REVIEW

# The clinical characteristics of acute trauma and prognostic evaluation

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**Received:** July 30, 2023 **Accepted:** October 16, 2023 **Online Published:** November 9, 2023
**DOI:** 10.5430/dcc.v9n3p23 **URL:** https://doi.org/10.5430/dcc.v9n3p23

## ABSTRACT

Acute trauma is one of the most commonly seen diseases in the Emergency Department, and it attracts more attention due to the increasing disability rate and mortality. Early rapid and accurate assessment of the severity of trauma has a positive significance for improving clinical prognosis. The paper aims to review the characteristics of the severity score based on trauma severity, blood biochemical changes and serum biomarkers, and discuss its prognostic significance.

**Key Words:** Acute trauma, Clinical characteristics, Prognostic evaluation

## 1. INTRODUCTION

Acute trauma is one of the most commonly seen diseases in the Emergency Department. With the continuous development of society, the incidence of acute trauma caused by traffic accidents, accidental falls, and other factors is increasing. It is characterized by acute onset rapid progression, and critically ill patients can lead to disability or death, significantly affecting patients' survival quality and causing physical and psychological harm to patients. Early and accurate judgment of the severity of acute trauma and timely treatment are crucial to the prognosis.[1] This paper reviews the recent research on sensitive trauma-related scores, blood biochemical changes, and serum biomarkers to identify high-risk patients as soon as possible, predict the outcome of acute trauma patients, formulate individual diagnosis and treatment plans, and improve adverse prognosis.

## 2. TRAUMA SCORE

The prediction of the mortality and intensive care needs of trauma patients is an essential part of trauma diagnosis and care, and trauma severity scoring is often used to monitor the outcomes of trauma patients.[2] Various pre-hospital scores are available to assess trauma severity and post-traumatic blood loss. The ideal pre-hospital trauma scoring system should be simple to use, optimizing the use of healthcare resources and significantly reducing mortality among trauma patients by accurately distinguishing the degree of injury and transferring patients with severe trauma to advanced trauma centers and transferring patients with minor trauma to primary trauma centers.[3]

The mortality rate in critically ill trauma patients is about 20%, and many patients have poor prognoses.[4] At present, the most commonly used scoring system in clinical practice is the trauma index (TI) score, which was proposed by

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Kirkpatrick[3] in 1971 and is a simple and practical method to assess the degree of trauma from five perspectives of the site of injury, the injury type, circulation, respiration, and consciousness. The severity of the damage is more significant with the increase in TI value. A TI score less than 9 indicates minor injury, a score of 10-16 means moderate injury, a score more excellent than 17 shows serious injury, and a score greater than 27 indicates severe trauma.[5] After comparing commonly used trauma scoring systems clinically, Dai et al.[3] believed that TI can better predict the risk of early death in patients with acute trauma.

The shock index (SI) is the ratio of heart rate to systolic blood pressure, and it can assess the severity of trauma and the mortality SI $\geq$ 1 in trauma patients is significantly higher than that of SI < 1, which has a specific value for patient prognosis.[6] Modified shock Index (MSI) is the ratio of heart rate to mean blood pressure, which can more objectively evaluate the severity of hypovolemic shock. The age-adjusted shock index (ASI) evaluates the severity of trauma in special age groups, such as the elderly and children to a certain extent through the product of the age and the shock index. It thus indicates the need for blood transfusion in trauma patients. A study by Dai et al. believes that SI, as the most sensitive predictor, has a reference value in assessing the severity of trauma and early death risk in patients. At the same time, SI, MSI and ASI have an excellent predictive value for the premature death risk in acute trauma patients.[3] It may be a new direction for clinical evaluation in patients with acute trauma, which needs further study.

The Glasgow Coma Scale (GCS)[7] is used to assess and calculate patients' consciousness levels and is now widely used in clinical practice. GCS includes three different scoring systems: eye-opening response (normal score of 4), verbal response (normal score of 5), and motor response (normal score of 6), which add up to a total score between 3-15, and the normal score is 15 points. A lower score leads to more severe disease; 12-14 indicates mild degree, 9-11 indicates moderate degree, and a score below 8 indicates severe coma. Most patients with a score of no more than 3 cannot survive. Höke et al. have shown[2] that the BIG scoring system is calculated based on base deficit, international normalized ratio (INR) and GCS, with the formula BIG score = base deficit + (INR $\times$ 2.5) + (15-GCS), which can be used to assess the severity of trauma and mortality when children are admitted to hospital. It is predicted that morality is lower than 5% when BIG score is less than 12, and morality is more than 50% when BIG score is more than 26. BIG score can not only successfully evaluate the prognosis in trauma patients but also is convenient and fast to be used clinically. The Injury Severity Score (ISS)[8] is an anatomical scoring system that assesses the severity of injuries based on head/neck, face, chest, abdominal/pelvic organs, limbs/pelvis, and other body parts. If trauma involves only one body part, the ISS score is 3, if the above six body parts are traumatized, the maximum ISS score is 75, and ISS score greater than 16 indicates severe trauma. Martino et al. conducted a 10-year cross-sectional study. They concluded that the severity of the head injury has a clinically crucial clinical significance for long-term prognosis and that advanced age, increased ISS, and GCS $\leq$ 8 are predictors of long-term poor prognosis and increased disability in trauma patients.[9]

Rameshbabu et al.[10] tested the accuracy of ISS, Revised Trauma Score (RTS), and Trauma and Injury Severity Score (TRISS) in the prediction of mortality in elderly trauma cases. RTS is weighted according to 3 variables: GCS, systolic blood pressure and respiratory rate at admission. The formula is as follows: RTS value = 0.9368 $\times$ GCS + 0.7326 $\times$ systolic blood pressure + 0.2908 $\times$ respiratory rate, RTS score fluctuates in the range of 0 7.8408 points, and a higher score leads to a better prognosis, RTS less than 4 points determines that trauma patients are severely injured and should be treated in the trauma center.[10] TRISS uses the TRISS model and combines three factors of age, ISS and RTS to calculate the score. In the TRISS model, the age index for patients under 54 years old is set to 0, the age index for patients no less than 55 years old is 1, and the TRISS calculator predicts the survival rate and death probability in trauma patients according to ISS, RTS and the age. It was indicated by the study from Reza et al. that the TRISS model is a reliable and accurate model for determining the prognosis and survival rate in patients with multiple traumas. Besides, it was also tried to add hemoglobin test indicators to the TRISS model to improve the specificity of diagnosis with the highest diagnostic accuracy.[11]

## 3. SEROLOGICAL INDICATORS

Acute trauma often causes damage to several organs or tissues throughout the body, causing environmental disorders and triggering inflammatory reactions. It can be shown that several serological indicators change with the change of time dimension, and serological studies related to acute trauma are progressing continuously. Clinical characteristics and prognosis in patients with acute trauma can be evaluated differently.

### 3.1 Inflammation-related serological indicators

C-reactive protein (CRP) is a cyclic pentamer acute phase protein produced by the post-traumatic inflammatory response and is one of the most researched indicators of trauma-related inflammation.[12] Studies have shown that CRP level

peaks on day 1 of acute trauma. The elevated CRP level in trauma patients increases morbidity and mortality. The high CRP group has a higher incidence of sepsis, skin infection, and myocardial infarction ($p < .05$), as well as an increased risk of death, indicating that the elevated CRP level in trauma patients has a potential predictive value.[12] Procalcitonin (PCT) is a precursor to calcitonin, which inflammatory mediators trigger in response to post-traumatic inflammatory or bacterial infection. Parli et al. have found that the PCT value of trauma patients is elevated at admission and has a predictive assessment value, but a single PCT value is not specific for assessing trauma patients.[13] Li et al. have found that serum PCT, CRP and interleukin-6 (IL-6) levels in patients with early traumatic shock are higher than those in ordinary trauma patients, and the higher expression level of the three indicators leads to a worse prognosis. In addition, in patients with a good prognosis, CRP has been on a downward trend, with a short-term increase in PCT and IL-6 throughout treatment, followed by a decline; PCT, CRP, and IL-6 in patients with poor prognosis show an upward trend in the early stage, and after maintaining a high level, the expression level decreases subsequently.[1] Janicova et al. have found that alterations in antigen presentation on neutrophils are shown to have biomarker signatures that predict outcomes and susceptibility to infectious complications in patients with severe injury; potential modulation of neutrophil-dependent immune responses may provide future therapeutic targets to prevent post-traumatic complications.[14]

### 3.2 Blood biochemical indicators

Apolipoprotein A-I (apoA-I) is the primary apolipoprotein component of high-density lipoprotein, a polypeptide composed of 243 amino acids.[15] Wilbert L[16] et al. found that exogenous human apoA-I inhibited arachidonic acid and platelet activation, resulting in diminished clot strength and increased clot lysis, as well as increased apoA-I in trauma model mice, this may be used in trauma assessment of patients with acute trauma. Zheng[17] et al. measured the serum uric acid (UA) level of 421 patients and came to the following conclusions: serum levels of UA is associated with the severity of traumatic brain injury (TBI) patients, a subgroup of male patients with elevated UA regained consciousness more frequently within a month. Moreover, addition of UA to established clinical model had significantly improved predictive performance in male patients with TBI, however, similar results were not observed in female TBI patients.

### 3.3 Serological biomarkers

At present, sepsis has become the leading cause of in-hospital death in patients with severe trauma, and there is an urgent need for new predictive clinical biomarkers with high specificity, and panthenyl thioethanamine (Vanin-1) plays a crucial role in oxidative stress and inflammatory response.[18] Vanin-1 is an extracellular enzyme with pantodylemase activity that is highly expressed at the gene and protein levels in many organs, such as the liver, intestines, and kidneys, and its primary function is to break down pantothenethamide into cysteamine and pantothenic acid (vitamin B5).[19] Lu et al. included a total of 426 trauma patients and 16 healthy volunteers, and the study showed that elevated plasma vanin-1 on admission was independently associated with the risk of post-traumatic sepsis, and Vanin-1 may be a potential biomarker for the early prediction of post-traumatic sepsis.[18] Palmer[20] et al. conducted a 1-year prospective analysis on elderly trauma patients over 65 years old admitted to their first-level trauma center, and the results showed that: Insulin-like growth factor-1 (IGF-1) levels were lower in elderly (specific) syndrome trauma patients than in general trauma patients, and the two were negatively correlated. Understanding the endocrine response indexes of trauma patients may lead to a new therapeutic approach for elderly trauma patients.

After a severe head injury, most people have an elevated cortisol level in the acute phase. Foreign studies have found that people who have elevated serum and cerebrospinal fluid cortisol levels in the acute phase after brain injury and maintained high levels within 5 days after injury have worse cognitive ability in 6 months after injury than people who support low levels of cortisol or have high levels in the early stage but then declined. This finding suggests that high cortisol levels in the acute phase are associated with poorer cognitive function in 6 months after brain injury, and that critical cortisol levels in survivors with traumatic brain injury can be used to predict future cognitive performance.[21] It has been suggested that the concentration of serum neurofilament light chain protein (NfL) provides a rapid and convenient means for evaluating and predicting neuronal injury in patients with craniocerebral injury, and is expected to be a biomarker for critical evaluation in patients with acute, subacute and chronic craniocerebral injury.[22] Helmrich et al. collected blood from traumatic brain injury patients within 24 hours and measured the contents of S100 calcium-binding protein B (S100B), neuron-specific enolase (NSE), glial fibrillary acidic protein (GFAP), ubiquitin C-terminal hydrolase L1 (UCH-L1), neurofilament protein (NFL) and total tau (t-tau), the results showed that NFL had the most significant value in predicting incomplete recovery in patients with mild craniocerebral injury, followed by S100B, UCH-L1 and t-tau. Among moderate to severe traumatic brain injuries, UCH-L1 has the most significant predictive value for poor prognosis, followed by t-tau, NFL and S100B.[23] Several indicators have a positive clinical significance for the progno-

sis assessment of traumatic brain injury, which may be used as a new research direction to evaluate the clinical situation and prognostic value of acute trauma patients in the future.

## 4. Conclusions

This review summarizes blood biochemical indicators and serological biomarkers of trauma-related score scales in recent years. The results are free from human interference, with minor errors and easy operation.[24] The clinical characteristics and prognostic significance of trauma patients are expounded to guide clinicians in choosing the optimal treatment plan, which can improve the accuracy of critical assessment of trauma patients, and have predictive evaluation value and clinical application prospects.

## Acknowledgements

Not applicable.

## Authors contributions

Prof. Tong Zhou was responsible for study design. Master. FanLi and Master. Hanling He were responsible for literature search and data collection. Prof. Tong Zhou drafted the manuscript and revised it. All authors read and approved the final manuscript.

## Funding

This work was supported by Metallurgical Safety and Health Branch of Chinese Metal Society Health HygieneScientific Research Foundation (No.: jkws201828).

## Conflicts of Interest Disclosure

The authors declare that we have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Informed consent

Obtained.

## Ethics approval

The Publication Ethics Committee of the Sciedu Press. The journal's policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

## Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

## Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

## Data sharing statement

No additional data are available.



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