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RESEARCH ARTICLE

EVALUATING POLYTRAUMA PATIENT OUTCOMES AND THEIR CORRELATION WITH TRAUMA SEVERITY

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Abstract

Background: Worldwide, injuries are the cause of death for 4.4 million people per year. Identifying clinical indicators that reliably correlate with the severity and outcomes of polytrauma patients can play a crucial role in improving their care. The present study aimed to assess the outcome of polytrauma patients and relate it to the severity of the trauma.

Method and Material: This is a prospective observational study of 65 polytrauma patients (45♂) who came to the ER, aged over 16, with multiple injuries, and were admitted to the hospital. Data were collected through a structured recording form, including patient clinical data and outcome scales for life expectancy and outcome assessment (TRISS, APACHE II, Marshall CT Scan Grade, GOS-E).

Results: The average age of those with multiple injuries was 48.95 years (SD 19.91). The main mechanism of injury was blunt trauma (98.5%). The most common cause of treatment was traffic accidents (58.5%). The shortest median length of stay in the emergency room was 200'. The most common complications were transfusions (18.1%), sepsis (16.9%) and pneumonia (12.8%). The median length of hospital stay was 30 days, with 46.1% of patients recovered and 41.6% disabled. Trauma scores were analysed for the relationship between length of stay and outcome. The hazard function was statistically significant ($\chi^2(3) = 24.784$, $p < 0.001$), with the TRISS scale identified as a significant predictor ($p = 0.002$, OR = 0.96). Each increase in the TRISS scale reduces the risk of death by 4%. The model, including the TRISS scale, patient waiting time in the emergency department (ED), and oxygen saturation in the ED, was also statistically significant ($\chi^2(3) = 20.029$, $p < 0.001$), confirming the TRISS scale confirmed as a significant predictor ($p = 0.002$, OR = 0.96).

Conclusions: In patients with polytrauma, the TRISS scale was shown to be a valid predictor of results. Its use in clinical practice can enhance patient care and direct early action.

Key words: Multiple trauma, outcome, trauma rating scales.

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INTRODUCTION

According to the World Health Organization (WHO), trauma is defined as any violent tissue injury, whether internal or external, regardless of cause.[1] Globally, trauma is a cause of death for 4.4 million people per year, representing 8% of global mortality. A multi-injured patient is defined as a seriously injured patient who has sustained severe injuries to more than one organ system and, less commonly, two or more injuries to the same body region. Trauma is a serious public health problem with socioeconomic and demographic dimensions and consequences for the human body (e.g. temporary or permanent disabilities).[2,3]

Road traffic accidents are the main cause of numerous, serious injuries that can lead to death and temporary or permanent disability. In fact, by 2030, road traffic accidents will be the fifth leading cause of death, the third leading cause of disability in adults and the second leading cause of death and disability in children and adolescents worldwide. The majority of those injured (62%) are under 40 years old, mainly men (85%).[4,5] In addition, natural disasters, industrial accidents and even the effects of terrorist attacks are causes of multiple trauma.[6] Craniocerebral and thoracic injuries are the most common.[7] The combination of injuries to different systems increases the degree of difficulty of treatment (pre-hospital and in-hospital) and the likelihood of complications.[8,9] Depending on the severity and complexity of the patient with multiple injuries, in-hospital complications are associated with increased mortality, morbidity, length of hospital stay and healthcare costs, while impairing functional capacity and quality of life. All of the above factors are recorded internationally in a trauma medical record, which does not exist in Greece.[10]

At the hospital level, the health status of the injured patient is entirely determined by the actions and techniques of immediate care in the emergency department, which is the gateway to the hospital. Further management and treatment of these patients and transport to departments such as the Intensive Care Unit (ICU) or the High Dependency Unit (HDU), occurs later.[11]

Trauma scoring systems have been developed to assess the outcomes of trauma patients and quantify the severity of their injuries. These systems assist healthcare professionals in monitoring the progression of trauma.[12] This study focuses on evaluating the outcomes of polytrauma patients and investigating their association with injury severity.

METHODOLOGY

This was a prospective observational study in which the primary data was collected through observation and data collection based on the patient's medical and nursing history. The study population consisted of 65 patients - multiply injured patients who presented to the emergency department of a public tertiary hospital in Athens and were admitted to the department (ICU, HDU and surgical clinic) between March 2023 and September 2023, which was proportional to the severity of the trauma they presented with. Patients with open chest injuries were excluded.

The present study complies with the Declaration of Helsinki and was conducted after obtaining the relevant permission from the scientific council—the Ethics and Bioethics Committee of the hospital, which was involved in the research.

Methodology: A survey was conducted to collect the data, which consisted of two parts. The first part included demographic factors (such as gender and age of the patient), clinical characteristics (type of injury, organ-bearing trauma), independent variables (days of hospitalization, etc.) including the diagnostic tools used (diagnostic imaging and laboratory tests). The second part included five scales: Trauma Injury Severity Score (TRISS), Acute Physiology and Chronic Health Evaluation (APACHE II), Marshall Computed Tomography classification of traumatic brain injury-CT Scan Grade scale (Marshal CT Scan Grade) and Extended Glasgow Outcome Scale (GOS-E), which were used to derive results regarding the patient's life expectancy and also to evaluate the outcome. The scales were completed in the first 24 hours, with the exception of the GOS-E scale, which was completed before the patient was discharged from the hospital. The TRISS scale consists of 10 items related to the type of trauma.

More specifically, TRISS, which consists of 10 items focusing on the type of trauma (blunt or penetrating) and the degree of injury sustained by the patient, was originally used to assess the outcome of multiple injured patients. It also assesses the patient's respiratory, hemodynamic and neurological status. In particular, this scale consists of a summary of the Glasgow Coma Scale (GCS), the Revised Trauma Score (RTS) and the Injury Severity Score (ISS). The score is measured in percentage points, with a maximum value of 100 indicating the predicted mortality rate.[13] The APACHE II score was used to predict the progress of the patient in the ICU, compared to the successful or unsuccessful implementation of treatment measures. This scale includes 14 items that examine the physiologic status of laboratory tests and the hemodynamic status of the patient (from the patient's medical record for the first 24 hours). At the same time, it records the neurological status of the case and the comorbidity of chronic diseases. The maximum score it can achieve is 71 points and is characterized by high specificity (can predict 90% survival) but relatively low sensitivity (less accurate in predicting mortality).[14]

In addition, the Marshal CT Scan Grade is included, which evaluates the findings of the first CT scan of the brain after the event. The scale describes the classification of brain injury in 1grading from I to VI by severity and helps to identify patients early and categorize them into low and high-risk groups, with the ultimate goal of optimal treatment.[15]

Finally, the GOS-E was used to evaluate outcomes and assess disability and recovery after traumatic brain injury. This scale is divided into eight categories that classify severe disability, moderate disability and good recovery in the lower and upper organ systems of the human body.[16]

Statistical Analysis: the analyses presented in the research section were conducted using the SPSS statistical software program version 25 (IBM Statistical Package for Social Sciences for Windows, Version 25.0. Armonk, NY: IBM Corp.). In all analyses, the level of statistical significance was set at 5%.

Qualitative variables were described using absolute (n) and relative frequencies (%). For quantitative variables, the mean (M.O.) and standard deviation (SD) were used when the assumption of normality was met, and the median and interquartile range were used when it was not.

When it comes to the statistical methods used to investigate characteristics with two measurements in terms of possible differences in the values of the means and medians of these measurements, the paired t-test and Wilcoxon test were used, respectively, depending on normality. To investigate the differences in means between different characteristics with three measurements, the Repeated Measures of Analysis of Variance (ANOVA) and Friedman's test were used, respectively, depending on normality. The normality of the data was tested using the Kolmogorov-Smirnov and Shapiro-Wilk tests as well as through kurtosis and asymmetry. For survival analysis, Kaplan-Meier and Cox regression models were used.

RESULTS

The study included 65 multi-injured patients, of whom 45 (69.2%) were male and 20 (30.8%) were female. In terms of age, it ranged from 17 to 93 years with a mean of 48.95 years, a standard deviation of 19.91 years, and a median of 47 years. In terms of ethnicity, the majority of the sample was of Greek origin (80.0%), while 20.0% reported another ethnicity. The mechanism of injury almost in absolute majority was blunt trauma (98.5%). The causes of attendance at the ED were road traffic accidents for 58.5%, falls from height (12.3%), falls from the same height (12.3%), industrial accidents (6.2%), assault (3.1%), and other causes were 1.5% each. Regarding the time of attendance at the ED, the majority were admitted in the afternoon and evening hours between 16:00-23:59 (73.8%), 15.4% between 8:00-15:59, and 10.8% between 00:00-7:59. Subsequently, the vital signs of the patients in three phases are presented: a) prehospital, b) during hospitalization in ED and c) hospitalization after ED. The patient's saturation, pulse and temperature showed statistically significant differences ($p< 0.001$). A comparison was also made between the scales used to derive results, in terms of patient life expectancy and outcome assessment between hospital care in ED and hospital care after ED. More specifically, no differences were found in TRISS score ($p= 0.655$), APACHE II score ($p= 0.180$) and Glasgow Coma Scale (p= 0.340) (**Table 1**).

Below are some additional data collected on the patient's condition during hospitalization in the ED. More specifically, a bladder catheter was used for 28.3% of patients, while a Levin nasogastric tube was inserted to 23.8%. Meanwhile, a central venous line was applied in the majority (20.6%) in the femur. Finally, intubation was performed in 14.8%. Regarding the sites of lesions, a head lesion was in 25.3% of patients, the face in 16.3%, the chest in 20.8%, the abdomen and pelvis in 7.9%, and the extremities-pelvic girdle in 29.8%.

Next, the Marshall Computed Tomography classification of traumatic brain injury—CT Scan Grade, which assesses the findings of the first CT scan of the brain after the event—is discussed. For 40.0% the brain injury scored I (low risk), for 20.0% it was II, for 20.0% it was III, for 16.9% it was IV, and for 3.1% it was V. It is worth noting that the very high-risk category (VI) was not present in the patients included in the sample.

Regarding the time of admission to the department, the majority were admitted in the afternoon and evening hours between 16:00-23:59 (53.8%), 34.4% between 8:00-15:59, and 10.8% between 00:00-7:59. The departments that recorded more patient admissions after the ED department were the ICU (47.7%), then the H.D.U. with 29.2%, and finally the clinic with 23.1%. The longest median length of stay (in minutes) observed by ED patients in a hospital department was in the clinic (D = 270), followed by ICU (D = 260) and finally HDU (D = 200). These differences were not statistically significant (p = 0.076).

During the hospitalization of multi-injured patients, the complications that occurred varied. The most common complications were the need for transfusion (18.1%), sepsis (16.9%), and pneumonia (12.8%). It is worth noting that only 6 patients (2.5%) did not develop any complications during their period of hospitalization. Also shown in a graph (**Graph 1**) are the total days of hospitalization in the various departments where the patient was hospitalized. The median of days was found equal to 30 days, the interquartile range 34.50 days 53 while the minimum stay was 1 day and the maximum 132 days (approximately 4.5 months). Regarding the GOS-E scale, which assesses outcomes to evaluate disability and recovery. Recovery occurred in 46.1%, disability occurred in 41.6% and 12.3% died (8 patients).

Several survival analysis models are discussed below. In the first model, Cox regression was used where the risk function was modelled. In this case, the risk is the probability of an outcome (death of the multi-injured patient) at a certain period. The covariates used do not involve the concept of time variation. TRISS, APACHE II, and Glasgow Coma Scale were used in this model. It was found that the risk function is statistically significant as $\chi2(3) = 24.784$, $p < 0.001$; therefore, at least one of the variables is a significant predictor of the risk function. More specifically, the TRISS scale was found to have a statistically significant effect as p = 0.002 with OR = 0.96 (**Table 2**). That is, the higher the score a multi-injured patient has on this scale, the more the risk of death decreases by 4%.

In the second model, Cox regression was used to model the risk function. In this model, the TRISS scale, the patient's waiting time from the ED to a hospital department, and the saturation during the treatment in the ED were used.

The model was found to be statistically significant as $\chi2(3) = 20.029$, $p < 0.001$; therefore, at least one of the variables is a significant predictor of the risk function. More specifically, again the TRISS scale was found to have a statistically significant effect as p = 0.002 with OR = 0.96 (Table 3).

In the third model, Cox regression was also applied where the risk function was modelled. In this model, the TRISS scale was used along with the Marshall classification of traumatic brain injury.

The model was found to be statistically significant as $\chi2(2) = 22.897$, $p < 0.001$; therefore, at least one of the variables is a significant predictor of the risk function. More specifically, again the TRISS scale was found to have a statistically significant effect as $p < 0.001$ with OR = 0.96 (Table 4).

In the fourth model, Cox regression was used with TRISS scale factors as independent predictors (GCS, age, respiratory frequency, Injury Severity Score-ISS). It is worth noting that a new variable was created for the injury points, which summed the score of each point, which ranged from 1 to 5. The analysis showed that the statistically significant factor was injury points

(Table 5).

DISCUSSION

In the present study, the outcomes of multi-trauma patients and their correlation with trauma severity were investigated. Additionally, the interventions implemented during the hospitalization of these patients, with a median hospitalization duration of 30 days, were examined, as well as the complications that arose during this period and their ultimate outcomes. These data were analyzed utilizing prognostic scales such as TRISS, APACHE II, GCS, and Marshall CT Scan Grade.

The main finding of the study is that the TRISS scale is a significant predictor regarding the risk and outcome function of the multi-injured patient, as the higher a multi-injured patient's score on this scale, the higher the risk of death is reduced by 4%. Rameshbabu et al[17]corroborate the present findings after comparing the predictive accuracy of four scales, one of which is TRISS, to predict mortality in multi-injured patients. TRISS demonstrated a score of 91.6, with the next scale recording a score of 17, a value that underscores the TRISS scale in this study as a reliable predictor of survival with high sensitivity and specificity. A comparable result is also reported by Carlos Oliver Valderrama-Molina et al.18, in a study of 4085 multi-trauma patients who presented to a trauma center in Colombia. Similarly, the TRISS scale was compared with corresponding prognostic scales in terms of predicting mortality. TRISS exhibited superior performance in this case as well.

Concurrently, the APACHE II and GCS scales were utilized to assess life expectancy and outcome, yielding no statistically significant results. This lack of significance may be attributed to the limited sample size of 65 multi-injured patients, a constraint imposed by the data collection and recording time frame. However, extant literature demonstrates the statistical significance of the APACHE II scale in predicting life expectancy and outcomes for trauma patients. Specifically, Chaiyut et al.[19] and Wong et al.[20], in their respective studies of multi-trauma patients admitted to the ICU, demonstrated that both the APACHE II scale and TRISS accurately predicted mortality in ICU trauma patients. Furthermore, a study conducted by Ali Dalgiç et al.[21] at a trauma center in a tertiary hospital in Turkey, involving 266 patients, revealed that the APACHE II scale, in comparison to the Glasgow scale, exhibited a superior predictive capacity for mortality in multi-injured patients, owing to its incorporation of key physiological parameters.

Subsequently, the TRISS scale was analyzed for its independent predictive factors. Specifically, the signs of injuries - ISS acted as a statistically significant predictor for the outcome of the multi-injured patient. In a study by Shubham et al.[22], 96 multi-injured patients were admitted to a tertiary hospital trauma center for 18 months, of which 77 patients died during hospitalization and 19 survived. Patients who passed away appeared with a statistically higher significant ISS compared to survivors. The ISS values of the patients ranged between 15 and 66. Similarly, in the study by Arshad Alam et al.[23], in a total of 43 patients with blunt trauma, they presented the ISS scale as a more suitable way for predicting postoperative complications.

In addition, the present study showed that the length of stay in the ED until the patient was transferred to the appropriate hospital department did not affect the outcome. The shortest median length of stay in the ED at the tertiary hospital where the study was conducted was 200 minutes. However, in a study by Yuko Ono et al.[24], the length of stay in the ED was associated with the severity of the injury. The population of this study was high-risk patients within 10 years who were admitted to the hospital's EDs. The risk of unexpected death from trauma increased significantly when the length of stay in the ED exceeded 90 minutes. A similar result was highlighted through a study by Evangelatos A. et al.[25] where in a sample of 95 patients admitted to the ED of a tertiary hospital in Greece, the average length of stay was 210 minutes and was influenced by the time taken to perform diagnostic tests, the type of diagnostic tool used, and the number of physicians who examined the patients. At the same time, through research, the most prevalent mechanism of injury seems to be blunt trauma, while the most common cause of attendance at the ED is road traffic accidents. A similar result was also indicated by a study by Shubham et al.[22], where in a sample of 96 patients. the majority of them had blunt trauma caused by traffic accidents.

According to the study's findings, CT Scan Grade was not a statistically significant predictor. This is likely because most patients received full-body CT scans, which include brain CT scans, and not all of them suffered craniocerebral injuries. In a study by Akhill et al.[26], among 134 patients who carried moderate to severe craniocerebral injury (GCS: 3-12), the CT Scan Grade scale was a predictor of early mortality. Full-body CT scan, through studies, is proposed as a standard diagnostic method during the early resuscitation phase for trauma patients, as it is associated with a significant reduction in mortality. In a study by Jean-Michel Yeguiayan et al.[27], 1950 multitrauma patients were admitted to trauma centers of university hospitals, of which 1,696 patients (87%) underwent full-body CT scans. Mortality rates, with an endpoint of 30 days, were 16% among patients with full-body CT scans and 22% among patients undergoing focused imaging.

In the sample of patients in the study, the complications that occurred during their hospitalization in the ICU or the appropriate clinic were as follows: the need for transfusion due to anemia was the highest percentage, followed by sepsis and pneumonia. Regarding the interventions performed, intubation and central venous catheter placement (femoral vein in the majority) were the most common. In a study by Yating Li et al.[28], ventilator-associated pneumonia was common in patients carrying a craniocerebral injury and was associated with an unfavorable prognosis. The most common hospital-acquired complications, according to a study by Teixeira Lopes et al.[29], conducted in a Brazilian university hospital and involving 147 patients, were infectious, cardiovascular, and metabolic. Longer hospital stays and higher mortality occurred in those with cardiovascular complications.

The neurological complications that occurred in the multi-injured patients in this study were investigated through the GOS-E scale and it is evident that the majority of patients experienced moderate to severe disability or death. Although these patients have high rates of adverse outcomes, the use of conservative treatment and not promoting them to appropriate care and rehabilitation centers should not be justified.[30] It is worth noting that in the present study, GOS-E was used to evaluate all patients in the sample, without necessarily carrying a craniocerebral injury.

CONCLUSIONS

The management of multi-injury patients requires a coordinated approach in various aspects. The use of the TRISS scale enables health professionals to better understand and predict the potential outcome of polytrauma patients, as it takes into account the specific injury sites in the data recording. A higher score on this scale indicates a lower risk of death by 4% for multi-injured patients. However, it is important to note that this rating scale is a tool and clinical judgment should still be used in managing multi-injured patients. Early intervention and collaboration among specialist professionals are crucial in increasing the chances of successful recovery. Implementing an electronic trauma registry for patients with multiple injuries in Greece, using outcome assessment scales and trauma assessment systems, would greatly benefit the treatment and approach for each case.

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Conflicts of interest

None declared.

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ANNEX

TABLE 1. Descriptive analysis of variables related to the patient's vital signs, life expectancy and outcome assessment.

	Prehospital	*Hospital care at the ED*	*Hospital care afted ED*	*P*
Spo2 % ‡	*97,00 (4,00)*	*97,00 (5,00)*	*99,00 (1,00)*	***<0,001***$^{\beta,\gamma}$
Respiratory Rate§	*21,34 ± 8,27*	*20,38 ± 8,84*	*20,49 ± 4,38*	*0,543*
Systolic Blood Pressure§	*129,22 ± 24,61*	*126,80 ± 27,24*	*129,68 ± 17,31*	*0,408*
Heart Rate‡	*108,00 (25,00)*	*108,00 (33,50)*	*98,00 (11,00)*	***0,005***$^{\gamma}$
Temperature‡	*36,00 (0,00)*	*36,40 (0,80)*	*36,80 (1,00)*	***<0,001***$^{\alpha,\beta,\gamma}$
TRISS Score (%)†	-	*90,88 (25,42)*	*90,88 (25,69)*	*0,655*
APACHE II Score (%)†	-	*23,50 (28,70)*	*23,50 (28,70)*	*0,180*
*Glasgow Coma Scale**	-	*11,05 ± 3,83*	*10,89 ± 3,93*	*0,340*

*Values refer to mean, standard deviation (±), *paired t-test, §Repeated Measures of Analysis of Variance (ANOVA) and corresponding p-value.*
Values refer to median, interquartile range(25o - 75o), †Wilcoxon tests, ‡Friedman's test and corresponding p-value.
[a]Differences between prehospital indications and hospital care in ED ,[b]Differences between prehospital indications and hospital care after ED, [c]Differences between hospital care in ED and hospital care after ED.

TABLE 2. Cox regression model of total number of hospital days and outcome.

	B	*p*	*OR*	*CI 95%OR*
TRISS score (% survival)	-0,040	**0,002**	0,96	0,94 - 0,98
APACHE II score (% mortality)	0,023	0,302	1,02	0,98 - 1,07
Glasgow Coma Scale	0,147	0,205	1,16	0,92 - 1,45

OR: odds ratio, CI: confidence interval.

TABLE 3. Cox regression model of total number of hospital days and outcome.

	B	*p*	*OR*	*CI 95%OR*
TRISS score (% survival)	*-0,038*	***0,002***	*0,96*	*0,94 - 0,99*
Patient waiting time for the patient from the ED	*0,000*	*0,978*	*1,00*	*0,99 - 1,01*
Spo2 during treatment in the EDs	*-0,057*	*0,567*	*0,94*	*0,78 - 1,15*

OR: odds ratio,CI: confidence interval.

TABLE 4. Cox regression model of total number of hospital days and outcome.

	B	*p*	*OR*	*CI 95%OR*
TRISS score (% survival)	-0,046	**<0,001**	0,96	0,93 - 0,98
Marshall classification of TBI	-0,301	0,315	0,74	0,41 – 1,33

TBI: traumatic brain injury, OR: odds ratio, CI: confidence interval.

TABLE 5. Cox regression model of total number of hospital days and outcome.

	B	*p*	*OR*	*CI 95%OR*
Glasgow Coma Scale	*-0,236*	*0,114*	*0,79*	*0,59 - 1,06*
Age	*0,052*	*0,077*	*1,05*	*0,99 - 1,12*
Respiratory Rate	*0,092*	*0,214*	*1,10*	*0,95 - 1,27*
ISS	*0,273*	***0,027***	*1,31*	*1,03 - 1,67*

OR: odds ratio, CI: confidence interval.

GRAPH 1. Boxplot for total days of hospitalization