Original Article

Mortality Predictors in Trauma Patients in an Indonesian Emergency Department: A Retrospective Cohort Study

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ABSTRACT

Background: especially in low- and middle-income nations. Identifying mortality-related factors in trauma patients is essential to enhance early management and reduce death rates. This retrospective cohort study follows the STROBE guidelines and analyzes factors associated with mortality among trauma patients in the emergency department (ED) of a resource-limited setting.

Methods: This study included 356 trauma patients who presented to the ED of Bina Sehat Hospital in Jember between February 2023 and February 2025. Data were collected from electronic medical records. The variables assessed included age, gender, mean arterial pressure (MAP), systolic blood pressure, oxygen saturation, Glasgow Coma Scale (GCS), mechanism of trauma, and Revised Trauma Score (RTS). Bivariate and multivariate logistic regression analyses were conducted. A flow diagram was used to depict participant selection, and missing data were excluded listwise. Inter-rater agreement was ensured through standardized training of data collectors..

Results: Of 356 patients, 88.5% survived and 11.5% died. Bivariate analysis indicated that age, oxygen saturation, GCS, and RTS were significantly related to mortality ($p < 0.001$). Multivariate analysis identified that a low RTS ($p = 0.002$), a low GCS ($p < 0.001$), and high MAP ($p = 0.041$) were independent predictors of mortality. The RTS had the strongest association with mortality, reducing odds by 91.8% per unit increase.

Conclusion: RTS is the most robust predictor of mortality in trauma patients in this resource-limited ED setting. Implementing RTS in triage protocols may enhance early risk identification and guide targeted interventions. A multicenter validation is recommended.

***Keywords*:** Emergency Department; Glasgow Coma Scale; Mortality; Revised Trauma Score; Retrospective Cohort.

Implications for Practice:

- Given its significant predictive value for trauma-related mortality, the Revision Trauma Score (RTS) should be systematically utilized in emergency departments to inform clinical decision-making and improve outcome prediction.
- In settings with limited resources, structured clinical scoring systems such as the RTS or the Glasgow Coma Scale (GCS) can facilitate more efficient triage and management of high-risk patients.
- Furthermore, hospital policies should integrate standardized trauma assessment frameworks, and ongoing educational programs should be implemented to ensure these tools' consistent and proficient application among emergency care providers.

Introduction

Trauma represents one of the foremost causes of morbidity, mortality, and primary disability on a global scale. The World Health Organization (WHO) reports that approximately 20 to 50 million individuals are affected by trauma annually (WHO, 2022). In 2019, trauma was identified as the third leading cause of death worldwide, accounting for approximately 10% of total fatalities (Dobson, 2020). In nations such as the United States, trauma ranks as the leading cause of premature mortality after heart disease and cancer, particularly among individuals under the age of 65 (Ahmad & Anderson, 2021; Heron, 2021). The predominant contributors to trauma incidents are traffic accidents, with 90% occurring in low- and middle-income countries, including Indonesia (Hosseinalizadeh et al., 2023). This situation underscores the critical nature of trauma as a public health issue that necessitates effective management strategies, particularly within developing nations (Orukwowu et al., 2024).

Indonesia has experienced a notable rise in both the incidence of traffic accidents and the associated mortality rates. The Central Statistics Agency has documented a trending increase in traffic accidents in Indonesia from 2017 to 2022 (Badan Pusat Statistik, 2024). The Indonesian National Traffic Police (Korlantas POLRI) reported 139,258 traffic accident cases in 2022, reflecting a 34.32% increase from the prior year. Mortality from these accidents rose to 28,131 cases in 2022, significantly exceeding figures from neighbouring countries such as Singapore and Australia (WHO, 2020). This data highlights the urgent necessity to comprehend the factors contributing to trauma mortality in Indonesia. Patient characteristics, including age, gender, and vital signs, have been strongly correlated with the risk of mortality (Bick et al., 2022; Gaitanidis et al., 2021).

Research indicates that young adults constitute the most vulnerable demographic to trauma (Badan Pusat Statistik, 2021). Moreover, males exhibit a higher mortality risk associated with trauma compared to females (Bick et al., 2022; Gaitanidis et al., 2021). Several vital signs, such as systolic blood pressure, Mean Arterial Pressure (MAP), and oxygen saturation, have been significantly related to trauma mortality (Bansal et al., 2022; Hosseinalizadeh et al., 2023). Specifically, MAP values exceeding 95 mmHg and systolic blood pressure readings below 90 mmHg have been associated with an elevated risk of fatal outcomes (Bansal et al., 2022; Kamabu et al., 2023). Additionally, the level of consciousness, assessed using the Glasgow Coma Scale (GCS), is a critical indicator; a GCS score of 12 or below correlates with increased mortality (Gaitanidis et al., 2021). Notably, elderly trauma patients presenting with a high GCS score and mild injuries also require careful management, thereby warranting special attention during triage (Bick et al., 2022).

Another significant factor associated with mortality is the mechanism of trauma. Multiple studies have indicated that traffic accidents, especially those involving motorcycles, are the most prevalent cause of traumatic events (Difino et al., 2021) . Motor vehicle accidents encompass a variety of classifications, ranging from motor-vehicle collisions to pedestrian-vehicle and motor-motor incidents (Hosseinalizadeh et al., 2023). Data from countries such as Italy and Brazil further corroborate the assertion that traffic-related trauma, particularly from motorcycle accidents, leads to the highest rates of emergency room visits (Difino et al., 2021; Hosseinalizadeh et al., 2023). Motorcycle-vehicle collisions exhibit the highest mortality rates among the various types of motor vehicle accidents

(Hosseinalizadeh et al., 2023). Consequently, understanding the predominant mechanisms of trauma within a region is essential for enhancing the effectiveness of early interventions.

In addition to trauma mechanisms, the classification of injuries plays a critical role in determining mortality. Injury categorization is frequently conducted using scoring systems such as the Revised Trauma Score (RTS), which has demonstrated high accuracy in mortality prediction (Farzan et al., 2022; Hosseinalizadeh et al., 2023). The RTS categorizes injury severity into four classifications: mild, moderate, severe, and severe (Hosseinalizadeh et al., 2023). The RTS is commonly employed in Indonesia due to its user-friendliness and high validity (Farzan et al., 2022). Nevertheless, research focusing on mortality factors among trauma patients in resource-limited hospitals within Indonesia remains insufficient (Asim et al., 2024; Costa et al., 2022). Understanding these factors is essential for empowering healthcare professionals to make rapid, informed decisions. The selection of RTS, GCS, and MAP as predictors is grounded in trauma triage Theory, which emphasizes the use of physiologic parameters to estimate injury severity and guide prioritization in emergency care (Delianto & Kumar, 2025). These indicators also reflect core pathophysiological processes in trauma: MAP relates to systemic perfusion, GCS to neurologic status, and RTS integrates multiple vital signs into a composite score for rapid assessment. Their theoretical basis supports their utility as mortality predictors, especially in settings with limited diagnostic resources (Wang et al., 2025).

Jember Regency in East Java, Indonesia, is characterized by a comparatively high incidence of traffic accidents; however, it is deficient in a robust trauma registry system. Bina Sehat Hospital in Jember, classified as a resource-limited hospital, is a primary referral centre for trauma cases. Data from this hospital indicate a significant rise in trauma referrals and a 17.1% increase in mortality from 2022 to 2023 (Annual Report, Emergency Department, Bina Sehat Hospital, 2023). Interviews conducted with emergency nurses reveal a predominance of male trauma patients, primarily aged from late adolescence to adulthood, who predominantly suffer from motor vehicle accidents and severe injuries. A considerable proportion of these patients succumb to the severity of their injuries (Hornor et al., 2023; Islamiah et al., 2024). Therefore, this study aims to identify the factors associated with trauma-related mortality within a hospital setting characterized by limited resources. The objective is to facilitate early clinical decision-making and enhance patient outcomes through timely and targeted interventions.

Methods

Study Design

This research employed a quantitative, retrospective cohort design to investigate factors associated with mortality in trauma patients. The retrospective approach facilitated the examination of previously recorded clinical data to identify variables influencing patient outcomes following trauma incidents.

Participants

The study population comprised all trauma patients who presented to the Emergency Department of Bina Sehat Hospital in Jember, Indonesia, between February 1, 2023, and February 28, 2025. Due to its strategic location, this facility provides emergency services to a semi-urban population and frequently receives trauma cases. Participants were selected using purposive sampling, concentrating on trauma patients who fulfilled specific

inclusion and exclusion criteria. The inclusion criteria encompassed (1) patients aged 18 years or older, (2) those experiencing trauma resulting from traffic accidents, and (3) individuals initially treated at Bina Sehat Hospital without referral to another facility. Exclusion criteria included patients who were dead on arrival (DOA), pregnant or breastfeeding, under 18 years old, or those discharged against medical advice. A total of 356 eligible trauma cases were included in the final analysis **(Figure 1).**

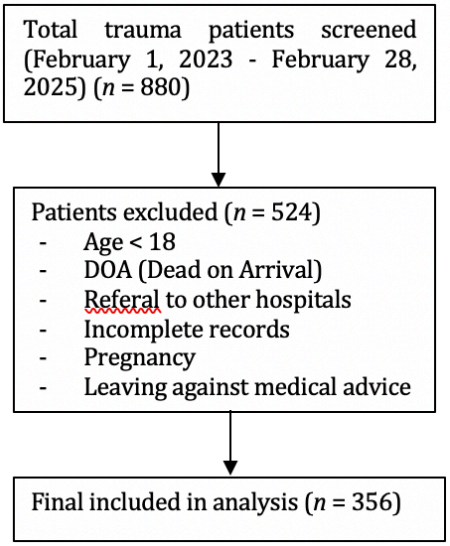

Figure 1. Selection Process Flow Diagram

Instruments

Data were extracted using a structured observation sheet from electronic medical records. The measured variables included demographic characteristics such as age and gender; vital signs including mean arterial pressure (MAP), systolic blood pressure (SBP), and oxygen saturation (SpO_2); neurologic status assessed using the Glasgow Coma Scale (GCS); the mechanism of injury categorized by type of trauma; and injury severity measured by the Revised Trauma Score (RTS), which was calculated using GCS, SBP, and respiratory rate.

MAP was classified according to Kandil et al. (2023). GCS ranged from 3 to 15. All measurements were taken at initial presentation. To reduce measurement bias, data extraction and scoring were performed by two trained raters who received standardized instruction on the RTS and GCS application. Inter-rater agreement was verified through initial calibration on 20 cases before full data collection.

Data Collection

Data collection involved a retrospective review of electronic medical records. Key steps included the identification of eligible trauma cases based on predefined inclusion and exclusion criteria, documentation of initial assessment variables upon arrival at the emergency department (ED), independent verification of the extracted data by two trained raters, and the application of validated scoring protocols for both the Revised Trauma Score (RTS) and the Glasgow Coma Scale (GCS).

Cases with missing data in any of the study variables were excluded listwise from the analysis to ensure dataset consistency. The sample size of 356 was considered acceptable for logistic regression. With 41 deaths and 4 predictors retained in the final multivariate model (based on the backward likelihood ratio method), this corresponds to approximately 10.25 events per variable, meeting the commonly recommended threshold.

Data Analysis

Descriptive statistics summarized demographics and clinical variables. Bivariate analysis used chi-square, Fisher's exact test, or Kendall's tau. Variables with $p < 0.25$ proceeded to multivariate logistic regression. The model was tested for multicollinearity, outliers, and goodness-of-fit. Results were presented as odds ratios (OR) with 95% confidence intervals (CI), with $p < 0.05$ considered significant.

Ethical Considerations

This study was conducted in accordance with ethical principles governing human research. Ethical approval was secured from the Health Research Ethics Committee of the Faculty of Health Sciences, Universitas Brawijaya, with number 25F171121028M. Given that the study involved analyzing secondary data from electronic medical records without direct patient interaction, informed consent was not deemed necessary. All data were anonymized and managed with strict confidentiality to protect patient privacy and data integrity.

Results

Demographic Characteristics of Trauma Patients

Three hundred fifty-six trauma patients were enrolled in this study, which employed purposive sampling from electronic medical records at an emergency department within a resource-limited setting hospital. The study predominantly comprised male participants, with 220 individuals (61.8%). Nearly half of the respondents fell within the late adolescent age demographic, totalling 125 individuals (35.1%). A significant proportion of the trauma patients presented with an optimal mean arterial pressure (MAP) value, as evidenced by 143 respondents (40.2%), alongside normal systolic blood pressure, reported by 142 individuals (39.9%). Additionally, the majority of respondents exhibited normal oxygen saturation levels, with 338 individuals (94.9%), and demonstrated a comatose level of consciousness, as determined by the Glasgow Coma Scale (GCS), with 292 individuals (82%). The predominant mechanism of trauma identified was motor vehicle collision, affecting 150 respondents (42.1%). Based on the Revised Trauma Score (RTS), most patients were categorized as low-risk, with 307 individuals (86.2%). Moreover, it is noteworthy that a substantial majority of trauma patients in this study survived, with 315 respondents (88.5%) **(Table 1).**

Table 1. Demographic Characteristics of Trauma Patients

Variable	Category	Frequency (n)	Percentage (%)
Age Group	Late adolescence	125	35.1%
	Early adulthood	69	19.4%
	Late adulthood	42	11.8%
	Early elderly	42	11.8%
	Late elderly	52	14.6%
	Old age	26	7.3%
Gender	Male	220	61.8%
	Female	136	38.2%
MAP Category	Optimal	143	40.2%
	Normal	82	23.0%
	High Normal	60	16.9%
	Hypertension stage 1	41	11.5%
	Hypertension stage 2	19	5.3%
	Hypertension stage 3	11	3.1%
SBP Category	Hypotension	11	3.1%
	Normal	142	39.9%
	Pre-Hypertension	113	31.7%

Variable	Category	Frequency (n)	Percentage (%)
	Hypertension stage 1	55	15.4%
	Hypertension stage 2	35	9.8%
Oxygen Saturation	Normal	338	94.9%
	Mild Hypoxia	4	1.1%
	Moderate Hypoxia	11	3.1%
	Severe Hypoxia	3	0.8%
GCS	Compos Mentis	292	82.0%
	Apathetic	21	5.9%
	Delirium	1	0.3%
	Somnolent	10	2.8%
	Sopor	3	0.8%
	Semi-coma	11	3.1%
	Coma	18	5.1%
Trauma Mechanism	Motorcycle vs motorcycle	150	42.1%
	Vehicle vs object	122	34.3%
	Motor-car	50	14.0%
	Bicycle vs motorcycle	13	3.7%
	Pedestrian vs motorcycle	18	5.1%
	Pedestrian vs car	1	0.3%
	Car vs car	2	0.6%
RTS Category	Mild	307	86.2%
	Severe	49	13.8%
Outcome	Survived	315	88.5%
	Mortality	41	11.5%

Factors Associated with Trauma Mortality

Bivariate analysis utilized Kendall's tau for ordinal variables (age, MAP, SBP, oxygen saturation, GCS, and RTS), chi-square for nominal variables (gender), and Fisher's exact test for trauma mechanisms. The bivariate analysis showed that age, oxygen saturation, GCS, and RTS were significantly associated with trauma mortality ($p < 0.001$). Other variables, including gender, MAP, SBP, and trauma mechanism, were not statistically significant ($p > 0.05$). The results are detailed below **(Table 2).**

Table 2. Association Between Independent Variables and Trauma Mortality

Variable	Category	Mortality (n)	Survived (n)	Total	p-value	Correlation/ RR
Age	Late adolescence	12	113	125	<0.001*	-0.167
	Early adulthood	0	69	69		
	Late adulthood	4	38	42		
	Early elderly	3	39	42		
	Late elderly	13	39	52		
	Old age	9	17	26		
Gender	Male	27	193	220	0.570	1.192
	Female	14	122	136		

Variable	Category	Mortality (n)	Survived (n)	Total	p-value	Correlation/ RR
MAP	Optimal	15	128	143	0.173	-0.066
	Normal	8	74	82		
	High Normal	5	55	60		
	Hypertension stage 1	5	36	41		
	Hypertension Stage 2	3	16	19		
	Hypertension Stage 3	5	6	11		
Systolic BP	Hypotension	8	3	11	0.870	-0.008
	Normal	11	131	142		
	Pre-Hypertension	6	107	113		
	Hypertension stage 1	5	50	55		
	Hypertension Stage 2	11	24	35		
Oxygen saturation	Normal	27	311	338	<0.001*	-0.480
	Mild Hypoxia	1	3	4		
	Moderate hypoxia	10	1	11		
	Severe hypoxia	3	0	3		
GCS	Coma	18	0	18	<0.001*	0.689
	Semi-coma	11	0	11		
	Sopor	3	0	3		
	Somnolent	3	7	10		
	Delirium	0	1	1		
	Apathetic	1	20	21		
	Compos mentis	5	287	292		
Trauma Mechanism	Motor-car	4	46	50	0.093	0.209
	Pedestrian vs car	0	1	1		
	Pedestrian vs motorcycle	3	15	18		
	Vehicle vs object	18	104	122		
	Motorcycle vs motorcycle	14	136	150		
	Car vs car	2	0	2		
	Bycycle vs motorcycle	0	13	13		
RTS	Severe	37	12	49	<0.001*	57.954
	Mild	4	303	307		

*significant at p<0.005

After candidate selection based on bivariate results ($p < 0.25$), four variables were included in logistic regression: age, MAP, GCS, and RTS. Assumption testing (multicollinearity, goodness-of-fit, outlier detection) confirmed model validity.

Table 3. Multivariate Logistic Regression Analysis

Variable	B coefficient	p-value	OR	95% CI (Lower-Upper)	Interpretation

Age	-0.328	0.188	0.720	0.442-1.174	Not significant
MAP	0.511	0.041*	1.667	1.022-2.720	Higher MAP increases mortality risk.
GCS	-1.246	<0.001*	0.288	0.172-0.480	Higher GCS reduces mortality odds by 71.2%
RTS	-2.498	0.002*	0.082	0.017-0.410	Strongest predictor: Lower RTS strongly predicts higher mortality

*significant at p<0.05

The logistic regression analysis demonstrates that the Glasgow Coma Scale (GCS), Revised Trauma Score (RTS), and Mean Arterial Pressure (MAP) are significant predictors of mortality among trauma patients in the emergency department. The Revised Trauma Score exhibited the most substantial influence, with an odds ratio (OR) of 0.082, indicating that each unit increase in RTS corresponds to a 91.8% reduction in the odds of mortality. Similarly, each unit increase in GCS is associated with a 71.2% decrease in the odds of mortality. In contrast, higher values of MAP were linked to an increased mortality risk (Table 3). The model's explanatory power was robust, as reflected by a Nagelkerke R^2 value of 0.818, suggesting that 81.8% of the variance in trauma mortality can be accounted for by the variables incorporated in the model.

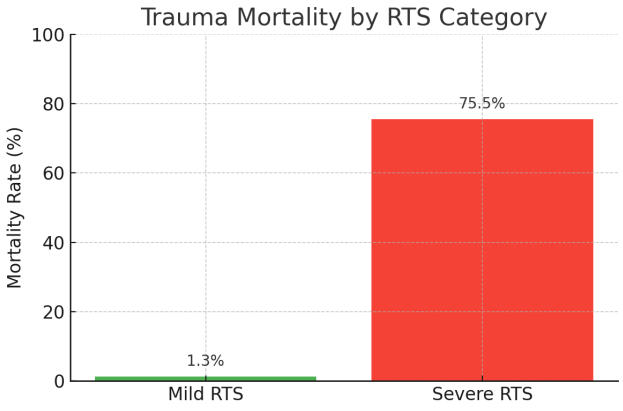

Figure 2. Mortality Rate Among Trauma Patients Based on RTS Severity

Figure 2 illustrates the distribution of mortality by RTS category. Patients categorized as having severe RTS had a markedly higher mortality rate (75.5%) compared to those with mild RTS (1.3%). This visual underscores the strong inverse relationship between RTS scores and trauma mortality, reinforcing the predictive value of RTS in clinical settings.

Discussion

This study identified several clinical factors significantly associated with mortality among trauma patients admitted to a secondary referral hospital in rural Indonesia. Notably, the Revised Trauma Score (RTS), Glasgow Coma Scale (GCS), Mean Arterial Pressure (MAP), and age demonstrated strong associations with mortality. In contrast, systolic blood pressure, oxygen saturation, gender, and trauma mechanism were not significant in the final multivariate model.

Revised Trauma Score (RTS)

RTS emerged as the most significant predictor of mortality (p = 0.002, OR = 0.082, 95% CI: 0.017–0.410). Each one-point increase in the RTS was associated with a 91.8% reduction in the odds of death. This finding is consistent with the study by Farzan et al., (2022), which reported that RTS outperforms other trauma scoring systems, such as GCS, GAP, and ISS, in predicting mortality. The integration of vital

physiological parameters in the RTS facilitates rapid assessment of patient condition and supports clinical decision-making in emergency settings, particularly where diagnostic resources are limited (Bucak & Karakus, 2023; Jiang et al., 2023).

Glasgow Coma Scale (GCS)

GCS also showed a strong inverse correlation with mortality ($p < 0.001$, OR = 0.288, 95% CI: 0.172–0.480). A one-point increase in GCS was associated with a 71.2% decrease in the odds of mortality. This result reinforces previous evidence Asim et al., (2024) Chiang et al., (2021), supporting GCS as a key indicator for early neurological assessment. However, as highlighted by Bick et al., (2022), higher GCS scores in elderly patients do not always reflect minor injuries. Our findings support this, with nearly 100% mortality observed in patients with GCS scores ≤4, thereby supporting current recommendations for aggressive intervention in patients with GCS ≤8 (Hosseinalizadeh et al., 2023; Mawuntu, 2019).

Mean Arterial Pressure (MAP)

MAP demonstrated an unexpected association with mortality; higher MAP values were linked to increased mortality risk ($p = 0.041$, OR = 1.667, 95% CI: 1.022–2.720). This may reflect compensatory responses in patients with head or thoracic trauma, where elevated arterial pressure can worsen hemorrhage or intracranial hypertension (Kamabu et al., 2023). Similarly, Gaitanidis et al., (2021) reported increased mortality in patients with traumatic brain injury and systolic blood pressure ≥110 mmHg. Therefore, MAP should be interpreted in its clinical context rather than in isolation.

Age

Although age was not a statistically significant factor in the multivariate analysis ($p = 0.188$), it demonstrated significance in the bivariate analysis ($p < 0.001$), with the highest mortality (34.6%) observed in patients aged ≥75 years. This is consistent with findings from Lu et al., (2024) and Wongweerakit et al., (2022), which emphasized diminished physiological reserves and increased complication rates in elderly trauma patients. While age was likely excluded from the final model due to interaction effects with GCS and RTS, it remains a vital parameter in triage tools such as GAP and MGAP.

Other Non-significant Factors

Systolic blood pressure and oxygen saturation did not remain significant in the final model. This could be attributed to early compensatory mechanisms or the transient nature of these parameters. Gaitanidis et al., (2021) have proposed lowering the threshold for hypotension in trauma patients to <110 mmHg, particularly in cases involving brain injury. Additionally, a single-point SpO_2 measurement on admission may not accurately reflect the patient's evolving respiratory status (Bansal et al., 2022).

Sex and the mechanism of injury were also not independently associated with mortality. Although male patients predominated in trauma cases, this was not linked to a higher risk of death ($p = 0.570$), consistent with findings by Bick et al., (2022). While motorcycle-related trauma was the most common mechanism of injury, it did not show a statistically significant association with mortality ($p = 0.093$). Nevertheless, injury mechanisms remain a critical consideration in public health policy in low- and middle-income countries.

This study has several limitations. First, it was conducted at a single rural hospital, limiting generalizability to urban or tertiary care settings. Second, the retrospective design introduces the possibility of selection bias, incomplete data, and misclassification.

Relevance to Clinical Practice

This study reinforces the value of the Revised Trauma Score (RTS) as a key predictor of mortality and supports its integration into emergency care, especially in resource-limited hospitals. RTS can be applied through triage flowcharts or EHR-based alerts to help clinicians quickly identify high-risk patients and allocate care efficiently. Its routine use can also strengthen trauma registries and guide EMS protocols by providing consistent, data-driven assessments of injury severity.

Conclusion

This study identified the Revised Trauma Score (RTS), Glasgow Coma Scale (GCS), and Mean Arterial Pressure (MAP) as significant predictors of mortality among trauma patients. RTS emerged as the most reliable predictor, highlighting its clinical importance in early triage, particularly in resource-constrained emergency departments. RTS should be routinely integrated into triage algorithms in EDs with limited resources to improve early risk stratification and guide prompt interventions. We recommend that hospital policies incorporate RTS into standard triage protocols and support staff training programs to ensure its effective application. Additionally, broader multicenter validation is essential to confirm the generalizability of these findings and strengthen national trauma care systems.

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CrediT Authorship Contributions Statement

Kholisah Widiyawati: Conceptualization, Methodology, data collection, Writing - Original Draft
Retno Lestari: Supervision, Writing - Review & Editing
Suryanto: Supervision, Writing - Review & Editing

Conflicts Of Interest

There is no conflict of interest.

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