds ratio (OR) and p-value for statistical significance based on the chi-square test.

The results indicate that edema (p = 0.833), headache (p = 0.166), upper abdominal pain (p = 0.232), and blurred vision (p = 0.188) are not significantly associated with mortality in eclampsia cases, as their p-values exceed the 0.05 threshold. This suggests that these symptoms alone do not significantly contribute to the risk of death.

However, systolic blood pressure (p = 0.034) is significantly associated with mortality, indicating that higher systolic blood pressure levels may play a critical role in determining fatal outcomes in eclampsia cases. In contrast, diastolic blood pressure does not show a significant association with mortality.

Table 7 shows that proteinuria is not significantly associated with mortality in eclampsia cases, as indicated by a p-value of 0.050 (p > 0.05). However, hemoglobin (p = 0.001), hematocrit (p = 0.001), creatinine (p = 0.001), and HELLP syndrome (p = 0.001) all demonstrated significant associations with mortality (p < 0.05). Patients with hemoglobin levels ≥11 g/dL had a 0.078 times lower risk of mortality compared to those with hemoglobin <11 g/dL. Similarly, patients with hematocrit <35% had 2.25 times higher odds of mortality than those with hematocrit ≥35%. Creatinine levels ≥1.13 mg/dL were linked to a 1.672 times greater risk of mortality, and individuals with HELLP syndrome had 2.825 times higher odds of death

Table 7 Association Between Laboratory Parameters, HELLP Syndrome, and Maternal Mortality in Eclampsia Cases

Variable	Category	Maternal Death (Yes) N (%)	Maternal Death (No) N (%)	Odds Ratio (OR)	P value
Proteinuria†	1+	2 (8.70%)	17 (19.10%)	0.259	0.050*
	2+	6 (26.10%)	39 (43.80%)	0.338	
	≥3+	15 (65.20%)	33 (37.10%)	1.672	
Hemoglobin (g/dL)	≥11	2 (8.70%)	49 (55.10%)	0.078	0.001*
	<11	21 (91.30%)	40 (44.90%)		
Hematocrit (%)	<35	22 (95.70%)	44 (49.40%)	2.25	0.001*
	≥35	1 (4.30%)	45 (50.60%)		
Creatinine (mg/dL)	<1.13	12 (52.20%)	77 (86.50%)	0.170	0.001*
	≥1.13	11 (47.80%)	12 (13.50%)		
HELLP Syndrome	Present	20 (87.00%)	17 (19.10%)	2.825	0.001*
	Absent	3 (13.00%)	72 (80.90%)		

Notes: *statistically significant result, p<0.05; † Proteinuria was categorized according to urine dipstick grading: 1+ (mild), 2+ (moderate), and ≥3+ (severe proteinuria).

compared to those without it. These findings indicate that hematological and renal dysfunction, along with the presence of HELLP syndrome, are significant risk factors for mortality in eclampsia cases.

Discussion

This study identified several key predictors of maternal mortality among patients with eclampsia, with laboratory abnormalities and severe clinical manifestations showing the strongest associations. The causes of maternal death in eclampsia are closely linked to end organ dysfunction, including cerebral complications, renal failure, hematological disturbances, and hepatic involvement. These mechanisms are reflected in the statistically significant associations observed in this study.

Severe systolic hypertension was significantly associated with maternal death. Patients with systolic blood pressure greater than 160 mmHg had higher mortality compared to those with lower systolic values, with a statistically significant association ($p = 0.034$). The odds ratio for maternal death in patients with systolic blood pressure above 160 mmHg was 1.10. This finding highlights the role of uncontrolled hypertension in precipitating fatal complications such as intracranial hemorrhage and hypertensive encephalopathy.

Severe systolic hypertension was significantly associated with maternal death. Patients with systolic blood pressure greater than 160 mmHg had higher mortality compared to those with lower systolic values, with a statistically significant association ($p = 0.034$). The odds ratio for maternal death in patients with systolic blood pressure above 160 mmHg was 1.10. This finding highlights the role of uncontrolled hypertension in precipitating fatal complications such as intracranial hemorrhage and hypertensive encephalopathy.[10,11]

Similar findings were reported in the CLIP trials, where increasing systolic and diastolic blood pressure levels were associated with higher maternal and perinatal mortality and morbidity.[10] Vigil et al also demonstrated an independent association between severe systolic hypertension and maternal mortality in eclamptic patients.[12] These findings support current recommendations for careful but timely blood pressure control in eclampsia.[8,13]

Anemia was one of the strongest predictors of maternal mortality in this study. Hemoglobin <11 g/dL was significantly associated with maternal death (OR for hemoglobin ≥11 g/dL = 0.078, $p = 0.001$). Low hematocrit was also strongly associated with maternal death, with hematocrit <35% increasing the odds of mortality (OR = 2.25, $p = 0.001$). These findings suggest that reduced oxygen carrying capacity may worsen the effects of severe hypertension and increase susceptibility to multiorgan failure.[14,15] Previous studies have reported similar associations between anemia and maternal mortality in eclampsia and severe preeclampsia.[16,17]

Renal dysfunction also contributed significantly to maternal mortality. Creatinine ≥1.13 mg/dL was significantly associated with maternal death (OR = 0.170, $p = 0.001$). Elevated creatinine reflects impaired renal perfusion and glomerular injury, which may progress to acute kidney failure and systemic metabolic derangements.18 Although evidence on creatinine thresholds is inconsistent, the present results support renal impairment as an important predictor of adverse outcomes in eclampsia.[18,19]

HELLP syndrome emerged as the strongest predictor of maternal mortality in this study. The presence of HELLP syndrome significantly increased the odds of maternal death (OR = 2.825, $p = 0.001$). HELLP syndrome contributes to maternal death through mechanisms such as disseminated intravascular coagulation, hepatic failure, pulmonary edema, and multiorgan dysfunction.20 This finding is consistent with previous studies identifying HELLP syndrome as a major determinant of maternal mortality in eclamptic patients.[12,19] Early diagnosis and aggressive management are essential to reduce fatal outcomes.[16,20]

Overall, this study demonstrates that laboratory-based indicators of organ dysfunction, including anemia, renal impairment, and HELLP syndrome, are more strongly associated with maternal mortality than demographic characteristics or isolated clinical symptoms. These findings emphasize the importance of comprehensive laboratory evaluation and early risk stratification in patients with eclampsia. However, the cross-sectional design limits causal inference and may introduce selection bias. Future prospective studies are needed to further clarify causal pathways and improve predictive models for maternal mortality.

Conclusion

This study underscores the importance of comprehensive laboratory evaluation in patients presenting with eclampsia. Severe proteinuria, low hemoglobin levels, and HELLP syndrome were associated with increased maternal mortality. These findings are particularly relevant in low- and middle-income countries, where resource and logistical constraints may limit the availability and frequency of laboratory investigations, potentially delaying risk stratification and timely intervention. Future studies using stronger study designs are warranted to confirm these findings and further clarify independent predictors of maternal death in eclampsia.

Data Sharing Statement

Datasets used in this article are available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This study complies with the Declaration of Helsinki and was approved by the Health Research Ethics Committee of RSUD Dr. Slamet Garut with approval number 00001/KEP/RSUD/B/VIII/2025. Informed consent was obtained from all individual participants included in the study.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

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