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Simple risk scales for predicting mortality in multiple trauma patients with severe thoracic trauma during early posttraumatic period

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ABSTRACT

Continuous severity assessment of polytrauma patients is critical for triage, quality management, mortality prediction, and trauma research. Existing data stay dubious about final predictive risk assessment. The goal of this study was to develop simple scales for predicting outcome at three time points during the early posttraumatic period for blunt multiple trauma patients with severe thoracic trauma. Multiple trauma patients with severe thoracic trauma (ISS ≥ 16, age ≥ 18, blunt mechanism, two or more injured body regions with AIS thorax ≥ 3) were included in this single-center prospective observational cohort study. The examinations were performed on the 1st-2nd, 3rd-4th and 5th-6th days after the trauma. Multivariate logistic regression analyses were used to identify independent predictors of mortality. On the 1st-2nd day after trauma, risk factors for adverse outcome were identified among the severity of the head injury, RTS score, hemoglobin, total protein, urea and creatinine concentrations. On the 3rd-4th day – among RTS, NISS scores, total protein concentration and WBC, lymphocytes, band and segmented neutrophils counts. On the 5th-6th day – oxygen content, total protein concentration and RBC, monocytes, band neutrophils counts. Based on routine diagnostic tests performed daily in the ICU, the proposed scoring method, based on three regression equations, was developed to estimate the individual mortality risk of blunt multiple trauma patients with severe thoracic trauma during the first 5-6 days after trauma. Depending on the day of the early posttraumatic intensive care, the prognostic value of clinical and laboratory markers varies.

1. Introduction

Chest trauma is one of the most important contributors to mortality and development of complications in case of multiple trauma. It is an independent predictor of mortality in the trauma patients, irrespective of the severity of the trauma [1]. Typically blunt rather than penetrating injury lead to injury of thoracic structures such as lung tissue, bones, vessels or the heart [2], [3]. Extra-thoracic injuries are often associated in population of patients with severe chest trauma [1].

As with management of all traumas, thoracic trauma requires a systematic approach [4], and must involve an interdisciplinary trauma team with high experience in critical care, anaesthesia and surgical disciplines that is mandatory to ensure high-quality management with low morbidity and mortality rates [5].

Quick assessment of injury severity can significantly affect the outcome of trauma patients [6]. Various scoring systems have been created for risk evaluation in patients with thoracic trauma, however, existing data stay dubious about final predictive risk assessment in terms of morbidity and mortality [7]. The predictive ability of some of the existing clinical prediction models is acceptable, but high risk of bias and lack of subsequent external validation limits the extensive application of the models in the general blunt chest trauma population [8]. Most scoring systems only provide a static score and cannot be modified based on changes in the patient's clinical condition. Intensive care units are high-pressure, complex, technology-intensive medical environments where patient physiological data are generated continuously. ICU predictive models were originally developed as pre-calculated risk scores that are not updated based on real-time patient input. Therefore, they may not be suitable for continuous monitoring of a patient's status [9]. As the result of difficult applicability of some scales, sometimes as the result of resource limitation or lack of the predicting outcome significance, there is no universal scoring system for predicting mortality in multiple trauma patients [10], especially in combination with severe thoracic trauma.

The pathophysiology of MODS after polytrauma is multifactorial and involves systemic inflammation and cell stress responses representing a complex network of interactions between immune, endocrine, neural and other systems [11]. There are multiple interaction between mechanisms responsible for harmful effects and involved in the progression of MODS from the one hand and compensatory reactions directed on stabilization of vital function disturbances and maintenance of homeostasis during early posttraumatic period from the other hand [12], [13]. In such a setting the same laboratory or clinical markers cannot be helpful for outcome prediction during different time-periods.

The limited diagnostic capabilities of the first- and second-level trauma centers, especially in middle-income countries, is another problem of trauma care in the early post-trauma period. Therefore, the ideal prognostic tool should be based on simple predictors to allow easy calculation and correct interpretation by different specialists working in different health care centers of different levels, and to allow use in resource-limited diagnostic settings [14].

These findings indicate that there is still important work to be done in order to provide timely and equitable care to all critically injured patients [15], especially in case of mass casualties. This is especially important in modern, multi-leveled medical trauma services where the amount of information received about the traumatic victim significantly affects the accuracy of decisions made by critical care physicians [16]. Despite extensive research in the area of trauma scoring, the ideal score has yet to be developed [8], [17]. In previous study [18], cut-off values with significant outcome prediction properties were estimated for routine diagnostic tests performed daily in the ICU through the first 5-6 days of posttraumatic period in blunt multiple trauma patients with severe thoracic trauma. The issue then becomes the importance of developing simple dynamic outcome predictive scores to prepare better management strategies for polytraumatized patients with severe thoracic injuries by the trauma team at initial clinical presentation and early posttraumatic period. The goal of this study was to develop simple scales for predicting outcome at three time points during the early posttraumatic period for blunt multiple trauma patients with severe thoracic trauma.

2. MATERIALS AND METHODS

Study design

This single-center prospective observational cohort study was conducted on 73 male patients with blunt multiple trauma with severe thoracic trauma, treated in the Department of Anaesthesiology and Intensive Care for Patients with Combined Trauma of Kharkiv City Clinical Hospital of Emergency Aid named by Prof. O.I. Meshchaninov.

Patient Selection and Data Collection

Inclusion criteria were age ≥ 18 years, ISS ≥ 16, two or more injured body regions, AIS thorax ≥3 after blunt trauma. Presence of the concomitant chronic disease in the subcompensation or decompensation phase and the penetrating injuries were set as excluding criteria. All patients underwent diagnostic evaluation according to existing protocols and were managed according to the Advanced Trauma Life Support Programme. Laboratory tests were performed on the 1st-2nd (11-34 hours), 3rd-4th (48-75 hours) and 5th-6th (97-122 hours) days after trauma during their management in the ICU.

The survival to non-survival ratio of polytraumatized patients was 42 to 31 on the 1st-2nd day, 42 to 23 – on the 3rd-4th and 42 to 21 – on the 5th-6th day after trauma.

Polytrauma severity was assessed using the Abbreviated Injury Scales (AIS), Injury Severity Score (ISS), New Injury Severity Score (NISS), Revised Trauma Score (RTS) and Trauma and the Injury Severity Score (TRISS) [19]. All of the injury severity scores were calculated according to the clinical presentation, the imaging results and the surgical findings.

Table 1. Characteristics of the survival and non-survival groups of multiple trauma patients with severe thoracic trauma.

Characteristics	**Survivors** N=42	**Non-survivors** N=31	**p value**
Age, years	41 (38.21 – 44.89)	42 (36.7 – 46.46)	1
ISS score	24.5 (22.73 – 28.22)	34 (30.38 – 38.53)	0.0006
NISS score	34 (30.4 – 35.51)	41 (38.74 – 45.9)	<0.0001
RTS score	7.84 (7.05 – 7.68)	6.17 (5.35 – 6.46)	<0.0001
TRISS score	0.964 (0.871 – 0.961)	0.717 (0.556 – 0.766)	<0.0001
Admission time, hours	1 (0.854 – 1.97)	1 (0.435 – 3.297)	0.8434
Controlled mechanical ventilation > 48 h	11 (26 %)	20 (64 %)	0.0017
Number of patients with concomitant alcohol exposure	23 (55 %)	15 (48 %)	0.6407
Traumatized body regions, N (%)			
Craniothoracic	6 (14 %)	3 (10 %)	0.0901
Thoracoabdominal	3 (7 %)	1 (3 %)	
Thoracoscelethal	7 (17 %)	1 (3 %)	
Craniothoracoabdominal	5 (12 %)	5 (16 %)	
Craniothoracoscelethal	7 (17 %)	7 (23 %)	
Thoracoabdominoscelethal	5 (12 %)	2 (7 %)	
Craniothoracoabdominoscelethal	9 (21 %)	12 (39 %)	

Injury Severity, N (%)				
AIS Skin	0	18 (43 %)	15 (48 %)	0.7837
	1	22 (52 %)	14 (45 %)	
	2	2 (5 %)	2 (6 %)	
AIS Head	0	18 (43 %)	4 (13 %)	0.0008
	1	10 (24 %)	7 (23 %)	
	2	1 (2 %)	1 (3 %)	
	3	9 (21 %)	7 (23 %)	
	4	3 (7 %)	6 (19 %)	
	5	1 (2 %)	6 (19 %)	
AIS Facial	0	31 (74 %)	24 (77 %)	0.9312
	1	10 (24 %)	5 (16 %)	
	2	0	1 (3 %)	
	3	1 (2 %)	1 (3 %)	
AIS Thorax	3	12 (29 %)	3 (10 %)	0.0772
	4	30 (71 %)	28 (90 %)	
AIS Abdomen	0	20 (48 %)	11 (35 %)	0.2169
	1	11 (26 %)	8 (26 %)	
	2	1 (2 %)	2 (7 %)	
	3	6 (14 %)	4 (13 %)	
	4	4 (9 %)	6 (19 %)	
AIS Extremities	0	14 (33 %)	9 (21 %)	0.6032
	1	4 (9 %)	2 (7 %)	
	2	9 (21 %)	7 (23 %)	
	3	13 (31 %)	12 (39 %)	
	4	2 (5 %)	1 (3 %)	
Chest injuries, N (%)				
Unilateral pneumothorax		20 (48 %)	11 (35 %)	0.3446
Unilateral hemothorax		18 (43 %)	9 (29 %)	0.3268
Bilateral hemo- / pneumothorax		2 (5 %)	5 (16 %)	0.1269
Hemo- / pneumomediastinum		4 (9 %)	2 (6 %)	1
Unilateral lung contusion		27 (64 %)	20 (64 %)	1
Bilateral lung contusion		1 (2 %)	4 (13 %)	0.1559
Heart contusion		28 (67 %)	23 (74 %)	0.6081
Rib fractures <3		8 (19 %)	5 (16 %)	1
Rib fractures ≥ 3		25 (59 %)	16 (52 %)	0.6338
Flail chest		1 (2 %)	0	1
Sternum fracture		1 (2 %)	1 (3 %)	1
Thoracic spine fracture		0	3 (9 %)	0.0723
Diaphragmatic rupture		1 (2 %)	0	1
Subcutaneous emphysema		9 (21 %)	4 (13 %)	0.5373
Bilateral chest injuries		5 (12 %)	5 (16 %)	0.7343
Mechanism of injury, N (%)				
Car driver		13 (31 %)	3 (10 %)	0.1216
Bicycle accident		3 (7 %)	2 (7 %)	
Car passenger		1 (2 %)	4 (13 %)	
Pedestrain		9 (21 %)	6 (19 %)	
Falls from height		11 (26 %)	13 (42 %)	
Assault		3 (7 %)	1 (3 %)	
Crushed by the heavy object		1 (2 %)	1 (3 %)	
Injury by manufacture machines		1 (2 %)	1 (3 %)	

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Statistical Analysis

All data are presented as median with 95 % contingency interval for ordinal variables and number with percentage for categorical variables. Fisher's exact test, chi-square test for trends and Mann-Whitney U test were used to compare demographic and laboratory data using GraphPadPrism 5.03. StatGraphics Plus 5.0 was used for multivariate logistic regression analyses with backward elimination of categorical variables to identify the independent signs associated with mortality in each estimated time period [20]. In-hospital mortality was defined as the endpoint of the study and set as the dependent variable. Previously estimated cut-off values of demographic and laboratory data [18] were used as predictive variables for the categorical logistic regression analyses. The analysis of deviance was used to measure the usefulness of the model and the goodness of fit of the model was assessed using the chi-square goodness of fit test. Receiver Operating Characteristic (ROC) analysis was used to estimate classifier performance of developed regression models. All p-values are two-sided, and a value of $p < 0.05$ was considered as the criterion for statistical significance. Summary statistics for the main demographic characteristics of the patient groups are presented in Table 1.

Ethical Statements

All individuals gave informed consent before being included in the study. In the case of inability to give informed consent, the last one was given by relatives. No patient identifiable data were used in the analysis.

3. RESULTS

All 73 patients were admitted to the ICU after surgery, depending on the suffered injuries. The first examination with laboratory tests (on the 1st-2nd day) was performed the next morning after resuscitation measures.

There were no statistical differences between survivors and non-survivors with respect to age, time of admission, number of patients with concomitant alcohol exposure, type of chest injury, involved body regions, and aetiology of the polytrauma (Table 1). More severe head injuries were observed in those failing to survive. Recently reported cut-off values for each estimated time period obtained from ROC-analyses of laboratory data and polytrauma severity scores [18] were included as predictive categorical variables for multivariate regression analyses.

The upper part of Table 2 illustrates the summary statistics for the categorical logistic regression, which revealed six predictors of outcome for blunt multiple trauma patients with severe thoracic trauma on the 1st-2nd day after trauma. The percentage of deviance explained by this model is 92.26 % and adjusted percentage – 70.15 %. The chi-square goodness of fit test shows that chi-squared is 0.43 with 3 degrees of freedom and a p-value of 0.934. Therefore, the logistic function adequately fits the observed data. The area under the ROC curve is 0.9985 ± 0.00203; $p<0.0001$, indicating very good discrimination.

The results of the regression analysis on the 3rd-4th day after trauma are presented in the middle part of Table 2. The percentage of deviance explained by regression model on the 3rd-4th day after trauma is 87.2 %. The adjusted percentage is 65.9 %. The chi-square goodness of fit test shows that chi-squared is 0.22 with 4 degrees of freedom and the p-value is 0.9943. The area under the ROC curve is 0.9979 ± 0.002846; $p<0.0001$. This indicates a very good discriminatory power.

Regression analysis results for blunt multiple trauma patients with severe thoracic trauma on the 5th-6th day after trauma are presented in the bottom part of the Table 2. The percentage of deviance explained by this regression model is 87.83 % and adjusted 72.87 %. The chi-square goodness of fit test shows that chi-squared value is 0.0045 with 3 degrees of freedom and the p-value is 0.9999. The area under the ROC curve is 0.9966±0.00425; p<0.0001, which indicates a very good discrimination.

Table 2. The results of logistic regression analyses and the likelihood ratio tests for outcome prediction in case of multiple trauma with severe thoracic trauma during the early posttraumatic period.

Variable	Coefficient	SE	Odds	χ^2	p value
The 1st-2nd day after trauma					
Constant	31.779	9.345			
AIS Head =0, (No head injury)	-0.097	5.389	0.907	16.307	0.006
AIS Head =1	-5.742	5.394	0.003		
AIS Head =2	-21.588	20.433	4.209×10^{-10}		
AIS Head =3	-9.665	6.294	6.345×10^{-5}		
AIS Head =4	-13.016	6.512	2.223×10^{-6}		
Hemoglobin <104 g/L =0	-11.374	3.576	1.149×10^{-5}	19.545	0.0000
Total protein <49.36 g/L =0	-14.487	4.735	5.108×10^{-7}	21.117	0.0000
Creatinine >143.1 µmol/L =0	-4.326	1.851	0.013	21.175	0.0000
Urea >6.115 mmol/L =0	-19.451	5.737	3.568×10^{-9}	23.199	0.0000
RTS <7.004 =0	-9.007	2.627	1.226×10^{-4}	36.275	0.0000
The 3rd-4th day after trauma					
Constant	7.7509	1.8685			
Total protein <53.83 g/L =0	-14.895	3.7547	3.40×10^{-7}	21.812	0.0000
RTS <7.004 =0	1.0962	1.3084	2.99286	11.599	0.0007
Lymphocytes <10.03 % =0	-4.6604	1.3874	0.00946	12.860	0.0003
Band neutrophils >13.5 % =0	-11.926	3.2369	6.6146×10^{-6}	15.067	0.0001
WBC count >11.68x10^9/L =0	-6.6713	1.8299	0.001267	15.358	0.0001
Band neutrophils >2.276x10^9/L =0	8.7353	3.0356	6218.4	8.8234	0.003
NISS >37.5 points =0	-4.1025	1.4177	0.01653	6.9231	0.0085
Segmented neutrophils >7.226×10^9/L =0	-4.3389	2.2716	0.01305	17.604	0.0000
The 5th-6th day after trauma					
Constant	32.079	16.336			
Content O_2 <126.8 mL/L =0	-14.874	8.096	3.469×10^{-7}	11.373	0.0007
RBC count <3.283×10^{12}/L =0	-5.277	3.799	0.005	8.268	0.004
Monocytes <3.921 % =0	-12.623	6.705	3.294×10^{-6}	12.908	0.0003
Band neutrophils >1.235x10^9/L =0	-15.969	8.249	1.161×10^{-7}	17.641	0.0000
Total protein <53.49 g/L =0	-23.008	12.152	1.018×10^{-10}	19.936	0.0000

The following equation can be used to calculate the probability of mortality: p=1/(1+e-k), where k is the sum of the constant and all coefficients for the absence of clinical or laboratory symptoms obtained for the corresponding day after the trauma according to the Table 2.

Table 3 shows the proposed simplified outcome prediction scores for blunt multiple trauma patients with severe thoracic trauma in the early posttraumatic period, obtained by reversion of the categorical logistic regressions for estimation of probable mortality in the presence of the predictors calculated above.

Table 3. Mortality predicting scores for multiple trauma patients with severe thoracic trauma during early posttraumatic period.

The 1st-2nd day		**The 3rd-4th day**		**The 5th-6th day**	
Predictors	**scores**	**Predictors**	**scores**	**Predictors**	**scores**

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AIS Head 0	7.3	RTS < 7.004	-1	Content O_2 < 126.8 mL/L	2.8
AIS Head 1	6	NISS > 37.5	3.7	RBC count < 3.283×10^{12}/L	1
AIS Head 2	2.4	WBC count > $11.68\text{x}10^{9}$/L	6	Monocytes < 3.921 %	2.4
AIS Head 3	5.1	Band neutrophils > 13.5 %	10.9	Band neutrophils > $1.235\text{x}10^{9}$/L	3
AIS Head 4	4.3	Band neutrophils > $2.276\text{x}10^{9}$/L	-7.9	Total protein < 53.49 g/L	4.4
AIS Head 5	7.3	Segmented neutrophils > 7.226×10^{9}/L	3.9		
RTS < 7.004	2	Lymphocytes < 10.03 %	4.3		
Hemoglobin <104 g/L	2.6	Total protein < 53.83 g/L	13.6		
Total protein < 49.36 g/L	3.3				
Creatinine > 143.1 µmol/L	1				
Urea > 6.115 mmol/L	4.5				

All coefficients of each regression equation were divided by the value of the lowest coefficient. The simple charts shown in Figure 1 can be used to predict mortality.

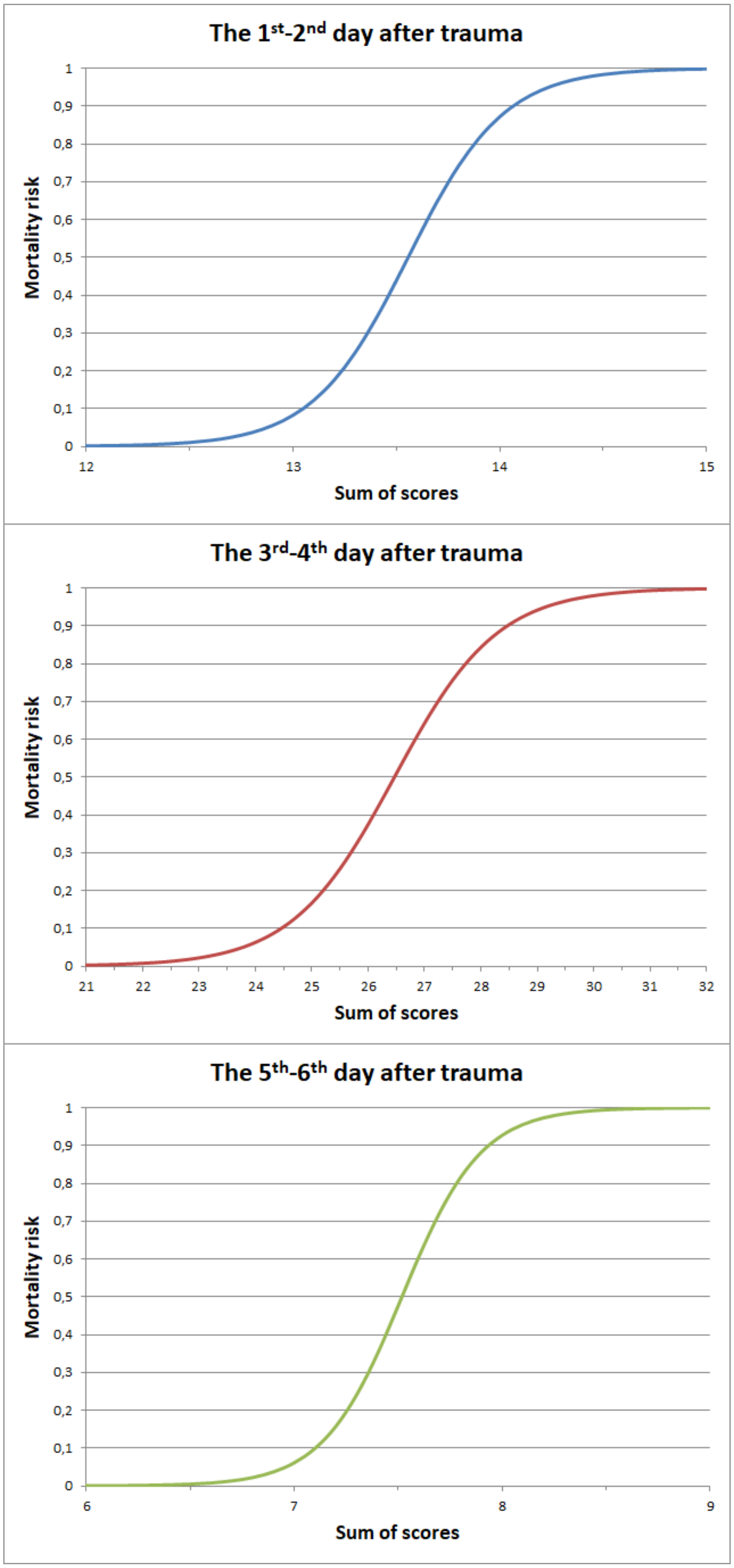

Figure 1. Diagrams for the prediction of mortality for blunt multiple trauma patients with severe thoracic trauma during the early posttraumatic period.

4. DISCUSSION

It is therefore imperative that all intensivists should be familiar with how to prioritize the management of injuries, identify ongoing or evolving injuries, and understand the language and approach of the trauma surgeon in order to appropriately intervene and coordinate the overall management of these patients [21]. They are faced with difficult decisions about how best to use critical care resources in the face of current disasters, increasing military conflicts and the latest pandemic [15]. In addition, the current practice of damage control resuscitation should be significantly modified by the specific treatment of posttraumatic disorders in multiple trauma patients with severe thoracic trauma [22]. These simple predictions, along with triage tools and early warning systems, can help critical care physicians prioritize patients for intensive care.

Risk stratification on admission is important, but also needs to be assessed after surgery and resuscitation, as intensive care during the early posttraumatic period represents another turning point. There is a need for a simple, easy to perform and accurate prognostic tool to identify those at high risk of adverse outcome for appropriate early intervention and supportive care [10]. Polytrauma in general or isolated thoracic injuries have been the main focus of most research into predicting outcomes for thoracic trauma victims. To our knowledge, this is the first study to identify mortality risk criteria for blunt multiple trauma patients with severe thoracic trauma during early posttraumatic period. A dynamic classification and adaptation of the treatment strategy can be achieved through repeated re-evaluation and assessment of the patient's physiology (Safe Definitive Surgery approach) [11]. This study proposes three regression models with good discriminatory statistics to classify such polytrauma patients into higher risk groups for in-hospital mortality during three time intervals, postulating that the effects of different risk factors on mortality may differ depending on the time after the polytrauma insult. To improve predictive accuracy, multivariate logistic regression analyses includes categorical predictors identified from ROC-analyses of demographic and laboratory variables with the most significant differences between survival and non-survival groups of multiple trauma patients with severe thoracic trauma for each investigated time period.

The results of the regression analyses support that head injury is the most important risk factor for multiple trauma patients with severe thoracic trauma, as indicated by the highest AIS head scores for the 1st-2nd day after trauma (Table 3). This finding is consistent with the results of other studies in this area linking the outcome of polytrauma victims to head injury [23]. What is surprising is that the AIS head scores of 0 and 5 were associated with the highest and identical scores according to the logistic regression analysis. The reason for this may be that the absence of head injury in case of blunt multiple trauma with severe thoracic trauma automatically implies the presence of severe injuries to the other body regions, which also indicates a poor outcome.

Another interesting finding is the presence of the cut-off value of hemoglobin concentration <104 g/L in the regression model on the 1st-2nd day after the trauma. This value is higher than the transfusion threshold value set in the modern guidelines for polytrauma management [24], but patients with only severe combined thoracic injuries were included in this study, suggesting that they may benefit from liberal transfusion strategy. Further prospective studies are needed to confirming this value of hemoglobin concentration as a possible target concentration in the context of a standardized management approach for this population of polytrauma patients. Absence of hemoglobin cut-off values on the 3rd-4th and 5th-6th days after trauma confirms importance of rapid compensation of the blood oxygen capacity for prevention of future consequences from blood loss [22].

In contrast to the model for the 1st-2nd day after trauma, two other regression equations include markers of the immune response. The results of our investigation demonstrate activation of the host defense with a maximum on the 3rd-4th day after trauma, in agreement with previous articles dedicated to the polytrauma pathophysiology staging [25]. Surprisingly, the cut-off value for band neutrophils >2.276x10^9/L got the opposite sign of coeficient in the logistic regression, suggesting that an increase in the band neutrophils absolute count alone is not dangerous for systemic inflammation as the presence of young neutrophils >13.5 % in the white blood cells formula is, exactly meaning a high degree of neutrophil recruitment [11]. The presence of injury severity scales in the logistic regression model for the 3rd-4th day following trauma suggests that the severity of the initial injury continues to influence the progression of the disease, even up to four days after the initial trauma.

Contrary to expectations, the model development process shows that the cut-off value of CtO_2 becomes predictive only on the 5th-6th day after trauma. Such result reflects that the prolongation (up to the 5th-6th day after trauma) of combined hypoxia (results from both anemia and respiratory cases of hypoxemia) during the early posttraumatic period of blunt multiple trauma with severe thoracic trauma is more detrimental than the degree of hypoxia itself. The role of monocytes in the healing process after their transformation into macrophages in the damaged tissue [11] explains the late appearance (only on the 5th-6th day after the trauma) in the regression equation of the monocyte cut-off value <3.921 % in the leukocytes formula.

With the help of this scoring system, trauma team members will be able to make more objective decisions about the prediction of survival for multiple trauma patients with severe thoracic trauma from simple clinical and laboratory data obtained in the early posttraumatic period. These regression models may be helpful in the assessment of the appropriate timing and extent of second look surgery, where preoperative conditions and risk/benefit aspects must be taken into account in the decision of individual indications for additional interventions in the early posttraumatic period [26]. It is possible that some therapeutic interventions may only be effective in reducing mortality in certain risk score-based patient subgroups [6]. These risk-scales provide an objective measure of severity of blunt multiple trauma with severe thoracic trauma in ICUs, allowing comparison of patients from various trauma centers from different levels of trauma care during early posttraumatic period. The advantage of the developed prediction method over the other scoring systems is that it is dynamic and can be also used to decide when to transfer the patient to a less intensive level of care. This can be helpful in making quick accurate decision about interhospital transfer too. Comparison of estimated and observed mortality rates can be used as a tool to evaluate and monitor the quality of ICU work. Further research and development, together with efforts to facilitate multi-centre collaborative research and improve applicability, should be undertaken to determine the role and evidence of improved patient outcomes with this monitoring modality.

5. LIMITATIONS

Like other prospective studies, this study has some limitations. Therefore, the results should be extrapolated cautiously to other polytrauma patients. This is a single-center study and these prognostic scores need to be validated in other trauma centers and regions. It is therefore possible that the results of this study cannot be generalised to a larger group of hospitals with a lower level of trauma care. Another limitation is that the patient groups are similar in age, making it impossible to analyse how this parameter contributes to these predictive equations. Age is a relevant factor in previous studies [1], [23], [27], but its contribution to mortality risk is not statistically significant in some other studies of chest trauma [28- 31]. In addition, the present study is based on a small sampled population. Nevertheless, the proposed scores can accurately define patients at high risk of negative outcome, as shown by the results of the regression analyses. Demographic and laboratory variables with only the highest values of the AUROC curves were included in multiple regression analyses for the accuracy enhancing. Despite these limitations, our results seem significant, consistent with other clinical and experimental studies. We hope that our scoring method will be able to identify patients with blunt multiple trauma patients with severe thoracic trauma at high risk of negative outcome in the early posttraumatic period. It would make it possible to target interventions, such as more intensive monitoring or treatment, at those who are most likely to benefit from them.

6. CONCLUSIONS

Using routine diagnostic tests performed daily in the ICU, the proposed scoring method, based on three regression equations, was developed to estimate the individual mortality risk for blunt multiple trauma patients with severe thoracic trauma during the first 5-6 days after trauma. Depending on the period of early posttraumatic intensive care, the prognostic value of clinical and laboratory markers varies. Since each of the investigated time periods is characterized by its own specific prognostic markers, it does not seem correct to use the same clinical and laboratory signs to predict the outcome of blunt multiple trauma patients with severe thoracic trauma during the several days of the early posttraumatic period. These scales provide a simple, rapid and valuable means of assessing the severity of post-traumatic disorders in a population of such polytrauma patients without the need for advanced diagnostic measures, and can therefore be easily incorporated into routine protocols by intensive care staff in different trauma centers at different levels of trauma care, particularly in resource-limited settings.

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Data Availability: The data that support the findings of this study are available on request from thecorresponding author: StupnytskyiMA@gamil.com
Ethical approval: This study was approved by the Ethics Committee of Kharkiv National Medical University (N8/2016, 5 October 2016) in accordance with the World Medical Association Declaration of Helsinki.

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