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Original Article

The prototype scoring system in predicting probability of survival for multiple trauma patients in Indonesia

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Abstract

Objective: Trauma-related deaths are among the top 10 causes of mortality, with an average of three deaths from traffic accidents every hour in Indonesia. In 2012, there were 117,949 traffic accidents resulting in 29,544 deaths (25.04%). In 2021, there were 103,645 accidents with 25,266 deaths (24.37%). Despite efforts to record trauma cases in Indonesia, existing scoring systems from developed countries face limitations. This study aims to propose a new, locally adapted scoring system to improve the management of multiple trauma cases, particularly at Saiful Anwar General Hospital (RSSA), Malang.

Methods: This observational analytic study with a retrospective cohort design was conducted at RSSA, Malang, Indonesia, from January 2021 to December 2022. A total of 506 multiple trauma patients from the RSSA Emergency Department were included, selected through purposive sampling. Data analysis involved the use of *t*he t-test or the Mann-Whitney *U* test for numerical and ordinal data, the chi-square or Fisher's test for nominal data, followed by multivariate logistic regression to establish a scoring system.

Results: Logistic regression through backward elimination identified 15 significant predictors of in-hospital mortality: age (P = 0.000, OR = 0.967), pulse rate (P = 0.006, OR = 0.981), GCS (P = 0.000, OR = 1.381), intracerebral hemorrhage (P = 0.105, OR = 0.966), subdural hemorrhage (P = 0.001, OR = 0.875), infratentorial hemorrhage (P = 0.000, OR = 0.151), subfalcine herniation (P = 0.038, OR = 0.871), transtentorial herniation (P = 0.050, OR = 0.038), mandibular fracture (P = 0.004, OR = 0.235), etc. GCS was the strongest predictor (Wald = 50.54). Although intracerebral hemorrhage and lung tissue injury (P > 0.05) were retained due to clinical relevance, the model showed excellent discriminatory power, with an area under the curve (AUC-ROC) of 0.917 and a 95% confidence interval of 0.886–0.948.

Conclusion: The MTPS scoring system developed in this study can predict the prognosis of multiple trauma patients with strong discrimination (0.917) and is expected to improve the quality of trauma care in accordance with WHO guidelines at RSSA Malang.

Keywords: Hospital mortality, Logistic models, Multiple trauma, Retrospective studies, Scoring systems

Introduction

Trauma management has long been one of the main challenges of health services. There are several known definitions: multiple trauma implies injury to more than 1 area of the body or organ system, while polytrauma is injury to one organ system accompanied by one or more major fractures of the large bones, pelvis, or spine. According to the WHO (World Health Organization), traffic accidents are responsible for the death of 2.4 million people every year, and it is estimated that by 2030, deaths due to injury, especially due to traffic accidents, will increase from the ninth to the seventh highest in the world. In Indonesia, deaths due to trauma are among the top 10 causes of death overall, with an average of three people dying from road accidents every hour. According to data from the Transportation Directorate (Dishub) of the Republic of Indonesia in 2012, there were 117,949 traffic accidents in Indonesia with 29,544 deaths (25.04%). The data in 2021 shows 103,645 accident cases with 25,266 deaths (24.37%). From this data, it appears that the treatment of trauma patients has not experienced significant development in the last 10 years (1–6).

Trauma cases have become a concern since 1982 in developed countries such as the United States, where, 30 years ago, a trauma register, which was designed to document the acute phase of hospital care provided to trauma victims, was implemented. The injury assessment tool called the Abbreviated Injury Score (AIS) was developed by the American Association for Automotive Safety in 1969 for quantifying the impact of trauma, and it is still undergoing development. The trauma scoring system tries to translate injury severity into numbers so that it can be used in research to form a scoring system that can be objectively used in the field for referral decisions as well as for decision-making in the Emergency Department (ED). Several scoring systems are also being developed, aiming to estimate the probability of survival as part of the monitoring and evaluation program. There are three types of trauma scoring systems. The first is based on anatomy, which depends on the injury description. The second type is based on physiology obtained from observation and measurement of vital signs to determine the level of physiological decline due to injury. The third type is a combination of anatomical and physiological scoring systems. One example of the third type is the trauma injury severity score (TRISS), which is the most widely adopted scoring system in the world (7–12).

Several studies have been carried out in Indonesia regarding the use of trauma register scoring in patients with multiple traumas, but there are problems in data collection and AIS scoring when using this system. Some obstacles in filling out the AIS include the lack of availability of trained personnel to record the trauma assessment system, differences in service standards between hospitals, which cause differences in the probability of survival for patients with the same trauma case treated at different hospitals, and limited funding from the National Health Insurance (JKN). Research conducted in Jakarta, involving teaching hospitals, found limitations in applying the TRISS method in developing countries like Indonesia, as it requires complete and superior supporting examinations. Similarly, a study at RSSA Malang faced challenges in collecting sufficient data, which required several adjustments to meet the TRISS criteria. To date, no suitable local or national scoring system has been found to be used as a reference for predicting the probability of survival in patients with trauma in hospital care, especially considering that Indonesia is a vast country with different health service capacities in other regions. Several countries that have encountered the same obstacles have developed scoring systems that suit the limitations in their respective health service centers. One example is Uganda, which developed the Kampala trauma score system, and France, which developed the simpler MGAP and GAP systems (3–7,13–16).

Through this research, the researcher intends to examine a new scoring system better adapted to the limitations using a combination of physiological and anatomical parameters that can be used as a quality improvement modality in the management of multiple trauma cases, especially at the Saiful Anwar Hospital (RSSA) in Malang.

Methods

The research is an analytical observational study with a retrospective cohort approach conducted at Saiful Anwar General Hospital (RSSA), Malang. A total of 506 subjects were included in this research. The population in this study consisted of all trauma patients who presented to the RSSA Emergency Department (ED), including both walk-in patients and those referred. The sample in this study comprised all multiple trauma patients who came to the RSSA ED during the 2 years from January 2021 to December 2022. The sampling technique used in this research was purposive sampling, focusing on multiple trauma patients during the specified period. Data analysis was performed using *t*-tests or the Mann-Whitney *U* test for numerical and ordinal data, and chi-square or Fisher's test for nominal data, followed by multivariate logistic regression to establish a scoring system. Ethical approval for this study was obtained from the Health Research Ethics Committee of Saiful Anwar General Hospital under the code number 400/114/K.3/102.7/2023.

The inclusion criteria were all multiple trauma patients who came to the RSSA ED. The exclusion criteria for this study were 1) multiple trauma patients under 16 years of age, and 2) multiple trauma patients whose data were incomplete or insufficient for analysis in this study.

The independent variables in this study consist of i) Physiological data (age, systolic blood pressure, diastolic blood pressure, mean arterial pressure, level of consciousness (GCS), heart rate, and respiratory rate), ii) Anatomical data of head trauma (intracerebral hemorrhage (ICH), epidural hemorrhage (EDH), subdural hemorrhage (SDH), infratentorial hemorrhage, intraventricular hemorrhage (IVH), subarachnoid hemorrhage (SAH), diffuse axonal injury, subfalcine herniation, transtentorial herniation, pneumocephalus, and depressed fracture), iii) Anatomical data composing facial trauma (mandibular fracture, maxillary fracture, hematosinus, nasal fracture, and orbital fracture), iv) Anatomical data of chest trauma (rib fracture, lung contusion, pleural injury, and pericardial free fluid), v) Anatomical data composing abdominal trauma (estimated free fluid, free fluid in the right quadrant region, free fluid in the left quadrant region, free suprapubic fluid, and peri-intestinal free fluid), vi) Anatomical data for spinal trauma (cervical vertebral fractures and thoracolumbar vertebral fractures), and vii) Anatomical data composing musculoskeletal trauma (radius fracture, ulna fracture, humerus fracture, tibia fracture, fibula fracture, femur fracture, short bone fracture, pelvic fracture, clavicle fracture, and scapula fracture). The dependent variable in this study is the prognosis during hospital treatment.

Data collection was carried out retrospectively through the RSSA electronic medical record. In the first phase, all patient data from January 2021 to December 2022 were collected, and then screening was carried out based on the diagnosis to obtain the medical record numbers of patients with trauma. After that, further screening was carried out based on the results of supporting radiological examinations to obtain data on patients with multiple traumas, and the patients were sorted according to the exclusion criteria. The data on multiple trauma patients were then collected to be studied.

The *t*-test is a statistical test for normally distributed numerical data. The Mann-Whitney *U* test was used for data that were not normally distributed (age, systolic, diastolic, mean arterial pressure (MAP), GCS, pulse rate, respiratory rate, intracerebral hemorrhage, epidural hemorrhage, subdural hemorrhage, diffuse axonal injury (DAI), subfalcine herniation, depressed fracture, maxilla fracture, hematosinus, rib fracture, pleural injury, intraabdominal free fluid, and pelvic fracture). The chi-square or Fisher's test was used for nominal data (infratentorial hemorrhage, intraventricular hemorrhage, subarachnoid hemorrhage, transtentorial herniation, pneumocephalus, mandibular fracture, nasal fracture, orbital fracture, lung tissue injury, pericardial free fluid, right quadrant free fluid, left quadrant free fluid, suprapubic free fluid, peri-intestinal free fluid, cervical fracture, thoracolumbar fracture, radius fracture, ulnar fracture, humerus fracture, tibial fracture, fibular fracture, femur fracture, short bone fracture, clavicle fracture, and scapular fracture) using 95% confidence interval, $\alpha = 0.05$, and significance level of $p < 0.05$. Analysis was then followed by a multiple logistic regression, in which variables with $p \leq 0.25$ in the univariate analysis were included, controlling for potential confounders.

The results of data analysis after using the multivariate logistic regression test were developed into a scoring system, and then the probability of survival was calculated based on the scoring data. All statistical tests were analyzed using the Statistical Product and Service Solution (SPSS) 25 software.

Results

Patient data, along with a comparison between dead and surviving cases, are shown in Table 1. Overall, 506 patients were included in this study. One hundred twenty-four patients died in hospital care (24.50%), and 75.50% (382 patients) survived in hospital care. Data related to physiological and anatomical variables can be seen in Table 1.

After carrying out statistical tests, the results obtained based on 27 variables were included in the logistic regression analysis to obtain a logistic regression equation model to be developed into a scoring system. Some variables may do not have a statistically significant difference if they stand alone but can still be predictors in predicting the prognosis of patients in hospital care if combined with other predictors (mean arterial pressure, pneumocephalus, mandibular fracture, maxillary fracture, nasal fracture, rib fracture, lung tissue injury, pleural injury, estimated intra-abdominal free fluid, left quadrant free fluid, and femur fracture). Logistic regression analysis was carried out on these 27 variables to obtain the best combination of variables in determining the prognosis of patient care in the hospital. A logistic regression test was carried out on these variables, and the results are presented in Table 2. The following regression equation was derived:

$$y = 2.581 + \text{age} \times (-0.0330) + \text{pulse rate} \times (-0.019) + \text{GCS} \times (0.323) + \text{intracerebral hemorrhage} \times (-0.034) + \text{subdural hemorrhage} \times (-0.133) + \text{infratentorial hemorrhage} \times (-1.889) + \text{subfalcine herniation} \times (-0.138) + \text{transtentorial herniation} \times (-3.282) + \text{mandibular fracture} \times (-1.448) + \text{maxillary fracture} \times (-0.329) + \text{rib fracture} \times (-0.456) + \text{lung tissue injury} \times (-0.556) + \text{estimated free fluid} \times (-0.324) + \text{cervical injury} \times (-1.698) + \text{pelvic fracture} \times (-0.748)$$

Lung tissue injury ($P = 0.001$) and intracerebral hemorrhage ($P < 0.001$) were statistically significant in the bivariate analysis before entering the logistic regression model. As such, these variables were included in the final model due to their strong association with in-hospital mortality. Their clinical relevance and the established role they play in trauma-related mortality further justify their inclusion in the regression model even though their significance may change after adjusting for other factors.

The assessment of calibration parameters was carried out based on the Hosmer and Lemeshow test, where the *P* value was 0.172. This means that the equation obtained has good calibration. Thus, the logistic regression model used is sufficient to explain the data, while the area under the curve (AUC-ROC) for the probability of survival in hospital treatment from this equation was 0.917, with a 95% confidence interval of 0.886–0.948 (very strong) as shown in Figure 1.

Using logistic regression analysis, a simplified scoring model named the Malang Trauma Predictive Score (MTPS) provides the equation ($y = 3.375 - 0.195 \times \text{total model score}$) and the area under the curve of the probability of survival in hospital treatment shows the same predictive value as the previous scoring model, 0.917 with a 95% confidence interval of 0.887–0.948 (very strong) as shown in Figure 1. The probability of survival is calculated using the formula:

Table 1. Characteristics and relationships between anatomical and physiological variables of multiple trauma patients with prognosis in hospital care

Variable	Died (n = 124)	Survived (n = 382)	*P* value
Variable Physiological			
Age	47.50 (16.00–92.00)	32.50 (16.00–92.00)	0.005
Systolic	131.00 (73.00–280.00)	127.00 (88.00–225.00)	0.338
Diastolic	80.00 (46.00–177.00)	77.00 (45.00–132.00)	0.307
MAP	96.83 (56.33–206.67)	93.83 (42.33–155.33)	0.188
GCS	8.00 (3.00–15.00)	15.00 (3.00–15.00)	< 0.001
Pulse rate	100.00 (48.00–198.00)	90.00 (44.00–164.00)	< 0.001
Respiratory rate	24.00 (8.00–130.00)	20.00 (11.00–40.00)	< 0.001
Head trauma variables			
Intracerebral hemorrhage	0.10 (0.00–86.00)	0.00 (0.00–47.00)	< 0.001
Epidural hemorrhage	0.00 (0.00–147.00)	0.00 (0.00–165.00)	< 0.001
Subdural hemorrhage	1.45 (0.00–74.00)	0.00 (0.00–20.00)	< 0.001
Infratentorial hemorrhage			
Yes	24 (64.9)	13 (35.1)	< 0.001
No	100 (21.3)	369 (78.7)	
Bleeding intraventricular			
Yes	32 (60.4)	21 (39.6)	< 0.001
No	92 (20.3)	361 (79.7)	
Subarachnoid hemorrhage			
Yes	83 (37.4)	139 (62.6)	< 0.001
No	41 (14.4)	243 (85.6)	
Diffuse axonal injury (DAI)			
DAI 1	5 (38.5)	8 (261.5)	0.001
DAI 2	3 (60.0)	2 (40.0)	
DAI 3	9 (52.9)	8 (47.1)	
No	107 (22.7)	364 (77.3)	
Subfalcine herniation	0.00 (0.00–20.00)	0.00 (0.00–11.00)	< 0.001
Transtentorial herniation			
Yes	14 (93.3)	1 (6.7)	< 0.001
No	110 (22.4)	381 (77.6)	
Pneumocephalus			
Yes	8 (16.0)	42 (84.0)	< 0.001
No	116 (25.4)	340 (74.6)	
Depressed fracture	0.00 (0.00–16.00)	0.00 (0.00–20.00)	0.621
Facial trauma variables			
Mandibular fracture			
Yes	13 (37.1)	22 (62.9)	0.072
No	111 (23.6)	360 (76.4)	
Maxilla fracture			

Table 1. Continued.

Variable	Died (n = 124)	Survived (n = 382)	*P* value
Non lefort	31 (30.7)	70 (69.3)	0.100
Bilateral Lefort I	2 (40.0)	3 (60.0)	
Bilateral Lefort II	3 (17.6)	14 (82.4)	
Bilateral Lefort III	10 (30.3)	23 (69.7)	
No	78 (22.3)	272 (77.7)	
Hematosinus			
Hematosinus	59 (23.1)	196 (76.9)	0.316
Panhematosinus	16 (37.2)	27 (62.8)	
No	49 (23.6)	159 (76.4)	
Nasal fracture			0.060
Yes	39 (30.7)	88 (69.3)	
No	85 (22.4)	294 (77.6)	
Orbital fracture			0.981
Yes	44 (24.4)	136 (75.6)	
No	80 (24.5)	246 (75.5)	
Chest trauma variables			
Ribs fracture			0.112
Unilateral (1–3)	19 (30.6)	43 (69.4)	
Unilateral (> 3)	8 (25.0)	24 (75.0)	
Bilateral (2–3)	1 (0.8)	1 (0.3)	
Bilateral (> 3)	5 (50.0)	8 (50.0)	
Flail chest	0 (0.0)	0 (0.0)	
No	91 (22.9)	306 (77.1)	
Lung tissue injury			0.001
Yes	49 (34.5)	93 (65.5)	
No	75 (20.6)	289 (79.4)	
Pleural injury			0.151
Unilateral	44 (24.4)	136 (75.6)	
Bilateral	80 (24.5)	246 (75.5)	
Tension	0 (0.0)	0 (0.0)	
No	92 (23.1)	307 (76.9)	
Pericardial free fluid			1.00
Yes	2 (25.0)	6 (75.0)	
No	122 (24.5)	376 (75.5)	
Abdominal trauma variables			
Intra-abdominal free fluid			0.250
1–250 mL	12 (40.0)	18 (60.0)	
251–500 mL	0 (0.0)	0 (0.0)	
501–750 mL	1 (25.0)	3 (75.0)	
751–1000 mL	1 (25.0)	(75.0)	
> 1000ml	1 (11.1)	8 (88.9)	
No	109 (23.7)	350 (76.3)	
Right quadrant free fluid			0.400
Yes	12 (30.0)	28 (70.0)	
No	112 (24.0)	354 (76.0)	
Left quadrant free fluid			0.130

Table 1. Continued.

Variable	Died (n = 124)	Survived (n = 382)	*P* value
Yes	12 (35.5)	22 (64.7)	
No	112 (23.7)	360 (76.3)	
Suprapubic free fluid			0.952
Yes	6 (24.0)	19 (76.0)	
No	118 (24.5)	363 (75.5)	
Peri-intestinal free fluid			0.771
Yes	3 (18.8)	13 (81.3)	
No	121 (24.7)	369 (75.3)	
Bone trauma variables behind			
Cervical fracture			0.009
Yes	15 (42.9)	20 (57.1)	
No	109 (23.1)	362 (76.9)	
Thoracolumbar fracture			1.00
Yes	4 (25.0)	12 (75.0)	
No	120 (24.5)	370 (75.5)	
Musculoskeletal trauma variables			
Radius fracture			0.438
Yes	8 (19.5)	33 (80.5)	
No	116 (24.9)	349 (75.1)	
Ulnar fracture			0.950
Yes	7 (25.0)	21 (75.0)	
No	117 (24.5)	361 (75.5)	
Humerus fracture			1.00
Yes	4 (21.1)	15 (78.9)	
No	120 (24.6)	367 (75.4)	
Tibial fracture			0.417
Yes	4 (17.4)	19 (82.6)	
No	120 (24.8)	363 (75.2)	
Fibular fracture			0.499
Yes	7 (30.4)	16 (69.6)	
No	117 (24.2)	366 (75.8)	
Femur fracture			0.169
Yes	5 (14.7)	29 (85.3)	
No	119(25.2)	353 (74.8)	
Short bone fracture			0.936
Yes	11 (25.0)	33 (75.0)	
No	113 (24.5)	349 (75.5)	
Pelvic fracture			0.039
Stable fracture	5 (35.7)	9 (64.3)	
Pelvic ring fracture	7 (43.8)	9 (56.3)	
Vascular injury/APC3	1 (100)	0 (0.0)	
Vertical shear/number APC3	0 (0.0)	2 (100)	
Hemicorporectomy	0 (0.0)	0 (0.0)	
No	111 (23.5)	362 (76.5)	
Clavicle fracture			0.360
Yes	21 (28.8)	52 (71.2)	

Table 1. Continued.

Variable	Died (n = 124)	Survived (n = 382)	*P* value
No	103 (23.8)	330 (76.2)	
Scapular fracture			0.591
Yes	5 (20.0)	20 (80.0)	
No	119 (24.7)	362 (75.3)	

probability of survival = 1 ÷ (1 + exp(−y)).

It gives appropriate results shown in Table 3, as well as the scoring card in Table 4. as shown in Table 3, based on the scoring card in Table 4.

Discussion

The study included a total of 506 patients; the majority were young male patients, and the mortality rate was 24.5%. Several physiological factors (age, GCS, pulse rate, and respiratory rate) showed a significant relationship with hospital mortality. Among the head trauma variables, the associations in most were significant. Lung tissue injury was significantly associated with death in hospital care; however, rib fractures and pleural injuries did not show a significant relationship, though with a probability of < 0.25, indicating they can be included in further analysis. Death in hospital care was not significantly associated with the amount of intra-abdominal free fluid ($p < 0.25$) and the area where free fluid was found. Fractures of the cervical spine and pelvis showed a significant association with hospital mortality in musculoskeletal trauma analysis. Analysis revealed 15 statistically and clinically significant variables, as explained in the results. GCS was identified as the strongest predictor of prognosis for multiple trauma patients in hospital care.

The descriptive findings regarding sex and mortality rate are in line with most research that has been conducted previously. Mortality in multiple trauma patients is not much different from mortality in trauma patients, as reported by the Indonesian Traffic Directorate, where mortality in trauma cases was 20–25%. This number has not changed from 2012 to 2021. In terms of age, it also appears that multiple trauma patients are predominantly aged 15–24 years. Additionally, the cumulative percentage shows that individuals aged 15–44 years old account for more than 50% (58%) of the cases. This is not surprising because, according to findings in previous research, young patients have higher mobility compared to older patients, increasing the possibility of accidents (1,3,5,6).

Most of the physiological factors have a significant relationship with hospital mortality, which is in accordance with many previous studies where the Revised Trauma Score is used. The RTS only uses physiological data in predicting mortality. Before the RTS was revised, peripheral oxygen saturation was one of the variables involved in predicting death; however, there were many obstacles in using this data because it was greatly

Table 2. Results of logistic regression analysis of physiological and anatomical variables for multiple trauma patients as predictors of patient survival in hospital care

Variable	B	SE	Wald	*P* value	OR	IK 95%		Model
						Min.	Max.	
Age	−0.033	0.009	14.952	0.000	0.967	0.951	0.984	0.2
Pulse rate	−0.019	0.007	7.629	0.006	0.981	0.969	0.995	0.1
GCS	0.323	0.045	50.540	0.000	1.381	1.264	1.510	−1.5
Intracerebral hemorrhage	−0.034	0.021	2.629	0.105	0.966	0.927	1.007	0.2
Subdural hemorrhage	−0.133	0.041	10.718	0.001	0.875	0.808	0.948	0.7
Infratentorial hemorrhage	−1.889	0.484	15.202	0.000	0.151	0.059	0.391	10
Subfalcine herniation	−0.138	0.067	4.287	0.038	0.871	0.765	0.993	0.7
Transtentorial herniation	−3.282	1.675	3.839	0.050	0.038	0.001	1.001	17
Mandibular fracture	−1.448	0.507	8.168	0.004	0.235	0.087	0.634	7.5
Maxillary fracture	−0.329	0.125	6.881	0.009	0.720	0.563	0.920	2 .0
Rib fracture	−0.456	0.172	7.061	0.008	0.634	0.453	0.887	2.5
Lung tissue injury	−0.556	0.341	2.659	0.103	0.574	0.294	1.119	3 .0
Estimation of free fluid	−0.331	0.171	3.759	0.053	0.718	0.514	1.004	2 .0
Cervical injury	−1.698	0.539	9.907	0.002	0.183	0.064	0.527	9 .0
Pelvic fracture	−0.748	0.278	7.224	0.007	0.473	0.274	0.817	4 .0
Constant	2.581	0.927	7.745	0.005	13.209	-	-	-

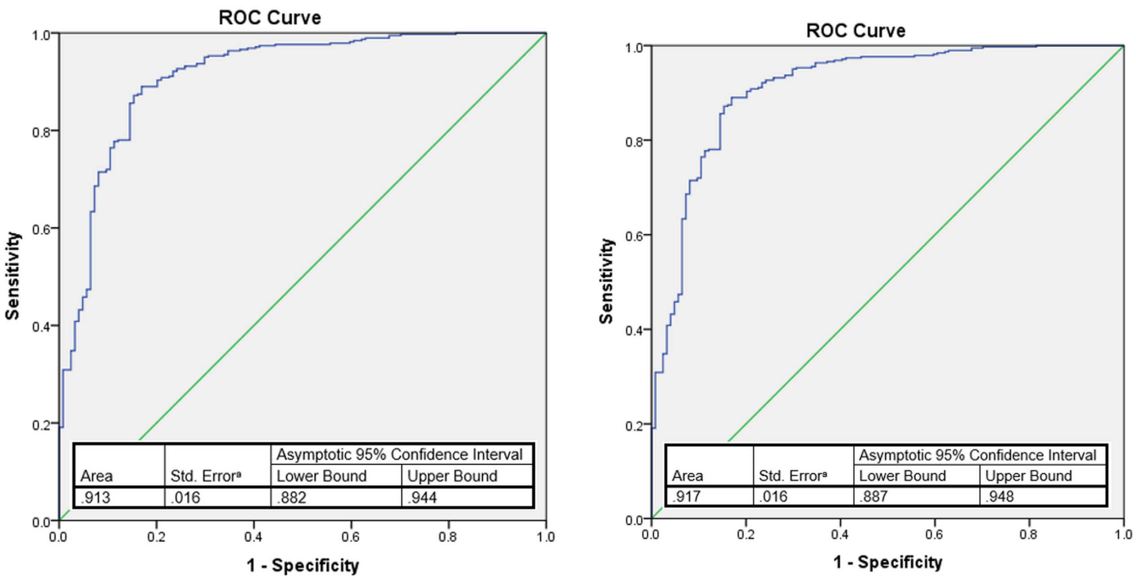

Figure 1. Area under the curve (AUC-ROC) of the initial regression equation and the regression equation of the simplified model

influenced by the oxygen support used. With poor initial recording, this variable often causes errors in predicting the probability of survival. Due to varying measurements caused by differences in oxygenation provided to the patients, the oxygen saturation variable was not included in this study. Neither systolic nor diastolic blood pressure had any significant relationship with in-hospital mortality; this is probably because the study sample was patients with multiple trauma, with the majority of deaths attributed to head trauma, according to the research results. According to the literature, it is known that patients with increased intracranial pressure due to trauma will experience an increase in blood pressure as compensation to maintain cerebral perfusion pressure, thereby masking the state of shock due to ongoing bleeding (8–11,17–19).

The results of the head trauma variable analysis show that most of the analyzed variables significantly predicted the diagnosis, which is consistent with existing data reporting head trauma as the most significant contributor to death in patients with multiple trauma. The data on patients with transtentorial herniation show that only 6.7% of patients survived hospital treatment, as expected based on the available literature. In line with existing reports, sub-arachnoid hemorrhage is the most common

Table 3. Probability of survival: physiological scoring model for multiple trauma patients

MTPS	y-value	Probability of survival
40.9	−4.59512	1%
28.6	−2.19722	10%
24.4	−1.38629	20%
22.9	−1.09861	25%
21.7	−0.84730	30%
19.4	−0.40547	40%
17.3	0.00000	50%
15.2	0.405465	60%
13.0	0.847298	70%
11.7	1.098612	75%
10.2	1.386294	80%
6.0	2.197225	90%
−6.3	4.59512	99%

MTPS: Malang Trauma Predictive Score

Table 4. Malang Trauma Scoring Score card for multiple trauma patients in predicting the probability of survival

Variable	Unit	Mark	Cons.	Score
Age	In years		X 0.2	
Rate pulse	Beats per minute		X 0.1	
GCS	In number		X (-1.5)	
Intracerebral bleeding	In mL		X 0.2	
Subdural hemorrhage	Diameter (mm) × No. of 10-mm slices		X 0.7	
Infratentorial bleeding	No: 0 Yes: 1		X 10	
Subfalcine herniation	In mm		X 0.7	
Transtentorial herniation	No: 0 Yes: 1		X 17	
Mandibular fracture	No: 0 Yes: 1		X 7.5	
Maxillary fracture	No: 0 Unilateral: 1 Bilateral LeFort I: 2 Bilateral LeFort II: 3 Bilateral LeFort III: 4		X 2	
Rib fracture	No: 0 Unilateral (1–3): 1 Unilateral (>3): 2 Bilateral (2–3): 3 Bilateral (>3): 4 Flail chests: 5		X 2.5	
Lung tissue injury	No: 0 Yes: 1		X 3	
Estimated free fluid	No: 0 1–250 mL: 1 241–500 mL: 2 501–750 mL: 3 751–1000 mL: 4 >1000 mL: 5		X 2	
Cervical injury	No: 0 Yes: 1		X 9	
Pelvic fracture	No: 0 Fracture stable: 1 Fracture pelvic ring: 1 Injury vascular / APC3: 2 Vertical shear / number APC3: 3 Hemicorporectomy: 4		X 4	
Total score				
Probability of survival Total score 22.9: probability of survival 25% Total score 17.3: probability of survival 50% Total score 11.7: probability of survival 75%				

injury in patients with head trauma (5,13,19–22).

Maxillofacial trauma can be life-threatening when it occurs simultaneously with head trauma, especially if it results in airway obstruction. However, the existing data show no significant relationship between maxillofacial trauma in the studied multiple trauma patients and death in hospital care. Despite this, some variables still can be predictors of death due to multiple trauma in hospital care in the scoring model; these factors include mandibular fractures, maxillary fractures, and nasal fractures. This is in line with the present study results because in tertiary hospitals, problems with airway obstruction can be immediately alleviated by stabilizing a secure airway compared to hospitals with lower levels of trauma management systems (13,14,16,19,23).

Lung tissue injury is significantly associated with death in hospital care. In contrast, rib fractures or pleural injuries do not show a significant relationship. However, these two variables can still be predictors of death during in-hospital care in combination with other variables, with a probability of ≤ 0.25. In the researchers' opinion, this is normal because in cases of rib fractures or pleural injuries, the problems that occur can be treated directly in the ED by administering analgesics and a chest tube procedure, but lung tissue injuries tend to be challenging to treat immediately and tend to develop into acute respiratory distress syndrome (7,9,19,24).

Regarding finding free fluid on the EFAST (extended focused assessment sonography in trauma) examination, this study found no significant difference between the estimated amount of intra-abdominal free fluid and the area where free fluid was found and death in hospital care. Finding free intra-abdominal fluid with stable hemodynamics generally only requires observation during treatment unless serious organ injury is found on abdominal CT examination. These findings become a significant predictor if this variable is combined with other physiological variables (18,19,25–27).

Fractures of the cervical spine are significantly associated with death in hospital care. Fractures in the cervical vertebrae increase the risk of cervical spinal cord injury, which can result in airway disturbances in the form of soft tissue swelling and respiratory disturbances due to weakness in the respiratory muscles. These respiratory issues are characterized by breathing using the abdominal muscles and disturbances in circulation, with manifestations of clinical neurogenic shock, and are not found in spinal cord injuries in the thoracolumbar vertebrae. Most of the musculoskeletal trauma variables did not have a significant association with death in hospital care, which aligns with previous findings. The only trauma with a significant relationship with death in hospital care is pelvic fracture, as it can result in massive, life-threatening bleeding (10,13,19,28–30).

Logistic regression analysis was carried out with backward elimination, and the results showed that GCS was the strongest predictor of the variables studied in predicting the prognosis of multiple trauma patients in hospital care. This is in accordance with existing theory, where GCS is a linear variable with the severity of head trauma. The results of the simplified equation are as follows: MTPS < 11.7 has a good prognosis with a probability of survival > 75%, MTPS 11.7–22.9 has a dubious prognosis with a likelihood of survival of 25%–75%, and MTPS > 22.9 has a poor prognosis with a probability of survival < 25% with a discrimination ability of 0.917.

Conclusion

MTPS (Malang Trauma Predictive Score), which is a scoring system developed in this research, can be used to predict the prognosis of patients with multiple trauma by combining existing physiological and anatomical data with a discrimination ability of 0.917. Factors that are predictors of MTS are age, pulse rate, GCS, intracerebral hemorrhage, subdural hemorrhage, infratentorial hemorrhage, subfalcine herniation, transtentorial herniation, mandible fracture, maxillary fracture, rib fracture, lung tissue injury, estimated free fluid, cervical injury, and pelvic fracture. By implementing WHO guidelines in the program to improve the quality of trauma services, this scoring is expected to enhance the quality of treatment of multiple trauma patients at RSSA Malang (12,31,32).

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Competing Interests

None.

Ethical Approval

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References

1. Statistics Indonesia (Badan Pusat Statistik). Indonesia Statistical Yearbook 2023 [Internet]. Jakarta: Statistics Indonesia; 2023 [cited 2023 Nov 15]. Available from: https://www.bps.go.id/en/publication/2004/05/15/7b19d65de26d16c1ff00c8de/statistical-yearbook-of-indonesia-2003.html
2. Delany HM, Berlin AW. Multiple injuries. In: Tinker J, Rapin M, eds. Care of the Critically Ill Patient. 1st ed. London: Springer; 1983. p. 611-28. doi: 10.1007/978-1-4471-3498-5_35
3. Mboi N, Murty Surbakti I, Trihandini I, Elyazar I, Houston Smith K, Bahjuri Ali P, et al. On the road to universal health care in Indonesia, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2018;392(10147):581-91. doi: 10.1016/s0140-6736(18)30595-6
4. Joosse P, Soedarmo S, Luitse JS, Ponsen KJ. Trauma outcome analysis of a Jakarta University Hospital using the TRISS method: validation and limitation in comparison with the major trauma outcome study. Trauma and Injury Severity Score. J Trauma. 2001;51(1):134-40. doi: 10.1097/00005373-200107000-00021
5. Santosa SP, Mahyuddin AI, Sunoto FG. Anatomy of injury severity and fatality in Indonesian traffic accidents. J Eng Technol Sci. 2017;49(3):412-22. doi: 10.5614/j.eng.technol.sci.2017.49.3.9
6. Widyastuti R, Achadi A, Usman Y, Rosita T, Lusiana M. Analysis of the causes of death in Indonesia due to accident based on the sample registration system from 2014 to 2016. The International Conference on Public Health Proceeding. 2020;5(1):12-22. doi: 10.26911/the7thicph-FP.01.02
7. Boyd CR, Tolson MA, Copes WS. Evaluating trauma care: the TRISS method. Trauma Score and the Injury Severity Score. J Trauma. 1987;27(4):370-8.
8. Jeong JH, Park YJ, Kim DH, Kim TY, Kang C, Lee SH, et al. The new trauma score (NTS): a modification of the revised trauma score for better trauma mortality prediction. BMC Surg. 2017;17(1):77. doi: 10.1186/s12893-017-0272-4
9. Demetriades D, Chan LS, Velmahos G, Berne TV, Cornwell EE, Belzberg H, et al. TRISS methodology in trauma: the need for alternatives. Br J Surg. 1998;85(3):379-84. doi: 10.1046/j.1365-2168.1998.00610.x
10. Osler T, Rutledge R, Deis J, Bedrick E. ICISS: an international classification of disease-9 based injury severity score. J Trauma. 1996;41(3):380-8. doi: 10.1097/00005373-199609000-00002
11. Li H, Ma YF. New injury severity score (NISS) outperforms injury severity score (ISS) in the evaluation of severe blunt trauma patients. Chin J Traumatol. 2021;24(5):261-5. doi: 10.1016/j.cjtee.2021.01.006
12. Beuran M, Stoica B, Negoi I, Tănase I, Gaspar B, Turculeț C, et al. Trauma registry -- a necessity of modern clinical practice. Chirurgia (Bucur). 2014;109(2):157-60.
13. Osler T, Baker SP, Long W. A modification of the injury severity score that both improves accuracy and simplifies scoring. J Trauma. 1997;43(6):922-6. doi: 10.1097/00005373-199712000-00009
14. Bangun K, Kesuma AD. Evaluation of facial trauma severity in Cipto Mangunkusumo Hospital using FISS scoring system. Jurnal Plastik Rekonstruksi. 2012;1(2):162-5. doi: 10.14228/

jpr.v1i2.45
15. Tung M, Sharma R, Hinson JS, Nothelle S, Pannikottu J, Segal JB. Factors associated with imaging overuse in the emergency department: a systematic review. Am J Emerg Med. 2018;36(2):301-9. doi: 10.1016/j.ajem.2017.10.049
16. Van Ditshuizen JC, Rojer LA, Van Lieshout EM, Bramer WM, Verhofstad MH, Sewalt CA, et al. Evaluating associations between level of trauma care and outcomes of patients with specific severe injuries: a systematic review and meta-analysis. J Trauma Acute Care Surg. 2023;94(6):877-92. doi: 10.1097/ta.0000000000003890
17. Salim C. Sistem penilaian trauma. Cermin Dunia Kedokteran. 2015;42(9):702-9.
18. Nakahara S, Yokota J. Revision of the International Classification of Diseases to include standardized descriptions of multiple injuries and injury severity. Bull World Health Organ. 2011;89(3):238-40. doi: 10.2471/blt.10.078964
19. American College of Surgeons (ACS). ATLS Advanced Trauma Life Support [Internet]. 10th ed. ACS; 2018. p. 1-474. Available from: https://store.facs.org/atls-student-course-manual-10th-edition.
20. Llullaku SS, Hyseni NS, Bytyçi CI, Rexhepi SK. Evaluation of trauma care using TRISS method: the role of adjusted misclassification rate and adjusted w-statistic. World J Emerg Surg. 2009;4:2. doi: 10.1186/1749-7922-4-2
21. Alberdi F, García I, Atutxa L, Zabarte M. Epidemiology of severe trauma. Med Intensiva (Engl Ed). 2014;38(9):580-8. doi: 10.1016/j.medine.2014.06.002
22. Yap KE, Islam AA, Ihwan A, Baan JA, Hamid F. Comparison of Helsinki CT and Rotterdam CT scoring systems as prognostic factors of brain injury. Nusant Med Sci J. 2021;6(1):33-43. doi: 10.20956/nmsj.v6i1.13967
23. Madhuri M, Punjabi S, Kumar S, Khan A, Channar K, Shams S. Assessment of maxillofacial trauma by facial injury severity score (FISS) system. Open Access J Biomed Sci. 2020;2(4):557-61. doi: 10.38125/oajbs.000211
24. Sharma AK, Rathore SS, Verma V, Yadav P. A study to validate thoracic trauma severity score in chest trauma patients. Int Surg J. 2020;7(5):1526-9. doi: 10.18203/2349-2902.isj20201863
25. Savoia P, Jayanthi SK, Chammas MC. Focused assessment with sonography for trauma (FAST). J Med Ultrasound. 2023;31(2):101-6. doi: 10.4103/jmu.jmu_12_23
26. Manka M, Moscati R, Raghavendran K, Priya A. Sonographic scoring for operating room triage in trauma. West J Emerg Med. 2010;11(2):138-43.
27. Shah DK, Patel KM, Patel S, Padshala R, Doliya T. Efficacy of blunt abdominal trauma scoring system in management of blunt abdominal trauma. Int Surg J. 2022;9(10):1726-30. doi: 10.18203/2349-2902.isj20222597
28. Azarhomayoun A, Aghasi M, Mousavi N, Shokraneh F, Vaccaro AR, Haj Mirzaian A, et al. Mortality rate and predicting factors of traumatic thoracolumbar spinal cord injury; a systematic review and meta-analysis. Bull Emerg Trauma. 2018;6(3):181-94. doi: 10.29252/beat-060301
29. Corrêa WO, Batista VG, Cavalcante EF, Fernandes MP, Fortes R, Ruiz GZ, et al. Mortality predictors in patients with pelvic fractures from blunt trauma. Rev Col Bras Cir. 2017;44(3):222-30. doi: 10.1590/0100-69912017003001
30. Miclau T, Hoogervorst P, Shearer DW, El Naga AN, Working ZM, Martin C, et al. Current status of musculoskeletal trauma care systems worldwide. J Orthop Trauma. 2018;32 Suppl 7:S64-70. doi: 10.1097/bot.0000000000001301
31. World Health Organization (WHO). Guidelines for Trauma Quality Improvement Programmes. 1st ed. Malta: WHO; 2009. p. 1-114.
32. Moore L, Clark DE. The value of trauma registries. Injury. 2008;39(6):686-95. doi: 10.1016/j.injury.2008.02.023