



Frequency of Miss Triage Using Emergency Severity Index and Shock Index in Patients with Abdominal Trauma

Ali Samanian,¹ Tabandeh Sadeghi,^{2,3,*} and Majid Kazemi^{2,4}

¹Medical Surgical Nursing Student, Student Research Committee, School of Nursing and Midwifery, Rafsanjan University of Medical Sciences, Rafsanjan, Iran

²Non-Communicable Diseases Research Center, Rafsanjan University of Medical Sciences, Rafsanjan, Iran

³Department of Pediatric Nursing, School of Nursing and Midwifery, Rafsanjan University of Medical Sciences, Rafsanjan, Iran

⁴Department of Medical Surgical Nursing, School of Nursing and Midwifery, Rafsanjan University of Medical Sciences, Rafsanjan, Iran

*Corresponding author: Tabandeh Sadeghi, Assistant Professor, Jomhori St, Non-Communicable Diseases Research Center, School of Nursing and Midwifery, Rafsanjan University of Medical Sciences, Rafsanjan, Iran. Tel: +98-3434255900, Fax: +98-3434258497, E-mail: t.sadeghi@rums.ac.ir

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Abstract

Background: Triage of trauma patients is particularly important. Correct triage can reduce the rate of mortality and prevent disability in trauma patients.

Objectives: The current study aimed at comparing the frequency of miss triage using the two methods namely emergency severity index (ESI) and shock index, in patients with abdominal trauma.

Methods: Trauma patients referring to Shahid Rajaei hospital, were included as the study population. A census survey was conducted for three months. Data were collected by a demographic questionnaire, a five-level triage system checklist, and triage form based on the shock index. Content validity of the questionnaire was confirmed by experts and Patients were simultaneously evaluated by both ESI and shock index methods. The triage level in each method was compared with the triage level approved by an emergency clinician. Data were analyzed with SPSS version 18.

Results: Based on ESI, 6.3% of patients were under-triaged and 2.7% over-triaged; but based on the shock index, 36.2% of the patients were under-triaged and 19.2% over-triaged. There was a positive correlation between each of the two methods and the final score of triage. Moreover, the correlation coefficient of the final score in the five-level triage system was higher than that of the shock index ($r = 0.834$ vs. $r = 0.162$).

Conclusions: According to the results, the shock index can be used as an auxiliary tool in the triage of traumatic patients in emergency departments.

Keywords: Abdominal Trauma, Shock Index, Emergency Severity Index, Missing Triage

1. Background

Trauma is one of the major health problems in the world. It is the most common cause of mortality and disability in people aged 1 to 40 years. Additionally, trauma is the third cause of death among all age groups, which imposes a substantial financial burden on the health system annually (1, 2). In Iran, trauma is the second leading cause of death among young people and occurs mostly due to traffic accidents (3). Nearly 20% of traumas occur in the abdominal region (4). Abdominal trauma refers to any type of penetrating and non-penetrating injury or trauma in the abdominal region, which can damage organs within the abdominal cavity; the signs of abdominal trauma are pain, tenderness, stiffness, and bruising of the abdominal surface. There is also associated with the risk of bleeding and internal infection (1-5). The mortality rate of non-

penetrating abdominal trauma is higher than that of penetrating trauma; car accidents are the cause of more than 60% of this type of trauma (5). The most common causes of death in abdominal trauma include hypovolemic shock, multiple organ failure, sepsis, and pulmonary embolism (6). This type of trauma has a low mortality rate compared with chest and head traumas (7).

Triage of traumatic patients is particularly important. Various triage systems are used across the world including experience-based triage, hospital and pre-hospital systems, as well as three, four, and five-level triage systems, of which the five-level system of ESI is the most commonly used system in emergency departments in most countries (8, 9). This system was developed in the United States in late 1990 by two emergency clinicians, David Eitel and Richard Wuerz (10). In this type of triage, patients are put into five

categories (ranging from immediate to delayed priority) according to the severity of health conditions and illness. The person in charge of triage prioritizes patients with unstable vital signs at level 1; critically ill patients with stable vital signs at level 2; patients requiring para-clinic and radiographic measures at levels 3 and 4; and patients who can be treated in outpatient settings at level 5 (8).

While correct triage can be useful to determine the treatment modality for patients, and facilitate medical status and admission processes for them, inappropriate triage may cause waste of resources, delay in treatment, dissatisfaction, and adverse outcomes (11). Triage error can occur in two forms - under-triage, which considers the patient a level lower than the exact level and causes delay in receiving timely treatment that may worsen the patient's conditions; or over-triage, which considers the patient a level higher than the original level and may limit the access of other patients requiring urgent measures (12). The results of a study by Holst et al., showed that nearly half of the traumatic patients across the United States (5.44%) and one-third of the patients traumatized in urban areas of the USA died from under-triage measures in non-specialized trauma centers (13). However, this rate varies 34% - 69% in different studies (14, 15). According to Grossman et al., the main cause of miss triage is inappropriate interpretation of vital signs and lack of proper understanding of high-risk situations (16).

Correct triage can reduce the mortality rate and prevent disability in traumatic patients. With regard to this, application of specific indicators can be useful to predict the severity of injuries, and determine the critical and general health condition of patients. Such indicators are involved in determining the care plan and reducing the mortality rate (17). One of these indicators is the shock index, first used in 1967; it is a good measure to estimate hypovolemia and occult hemorrhages in emergency situations (18). This index is measured by dividing heart rate to systolic blood pressure. In healthy subjects, it has a normal value of 0.5 - 0.7. This index increases in bleedings and circulatory failures; therefore, it can be used for the early detection of acute hypovolemia. It can also be applied as a mean to determine the severity of injuries and deterioration in the general health condition of patients with trauma, heart attack, or sepsis (19, 20).

An increase in value of the shock index indicates an increase in blood loss, showing a direct correlation between this index and the volume of blood in the abdomen of traumatic patients (18). The results of a study by Allgower and Burri showed that an increase in this index is a good predictor for poor outcomes and increased need for care support; 40% death occur in patients with an index shock above 1 (21).

In Iran, since mid-2006, five-level triage on the basis of ESI was considered by the health system. In the spring of 2011, all hospital units were required by the Ministry of Health to implement the triage system instructions (8). However, the shock index is not used as an indicator for triage. Although the author found some studies on the association of shock index with mortality rate in traumatic patients (18-22) and its relationship with sepsis in patients with emergency conditions (23), none of these studies used the shock index as a triage tool.

2. Objectives

The current study aimed at comparing the frequency of miss triage using ESI and shock index in patients with abdominal trauma at the emergency department of a hospital in Shiraz, Iran.

3. Methods

In the current descriptive correlational study, the study population included patients with abdominal trauma referred to Shahid Rajai hospital affiliated to Shiraz University of Medical Sciences. Samples were selected using the census method. The inclusion criteria consisted of patients above 18 years old, patients with abdominal trauma (penetrating and non-penetrating types), moderate to severe trauma requiring admission and monitoring, and no history of hypertension. The exclusion criteria were mild and superficial trauma that does not require admission based on physical examinations.

Data collection tools included a demographic information questionnaire (comprising age, gender, type of trauma, cause of trauma, etc.), five-level triage checklist, and triage form based on the shock index. Content validity of the forms was confirmed by experts. Reliability of the forms was assessed using the inter-observer reliability method and the reliability coefficient was 0.81.

For this purpose, patients with abdominal trauma who referred to the medical center were examined by a nurse in-charge based on the five-level triage system (requiring life-saving action at level 1; high-risk conditions like confusion, drowsiness, navigation impairment, and vital signs in high-risk range at level 2; requiring more than one facility at level 3; requiring one facility at level 4; and requiring no facilities at level 5). At the same time, patients were evaluated by the author based on the shock index (shock index 0.5 - 0.7 as level three; 0.71 - 0.9 level 2; and > 0.91 level 1). Thereafter, patients in the emergency department were evaluated by an emergency clinician and the level of triage was determined. When the diagnosis need to be

completed by a physician, the case was considered under-triage. When the diagnosis can be done by a triage nurse, the case was considered over-triage. The comparison was also made between the author evaluations (based on the shock index) and that of the emergency clinician.

The protocol of the study was approved by the ethics committee of the bioethics research of Rafsanjan University of Medical Sciences (IR.RUMS.REC.1395.118). The study objectives were explained to patients as well as emergency staff; all information kept confidential. Additionally, ethical considerations such as no intervention in the triage process and performing triage with two methods simultaneously were observed during the study. Sampling was conducted for three months. Data were analyzed with SPSS version 18 using descriptive statistics (mean and standard deviation, number and percentage) and analytical statistics (Spearman correlation coefficient). Miss triage was calculated based on the difference between the scores of emergency clinician and author or the nurse. Negative score indicated under-triage and a positive score indicated over-triage. P value < 0.05 was considered the significance level.

4. Results

Demographic characteristics indicated that of 224 patients with abdominal trauma, 152 (67.9%) were male and 72 (32.1%) female; the majority (74.1%) were transferred to the hospital. The mean time to trauma occurrence and transferring to the emergency department was 14.79 ± 6.42 hours (Table 1).

Table 1. Demographic Characteristics of Patients with Abdominal Trauma

Demographic Characteristics	Mean \pm SD
Age, y	33.45 \pm 14.32
Systolic blood pressure, mmHg	129.68 \pm 15.93
Diastolic blood pressure, mmHg	80.82 \pm 11.58
Pulse, beat/min	90.31 \pm 14.93
Breathing, breath/min	16.64 \pm 1.89
Arterial oxygen saturation, %	95.08 \pm 3.33

According to the obtained results, 204 cases (91.1%) were diagnosed with level 5 triage based on the triage system. In 14 cases (6.3%) under-triage and in 6 cases (2.7%) over-triage measures were taken. Comparison of triage level with shock index showed the triage level 5 in 100 cases (44.6%). In 81 cases (36.2%) under-triage and in 43 cases (19.2%) over-triage measures were taken.

Spearman's correlation coefficient was used to examine the correlation between the triage level based on the

five-level triage system and triage score based on the shock index. According to the results, there was a significant positive correlation between the results of each of the two methods and the final triage score. However, the correlation coefficient of the final score of triage in the five-level system was higher than that of the shock index (Table 2).

Table 2. Correlation Between Triage Score of the Five-level Triage System and That of Shock Index

Triage Type	Five-level System	Shock Index	Final Triage
Five-level system			
Spearman correlation coefficient	1	0.227	0.834
P value ^a		0.001	< 0.001
Shock index			
Spearman correlation coefficient	0.227	1	0.162
P value	0.001		0.015
Final triage			
Spearman correlation coefficient	0.834	0.162	1
P value	< 0.001	0.015	

^aSpearman coefficient.

5. Discussion

Based on the results of the current study, majority of patients with abdominal trauma were male with the mean age of 33.45 ± 14.32 years. In a study by Heydari Khayat et al. (18), the mean age of the subjects was 26.54 ± 13.12 years and most of the traumatic patients were also male. In a study by Amirbeiky Tafti et al. (5), the age range of patients with trauma was 30 - 40 years and among 166 patients with trauma, 80% were male and 20% female. In a study by Mehta et al. (24), 79% of the patients were male and 21% female, consistent with the results of the current study. The higher rate of trauma in males can be attributed to their occupational conditions and high rate of traffic accidents.

Results of the present study indicated that in the ESI triage system, 14 cases (6.3%) received under-triage and 6 cases (2.7%) received over-triage medical services. In Iran, Kamrani et al., (25) reported 23.7% under-triage and 11.7% over-triage cases in the emergency departments; although they reported a higher rate of under-triage error than the present study, the high frequency of under-triage error was in line with the results of the present study. However, Mirhaghi et al., (11) reported 8.57% under-triage and

48% over-triage errors in emergency departments. In a study by Rehn et al. (26), the incidence of under-triage and over-triage in traumatic patients was reported 10% and 55%, respectively. In a study by Lehmann et al. (27), 4% under-triage and 79% over-triage, and in a study by Cherry et al. (28), 22% under-triage were reported (28). Although the rate of under-triage in all the mentioned studies was higher than that of the present study, contrary to the results of the present study, the rate of over-triage was more than under-triage. Among the differences between the cited studies and the current study, dissimilarities in sample sizes and methods of data collection are noteworthy.

Triage based on the shock index was compared with the level of triage based on the triage system and results showed 81 cases (36.2%) of under-triage and 43 cases (19.2%) of over-triage. Results indicated that the frequency of miss triage in shock index was higher than that of ESI, but there was a significant positive correlation between each of the two methods and the triage level. Moreover, there was a significant positive correlation between the results of two methods. In other words, each of the two methods were useful to determine the level of triage. Accordingly, results of a study by Toccaceli et al., (22) on the shock index hinted the ability of this indicator to assess the complexity of care in traumatic patients and act as a guideline to select the appropriate clinical pathway for patients. Also, Montoya et al., (19) proposed the shock index as a useful, inexpensive, fast, easy-to-use, and safe tool for better performance of the triage system leading to more favorable outcomes for patients. Furthermore, the results of a study by Bruijns et al., (29) showed that heart rate, systolic blood pressure, and respiratory rate are poor predictors for the prognosis of trauma in patients; thus, it is more appropriate to use the shock index along with commonly evaluated symptoms for the triage of patients with trauma in emergency departments (29).

In Iran, results of a study by Heydari Khayat et al., (18) showed that since heart rate and blood pressure are considered in the shock index assessment (reflecting the changes in vital signs of patients), measuring this index can better demonstrate the hemodynamic status of patients with trauma compared with merely vital signs evaluation; thus, it can be utilized in hospitals and emergency rooms. Given the fact the shock index is fast, easy-to-use, and inexpensive, and systolic blood pressure and heart rate are considered in this indicator, the shock index can be used to prevent miss triage along with the triage system in emergency departments. By the use of the results of the current study and providing necessary information to emergency staff and nurses, the incidence of miss triage and its undesirable consequences can be reduced. Since the shock index is not used as an instruction for triage,

the current study could not perform an intervention. It was one of the limitations of the present study. Another limitation was that the study was only conducted at one trauma center. Therefore, it is suggested to conduct further interventional studies including more than one emergency trauma centers. The study was the first that used the shock index as a criterion for triage. Hence, it paved the way to conduct further studies in this area. The results can be helpful for the management of emergency department and triage nurses in hospitals in order to diagnose the triage level accurately for patients with trauma.

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Footnote

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References

- Andersen DK, Billiar TR, Brunicaudi FC, Dunn DL, Hunter GJ, Matthews JB. *Schwartz's Principles of Surgery*. 10 th ed. 2015.
- Beauchamp RD, Evers BM, Mattox K. *Sabiston Textbook of Surgery: The Biological Basis of Modern Surgical Practice*. 20th ed. Elsevier; 2017.
- Montazer H, Bozorgi F, Hosseini Nejad M, Golikhatir I, Jahanian F, Motaleb-Nejad M, et al. [Accuracy of focused assessment with sonography for trauma in blunt abdominal trauma in emergency department]. *J Mazandaran Univ Med Sci*. 2016;**26**(140):187-91. Persian.
- Mefire AC, Pagbe JJ, Fokou M, Nguimbous JF, Guifo ML, Bahebeck J. Analysis of epidemiology, lesions, treatment and outcome of 354 consecutive cases of blunt and penetrating trauma to the chest in an African setting. *S Afr J Surg*. 2010;**48**(3):90-3. [PubMed: 21924001].
- Amirbeiky Tafti M, Davoud Abadi A, Amirbeigy M. [Evaluating frequency and cause of laparotomy in penetrating and blunt abdominal trauma in at Shahid Beheshti hospital of kashan during the years 2009-2012]. *Iran J Surg*. 2014;**22**(2):34-41. Persian.
- García A. Critical care issues in the early management of severe trauma. *Surg Clin North Am*. 2006;**86**(6):1359-87. doi: 10.1016/j.suc.2006.07.004. [PubMed: 17116453]. [PubMed Central: PMC3413270].
- Motie MR, Behnampour N, Alinezhad H. [Epidemiology of blunt abdominal trauma in Gorgan-Iran (2001-05)]. *J Gorgan Univ Med Sci*. 2009;**10**(4):55-9. Persian.

8. Safari S, Rahmati F, Baratloo A, Motamedi M, Forouzanfar MM, Hashemi B. Hospital and pre-hospital triage systems in disaster and normal conditions; a review article. *Iran J Emerg Med.* 2015;**2**(1):2-10.
9. Christ M, Grossmann F, Winter D, Bingisser R, Platz E. Modern triage in the emergency department. *Dtsch Arztebl Int.* 2010;**107**(50):892-8. doi: [10.3238/arztebl.2010.0892](https://doi.org/10.3238/arztebl.2010.0892). [PubMed: [21246025](https://pubmed.ncbi.nlm.nih.gov/21246025/)]. [PubMed Central: [PMC3021905](https://pubmed.ncbi.nlm.nih.gov/PMC3021905/)].
10. Gilboy N, Tanabe T, Travers D, Rosenau A. *Emergency severity index (ESI): A triage tool for emergency department care.* 4th ed. AHRQ Publication; 2011.
11. Mirhaghi A, Roudbari M. [A survey on knowledge level of the nurses about hospital triage]. *Iran J Crit Care Nurs.* 2011;**3**(4):167-74. Persian.
12. Ebrahimi M, Mirhaghi A, Mazlom R, Heydari A, Nassehi A, Jafari M. The Role Descriptions of Triage Nurse in Emergency Department: A Delphi Study. *Scientifica (Cairo).* 2016;**2016**:5269815. doi: [10.1155/2016/5269815](https://doi.org/10.1155/2016/5269815). [PubMed: [27382500](https://pubmed.ncbi.nlm.nih.gov/27382500/)]. [PubMed Central: [PMC4921622](https://pubmed.ncbi.nlm.nih.gov/PMC4921622/)].
13. Holst JA, Perman SM, Capp R, Haukoos JS, Ginde AA. Undertriage of Trauma-Related Deaths in U.S. Emergency Departments. *West J Emerg Med.* 2016;**17**(3):315-23. doi: [10.5811/westjem.2016.2.29327](https://doi.org/10.5811/westjem.2016.2.29327). [PubMed: [27330664](https://pubmed.ncbi.nlm.nih.gov/27330664/)]. [PubMed Central: [PMC4899063](https://pubmed.ncbi.nlm.nih.gov/PMC4899063/)].
14. Mohan D, Rosengart MR, Farris C, Cohen E, Angus DC, Barnato AE. Assessing the feasibility of the American College of Surgeons' benchmarks for the triage of trauma patients. *Arch Surg.* 2011;**146**(7):786-92. doi: [10.1001/archsurg.2011.43](https://doi.org/10.1001/archsurg.2011.43). [PubMed: [21422329](https://pubmed.ncbi.nlm.nih.gov/21422329/)]. [PubMed Central: [PMC4090942](https://pubmed.ncbi.nlm.nih.gov/PMC4090942/)].
15. Nathens AB, Jurkovich GJ, MacKenzie EJ, Rivara FP. A resource-based assessment of trauma care in the United States. *J Trauma.* 2004;**56**(1):173-8. discussion 178. doi: [10.1097/01.TA.0000056159.65396.7C](https://doi.org/10.1097/01.TA.0000056159.65396.7C). [PubMed: [14749585](https://pubmed.ncbi.nlm.nih.gov/14749585/)].
16. Grossmann FF, Zumbunn T, Frauchiger A, Delport K, Bingisser R, Nickel CH. At risk of undertriage? Testing the performance and accuracy of the emergency severity index in older emergency department patients. *Ann Emerg Med.* 2012;**60**(3):317-25 e3. doi: [10.1016/j.annemergmed.2011.12.013](https://doi.org/10.1016/j.annemergmed.2011.12.013). [PubMed: [22401951](https://pubmed.ncbi.nlm.nih.gov/22401951/)].
17. Cannon CM, Braxton CC, Kling-Smith M, Mahnken JD, Carlton E, Moncure M. Utility of the shock index in predicting mortality in traumatically injured patients. *J Trauma.* 2009;**67**(6):1426-30. doi: [10.1097/TA.0b013e3181bbf728](https://doi.org/10.1097/TA.0b013e3181bbf728). [PubMed: [20009697](https://pubmed.ncbi.nlm.nih.gov/20009697/)].
18. Heydari Khayat N, Sharifi Poor H, Mohammadinia N. 2012. *Evid Based Care J.* The relationship of shock index (SI) with trauma patients' mortality after the first 24 hours of admission at Khatam-aL-Anbia Hospital in Iranshahr;**2**(3):61-8.
19. Montoya KF, Charry JD, Calle-Toro JS, Núñez LR, Poveda G. Shock index as a mortality predictor in patients with acute polytrauma. *J Acute Dis.* 2015;**4**(3):202-4. doi: [10.1016/j.joad.2015.04.006](https://doi.org/10.1016/j.joad.2015.04.006).
20. Sankaran P, Kamath AV, Tariq SM, Ruffell H, Smith AC, Prentice P, et al. Are shock index and adjusted shock index useful in predicting mortality and length of stay in community-acquired pneumonia? *Eur J Intern Med.* 2011;**22**(3):282-5. doi: [10.1016/j.ejim.2010.12.009](https://doi.org/10.1016/j.ejim.2010.12.009). [PubMed: [21570648](https://pubmed.ncbi.nlm.nih.gov/21570648/)].
21. Allgower M, Burri C. ["Shock index"]. *Dtsch Med Wochenschr.* 1967;**92**(43):1947-50. doi: [10.1055/s-0028-1106070](https://doi.org/10.1055/s-0028-1106070). [PubMed: [5299769](https://pubmed.ncbi.nlm.nih.gov/5299769/)].
22. Toccaceli A, Giampaolletti A, Dignani L, Lucertini C, Petrucci C, Lancia L. The role of shock index as a predictor of multiple-trauma patients' pathways. *Nurs Crit Care.* 2016;**21**(2):e12-9. doi: [10.1111/nicc.12152](https://doi.org/10.1111/nicc.12152). [PubMed: [25641362](https://pubmed.ncbi.nlm.nih.gov/25641362/)].
23. Berger T, Green J, Horeczko T, Hagar Y, Garg N, Suarez A, et al. Shock index and early recognition of sepsis in the emergency department: pilot study. *West J Emerg Med.* 2013;**14**(2):168-74. doi: [10.5811/westjem.2012.8.11546](https://doi.org/10.5811/westjem.2012.8.11546). [PubMed: [23599863](https://pubmed.ncbi.nlm.nih.gov/23599863/)]. [PubMed Central: [PMC3628475](https://pubmed.ncbi.nlm.nih.gov/PMC3628475/)].
24. Mehta N, Babu S, Venugopal K. An experience with blunt abdominal trauma: evaluation, management and outcome. *Clin Pract.* 2014;**4**(2):599. doi: [10.4081/cp.2014.599](https://doi.org/10.4081/cp.2014.599). [PubMed: [25332759](https://pubmed.ncbi.nlm.nih.gov/25332759/)]. [PubMed Central: [PMC4202181](https://pubmed.ncbi.nlm.nih.gov/PMC4202181/)].
25. Kamrani F, Ghaemipour F, Nikravan M, Alavi Majd H. [Prevalence of miss triage and outcomes under triage of patients in emergency department]. *J Health Promot Manag.* 2013;**2**(3):17-23. Persian.
26. Rehn M, Eken T, Kruger AJ, Steen PA, Skaga NO, Lossius HM. Precision of field triage in patients brought to a trauma centre after introducing trauma team activation guidelines. *Scand J Trauma Resusc Emerg Med.* 2009;**17**:1. doi: [10.1186/1757-7241-17-1](https://doi.org/10.1186/1757-7241-17-1). [PubMed: [19134177](https://pubmed.ncbi.nlm.nih.gov/19134177/)]. [PubMed Central: [PMC2639532](https://pubmed.ncbi.nlm.nih.gov/PMC2639532/)].
27. Lehmann R, Brounts L, Lesperance K, Eckert M, Casey L, Beekley A, et al. A simplified set of trauma triage criteria to safely reduce overtriage: a prospective study. *Arch Surg.* 2009;**144**(9):853-8. doi: [10.1001/archsurg.2009.153](https://doi.org/10.1001/archsurg.2009.153). [PubMed: [19797111](https://pubmed.ncbi.nlm.nih.gov/19797111/)].
28. Cherry RA, Bradburn E, Nichols PA, Snavely TM, Boehmer SJ, Mauger DT. Outcome assessment of blunt trauma patients who are undertriaged. *Surgery.* 2010;**148**(2):239-45. doi: [10.1016/j.surg.2010.05.004](https://doi.org/10.1016/j.surg.2010.05.004). [PubMed: [20633728](https://pubmed.ncbi.nlm.nih.gov/20633728/)].
29. Bruijns SR, Guly HR, Bouamra O, Lecky F, Lee WA. The value of traditional vital signs, shock index, and age-based markers in predicting trauma mortality. *J Trauma Acute Care Surg.* 2013;**74**(6):1432-7. doi: [10.1097/TA.0b013e31829246c7](https://doi.org/10.1097/TA.0b013e31829246c7). [PubMed: [23694869](https://pubmed.ncbi.nlm.nih.gov/23694869/)].