ORIGINAL ARTICLE

Markers of Increased Risk of death in Poly Trauma Patients in Conformity with Trauma Scores

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Abstract

Background: ***A high-risk patient with many injuries can be located using the Berlin polytrauma definition. This definition encompasses injuries where there is at least one physiological risk factor and an abbreviated injury scale score of 3 or higher in at least two areas of the body. Are based on age, particular threshold values for the Glasgow coma scale (GCS), acidosis, coagulopathy, and hypotension.***

Aim and objectives: ***To identify polytrauma patients, measure blood biomarkers (CPK, troponin I, Lactate, and alkaline phosphatase), and compare these biomarkers to trauma scores in order to establish early mortality predictors in polytrauma patients.***

Patients and methods: ***Observational prospective study for 40 patients coming to Al-Azhar University hospitals (El-Hussin-Sayed Galal) recruited from the Emergency &Critical Care Department. The duration of the recruiting period was 6 months, starting from May 2023 till the end of October 2023.***

Results: ***GCS can significantly predict mortality in polytrauma patients (P<0.001 and Area under the curve (AUC)=0.955) at cut-off ≤7 with 77.78% sensitivity, 90.32% specificity, 70% positive predictive value (PPV), and 93.3% negative predictive value (NPV). Revised Trauma score (RTS) can significantly predict mortality in polytrauma patients (P=0.002 and AUC=0.823) at cut-off≤4 with 77.78% sensitivity, 74.19% specificity, 46.7% PPV and 92% NPV.***

Conclusion: ***Mortality rate in polytrauma patients is associated with lower GCS and revised trauma score (RTS)and higher CPK, Lactate, and injury severity score (ISS). There was a negative correlation between GCS and (creatine phosphokinase (CPK) and Lactate). A negative correlation between RTS and (CPK and Lactate) and a positive correlation between ISS and (CPK and Lactate).***

Keywords: Poly trauma; Risk; Markers; Death

1. Introduction

As a means of identifying individuals at high risk of death due to numerous injuries, the Berlin polytrauma definition was developed. This definition encompasses injuries where at least one physiological risk factor is present and an abbreviated injury scale score of 3 or higher in at least two body areas (2AIS≥3) combined with other criteria. Are based on age, particular threshold values for the Glasgow coma scale (GCS), acidosis, coagulopathy, and hypotension.[1]

As a leading cause of death and disability, polytrauma ranks high among the most difficult emergency situations to manage.[2]

Scores for trauma injuries can help academics, registries, and individuals assess patients' chances of recovery after a traumatic event.[3]

Foundational to trauma epidemiology are these rating systems. For trauma management and as a prerequisite for clinical trials, injuries must be graded according to their severity. It is common practice to estimate injury-related mortality using the Trauma Injury Severity Score (TRISS), Injury Severity Score (ISS), and Glasgow Coma Scale (GCS).[4]

Patients with multiple traumas produce a plethora of risk indicators. For instance, coagulopathy increases the likelihood of trauma-related illnesses like SIRS and their sequelae, including multiorgan dysfunction syndrome.[5]

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A well-coordinated trauma care system, including high-quality pre- and in-hospital treatment as well as rehabilitation, is essential for lowering the death rate from polytrauma. In order to continuously evaluate the system and enhance its efficiency and results, evaluation using blood biomarkers is essential.[6]

Additionally, using blood biomarkers of elevated mortality risk in patients with many traumas in accordance with trauma scores allows for the most accurate assessment.

The present study set out to identify polytrauma patients, measure blood biomarkers (CPK, troponin I, Lactate, and alkaline phosphatase), and compare these biomarkers to trauma scores in order to establish early mortality predictors in polytrauma patients.

2. Patients and methods

An observational prospective study for 40 patients coming to Al-Azhar University hospitals (El-Hussin-Sayed Galal) recruited from the Emergency & Critical Care Department. The duration of the recruiting period was from May 2023 till the end of October 2023.

Sample size:

This study is based on a study carried out by Naredi et al.,[7] Epi Info STATCALC was used to calculate the sample size by considering the following assumptions: -95% two-sided confidence level, with a power of 80%. &an error of 5% odds ratio calculated=1.115. The final maximum sample size taken from the Epi-Info output was 33. Thus, the sample size was increased to 40 subjects to assume any dropout cases during follow-up.

Inclusion criteria:

Age more than 18-years, and polytrauma patients.

Exclusion criteria:

Age less than 18 years, patients presented with isolated trauma, patients with chronic organ dysfunction such as chronic liver cell disease, chronic kidney disease and diabetes mellitus, and pregnancy

Ethical consideration:

The Al-Azhar University Ethical Research Committee reviewed the protocol and gave their approval for the clinical trial. The patient or his legal guardian was given a thorough explanation of the study's procedures and purpose. In order to recruit patients for the study, we first secured their written informed consent.

Method:

Patients were enrolled from the emergency departments of hospitals affiliated with Al-Azhar University. After obtaining their informed consent, they were subjected to the following procedures: airway maintenance, which involved limiting cervical spine motion, breathing, and ventilation. Disability was assessed through a neurological evaluation. Exposure and environmental factors were controlled. The patients' histories were taken, including their age, sex, the time, and the mechanism of injury. A thorough physical examination was performed, and the systems impacted by the injury were surveyed after the primary evaluation.

Clinical assessment:

Arterial blood pressure, pulse rate, respiratory rate, temperature, and finally, oxygen saturation by pulse oximeter.

Initial laboratory assessment includes:

CBC, ABG, RBS, renal function test, and liver function test.

Blood biomarkers considered in our study include:

CPK, troponin I, Lactate, and alkaline phosphatase were done 3-times in the ER, after 24h and after 48h of hospitalization, and association with trauma scores

Radiological assessment represented in:

FAST, chest x-ray and CT chest if needed, CT brain, and X-ray for evaluation of suspected bone fractures.

Scores assessment represented by:

GCS, revised trauma score (RTS), and injury severity score (ISS).

Statistical analysis:

SPSS v26 (IBM Inc., Chicago, IL, USA) performed statistical analysis. Shapiro-Wilks and histograms assessed data normality. Quantitative parametric variables expressed as mean and SD were compared between groups using an unpaired Student's t-test. Non-parametric quantitative data were provided as median and IQR and examined by the Mann-Whitney test. Qualitative variables were provided as frequency and percentage (%) and examined using Chi-square or Fisher's exact tests. Two-tailed P-value < 0.05 indicated statistical significance. The Pearson moment correlation equation was used to correlate normally distributed variables linearly.

Evaluation of Diagnostic Performance:

Diagnostic sensitivity:

It is a metric for the frequency of actual positive outcomes in patient populations.

$$\frac{TP}{TP+FN} \times 100$$

Where:

The number of patients with disease who were correctly identified by the test is called TP (true positive), and the number of patients with disease who were correctly misclassified is called FN (false negative).

Diagnostic specificity:

In a healthy population, it quantifies the frequency of false negatives.

3. Results

Table 1. Demographic data, mechanism and time of injury of the studied groups and system affected.

		SURVIVAL GROUP (N=31)	NON-SURVIVAL GROUP (N=9)	P-VALUE
AGE (YEARS)	Mean ± SD	35.61±7.71	36.22±8.39	0.839
	Range	19-49	26-48	
SEX	Male	25(80.65%)	7(77.78%)	1
	Female	6(19.35%)	2(22.22%)	
MECHANISM OF INJURY	Traffic accident	25(80.65%)	6(66.67%)	0.586
	Fall from height	3(9.68%)	2(22.22%)	
	Injury by firearms	3(9.68%)	1(11.11%)	
TIME OF INJURY	<6 h	17(54.84%)	3(33.33%)	0.433
	6-12 h	10(32.26%)	5(55.56%)	
	>12 h	4(12.9%)	1(11.11%)	
SYSTEM AFFECTED				
	Total Number	survival	Non- survival	Percentage%
BRAIN	20	14	6	50%
CHEST	7	5	2	17.5%
ABD	3	2	1	7.5%
LONG BONE	10	10	--	25%
TOTAL	40	31	9	100%

Age, sex, mechanism of injury and time of injury were insignificantly different between males and females in both groups, but system affected noted most is TBI, (Table 1).

Table 2. Laboratory tests consider of the studied groups.

		SURVIVAL GROUP (N=31)	NON-SURVIVAL GROUP (N=9)	P-VALUE
CPK (IU/L)	At ER	105.29±49.76	298.78±92.6	<0.001*
	24h	103.81±49.67	325.11±92.63	<0.001*
	48h	101.29±49.66	370.22±92.69	<0.001*
TROPONIN I (NG/ML)	At ER	0.02±49.76	0.03±0.01	0.261
	24h	0.01±49.67	0.05±0.01	0.079
	48h	0.01±49.66	0.07±0.02	0.080
LACTATE (MG/DL)	At ER	18.16±49.76	22.41±2.22	<0.001*
	24h	16.75±49.67	23.19±2.12	<0.001*
	48h	14.26±49.66	24.52±2.61	<0.001*
ALKALINE PHOSPHATASE (IU/L)	At ER	83.29±49.76	89.22±14.16	0.330
	24h	82.23±49.67	90.33±14.75	0.191
	48h	80.94±49.66	92.33±14.99	0.074

*: Significant difference as P-value ≤ 0.05.

In the survival group, CPK and lactate were shown to be considerably lower than in the non-survival group at admission, 24 hours, and 48 hours (P-value < 0.001). Between the two groups, there was no statistically significant difference in troponin I or alkaline phosphatase at admission, 24 hours, or 48 hours, (Table 2).

Table 3. Trauma scores of the groupings that were examined.

		SURVIVAL GROUP (N=31)	NON-SURVIVAL GROUP (N=9)	P-VALUE
GCS	At admission	9(8.5-13)	5(5-7)	<0.001*
	24h	11(10-14)	4(4-6)	<0.001*
	48h	12 (11-15)	3(2-4)	<0.001*
RTS	At admission	6(4.5-8)	2(1-4)	0.002*
	24h	7(6-9)	2(1-3)	<0.001*
	48h	8(7-10)	1(1-2)	<0.001*
ISS	At admission	20.52±10.08	43.56±14.34	<0.001*
	24h	19±10.15	45.22±14.3	<0.001*
	48h	16.48±10.35	46.67±14.27	<0.001*

GCS:Glasgow coma score, RTS:Revised trauma score, ISS:Injury severity score,

*:Significant difference as P-value≤0.05.

GCS and RTS were significantly higher at admission, 24h and 48h in survival group than non-survival group (P-value < 0.05). ISS was significantly lower at admission, 24h and 48h in survival group than non-survival group (P-value < 0.001), (Table 3; Figures 1&2).

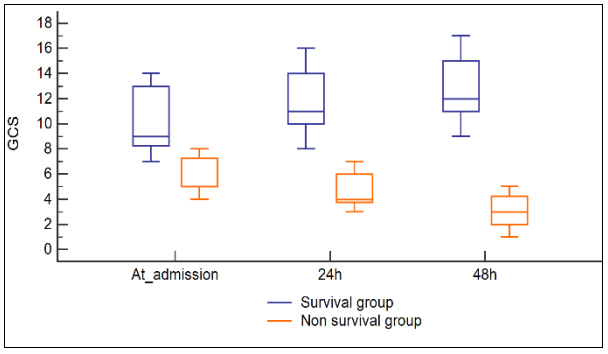

Figure 1. GCS of the studied groups.

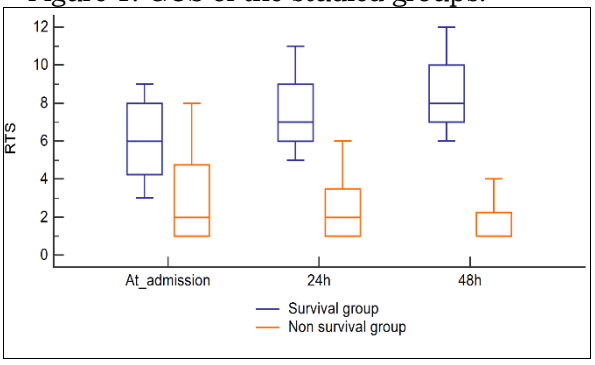

Figure 2. RTS of the studied groups.

Table 4. Correlation between blood markers and trauma score.

		GCS	RTS	ISS
CPK (IU/L)	r	-0.444	-0.505	0.437
	P-value	0.004*	0.009*	0.005*
LACTATE (MG/DL)	r	-0.369	-0.467	0.393
	P-value	0.019*	0.002*	0.012*
ALKALINE PHOSPHATASE (IU/L)	r	-0.194	0.021	0.259
	P-value	0.231	0.896	0.106
TROPONIN I (NG/ML)	r	-0.084	-0.116	0.007
	P-value	0.603	0.475	0.966

*Significant as p-value≤0.05.

Interactions between GCS, RTS, and ISS scores and alkaline phosphatase and troponin I levels were not identified. With a p-value of 0.004 for CPK and 0.019 for lactate, GCS was not positively correlated. Statistical analysis revealed an inverse relationship between RTS and both CPK and lactate (P=0.009 and 0.002, respectively). The connection between ISS and (CPK) and lactate was positive (P=0.005 and 0.012, respectively), (Table 4; Figures 3&4).

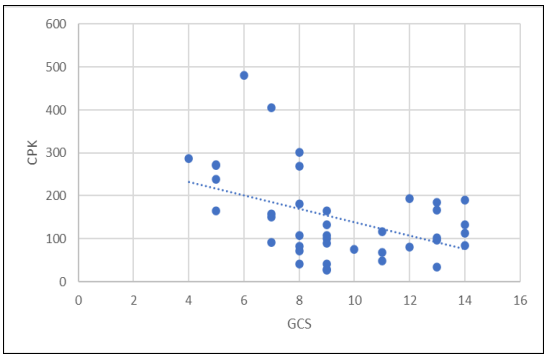

Figure 3. Correlation between GCS and CPK of the studied groups.

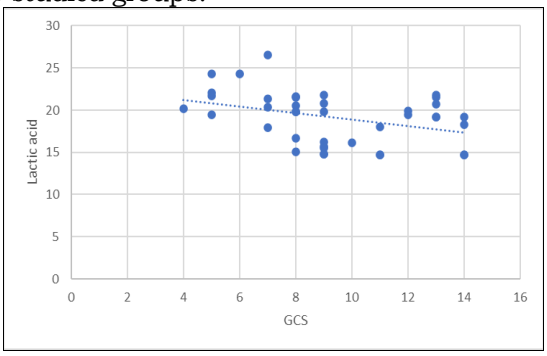

Figure 4. Correlation between GCS and Lactate of the studied groups.

4. Discussion

Patients presenting with multiple traumas pose unique challenges for intensive care unit specialists. The survival rate drops significantly when severe systemic inflammatory response syndrome (SIRS) causes various biochemical and physiological dysfunctions.[8]

Among people aged 15–45, trauma ranks as the sixth most common killer and the fifth most common cause of disability on a global scale.[9]

The survival group had much lower levels of CPK and Lactate compared to the non-survival group, according to our results. Neither group differed significantly from the other with respect to troponin I or alkaline phosphatase.

One probable explanation is that lactate levels indicate tissue hypoxia and damage severity; higher levels are linked to a higher risk of death and morbidity.[10,11]

Severe trauma can lead to rhabdomyolysis, which is characterized by the breakdown of skeletal muscle tissue, which results in the release of CPK into the bloodstream. The same mechanisms causing rhabdomyolysis (e.g., crush injuries, ischemia-reperfusion injury) can also affect brain perfusion, potentially leading to altered consciousness and lower GCS scores.[12,13]

This is agreed with He et al.,[14] who found that Lactate was significantly lower in the survival group than the non-survival group.

The present study found that the surviving group had much higher Glasgow coma scores (GCS) and revised trauma scores (RTS) compared to the non-survival group.

Compared to the non-survival group, the injury severity score (ISS) of the survivors was substantially lower. Patients with poor GCS scores may not have been able to protect their airways as effectively, which increased their risk of aspiration and compromised ventilator effort. They may also have been at increased risk of developing intracranial hypertension, which reduces cerebral perfusion and can cause secondary cerebral attacks and death.[15]

In agreement with the results of the present study, He et al. [14] proved that the survival group had a considerably lower ISS and a considerably higher GCS compared to the non-survival group.

According to our findings, there was no correlation between markers (GCS, RTS, and ISS) and (alkaline phosphatase, troponin I). There was a negative correlation between GCS (Creatine phosphokinase (CPK) and Lactate). There was a negative correlation between RTS and (CPK and Lactate). There was a positive correlation between ISS and (CPK and Lactate).

Polytrauma patients often experience shock, leading to decreased tissue perfusion. This results in anaerobic metabolism and increases Lactate production. The same mechanisms causing tissue hypoperfusion can also affect brain perfusion, potentially leading to altered consciousness and lower GCS scores.[16]

Severe trauma can lead to tissue hypoperfusion, which affects the physiological parameters measured in the RTS (e.g., blood pressure and respiratory rate). This hypoperfusion can also cause muscle ischemia, leading to increased CPK release.[17]

As the severity of the injury increases and the RTS score decreases in return, the level of Lactate in the blood increases due to more severe injuries, which are likely to cause more extensive tissue damage and hypoperfusion, leading to increased anaerobic metabolism and Lactate production.[18]

Coming in line with the results of the present study, Rao et al.,[19] assessed serum lactate and interleukin-6 as potential indicators for the prediction of mortality and morbidity in patients who had sustained multiple traumas. Their results showed that ISS was significantly related to serum lactate levels.

With a cut-off value of 7 and a sensitivity of 77.78%, specificity of 90.32%, positive predictive value of 70%, and negative predictive value of 93.3%, our results showed that GCS may accurately predict mortality in polytrauma patients ($P < 0.001$ and AUC = 0.955). RTS has a 77.78% sensitivity rate, 74.19% specificity rate, 46.7% PPV, and 92% NPV, and it can significantly predict death in polytrauma patients at a cut-off of 4 or less ($P = 0.002$ and AUC = 0.823). ISS

effectively predicts mortality in patients with multiple traumas (P<0.001 and AUC = 0.880) at a cut-off >35 with a sensitivity of 88.89%, specificity of 90.32%, PPV of 72.7%, and NPV of 96.6%. At a cut-off >165, CPK has a sensitivity of 88.89%, specificity of 83.87%, PPV of 61.5%, and NPV of 96.3% in predicting death in polytrauma patients (P < 0.001 and AUC = 0.980). When the cut-off value is more than 19.9, Lactate can accurately predict death in patients with multiple traumas (P < 0.001 and AUC = 0.903) with a sensitivity of 88.89%, specificity of 74.19%, 50% PPV, and NPV of 95.8%.

In agreement with the results of the present study, Jyoti et al.,[20] assessed the correlation between the levels of Lactate in the blood, the severity of the patient's base deficiency, and the likelihood of death in individuals who had suffered several traumas. They found that trauma patients' mortality rates were higher when ISS was present.

As regards demographic data, system affected, vital date, and initial (basic) labs on admission, we found in the current study that age, sex, and mechanism of injury were insignificantly different between both groups, with male predominance.

One primary reason for the male predominance is that men are more likely to engage in activities that carry a higher risk of injury. For instance, men are more frequently involved in occupations that involve physical labor, such as construction or manufacturing, which can lead to accidents and injuries.[21]

In agreement with the results of the present study, Van Wessem et al.[22] conducted prospective cohort research on 235 consecutive patients with polytrauma who were 15 years of age or older. Patients who were survivors and those who were not, with men making up the majority, showed no statistically significant differences in terms of sex. Among the systems examined, we discovered that traumatic brain injury (TBI) severely impacted both groups.

Although there was no statistically significant difference in the first few hours between the two groups in terms of blood type or red blood cell count (RBS), the survival group had a substantially lower RR and WBC than the non-survival group. Compared to the non-survival group, the survival group had considerably higher values for temperature, oxygen saturation, blood pressure (both systolic and diastolic), hemoglobin, red blood cell count, partial lipid tolerance, pH, bicarbonate, and bioxygen.

This is in harmony with da Costa et al.,[23] found that the survival group had substantially greater diastolic blood pressure than the non-survival group. The survival group, on the other hand, had a considerably greater arterial hemoglobin oxygen saturation than the non-survival group.

4. Conclusion

The mortality rate in polytrauma patients is associated with lower GCS and RTS and higher CPK, Lactate, and ISS. There was a negative correlation between GCS and (CPK and Lactate). A negative correlation between RTS and (CPK and Lactate) and a positive correlation between ISS and (CPK and Lactate).

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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Conflicts of interest

There are no conflicts of interest.

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