

Original Article



The ability of criteria-directed protocol versus emergency severity index and modified rapid emergency medicine score in triage of trauma

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Abstract

Introduction: With respect to high prevalence and high mortality of trauma in our country, Iran, triage of patient trauma is very important. Based on the country protocol, hospital emergencies use from five categories ESI (emergency severity index) in entire country. The ideal triage criteria would be 100% accurate with no under triage or over triage, however, this is not possible. We aimed to survey the ability of criteria -directed protocol versus ESI and modified rapid emergency medicine score (mREMS) in triage of trauma patients.

Methods: This retrospective cross-sectional study was carried out on 120 patients admitted in Emergency department of Imam Reza hospital in 2020 and triaged by ESI and criteria-directed protocol (CDP). After study of patients, we determined the score of patients in basis of injury severity score (ISS) and mREMS. If the scores of a patient were > 15 for ISS and > 4 for mREMS, the patient was transmitted to cardiopulmonary resuscitation (CPR), otherwise he or she was under triaged. If the scores of a patient was < 15 for ISS and < 6 for mREMS the patient was transmitted to trauma section, otherwise he or she was over triaged. American surgeon college advises the total of under triaged patients should not exceed 5%. In this study we calculated under triaged patients 8.3% and over triaged 4.1%.

Results: This study indicates ESI and ISS have direct connection in triage of patients. Also, CDP and ISS have direct connection in triage of patients. ESI and mREMS have not direct connection with each other. CDP and mREMS have not direct connection and they are independent.

Conclusion: Absence of important indices in ESI model for triage of patients for example age, vital sign and Glasgow Coma Scale (GCS) result in under triage and this injury to patients. Thus, adding of this index in ESI causes ESI have been more efficient and decrease under triage and finally diagnostic and therapeutic actions for patients do fast and exact.

Introduction

Reliable scoring systems in trauma can help quick determination of the severity of the injury and disease prognosis. In the modified rapid emergency medical score (mREMS), the design is done in such a way that the calculated score realistically and practically provides a more accurate prediction of hospital mortality compared to complex scoring systems that often require invasive measurements. In mREMS, compared to rapid emergency medical scoring system (REMS), more weighting is given to Glasgow Coma Scale (GCS) and less weight to age, as well as including the mechanism of trauma.¹

The extent of damages caused by traffic accidents in Iran and the world is so high that are always considered one of the important challenges in public health.² Although traffic injuries are considered the third cause of death in the world, the scope of this problem in Iran is much

higher than that ranked as the second cause of death after cardiovascular diseases.³

The simplicity and speed of triage, no need for tools and equipment, and the provision of required personnel with brief training are the strengths of triage by the emergency severity index (ESI) method. The methods of triaging patients may be two-level, three-level, four-level, or five-level. To date, the most reliable and valid methods available for evaluation are the comprehensive 5-level methods. In the existing conditions, due to the limited resources, the ESI triage method can be implemented and trained in a short time and with few facilities.^{4,5}

Triage to low levels or under triage means not identifying the sick patient in time and assigning low priorities to him. This situation should be kept to a minimum, as well as "triage to high levels or over triage, which means wrongly giving priority to a patient who is not very sick. Although

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the latter situation is relatively more favorable than the previous situation, it causes crowding in an emergency department. Transferring a patient with a lesion severity score of 15 or less to an over-triage trauma center is considered a false positive and conversely, transferring a patient with a score of 16 or more to a non-trauma center is considered an under-triage and a false negative.⁶

Although the guidelines for the implementation and principles of setting up the hospital triage system in the emergency department are based on ESI, the accuracy and correctness of this system have not been investigated. This triage method has been checked in many studies. It has been stated that although the emergency room deterioration index has many strengths among the standard triage tools, a large number of patients in this study who were triaged with this method suffered from under and over-triage.⁷

A detailed study on the efficiency of the ESI index, which is currently used, has not been done and no comparison has been made with other triage systems, and there is no information about over-triage and under-triage.

Methods

This study was a cross-sectional descriptive study comparing two methods of patients classification in trauma setting. Regarding the ESI-based implementation in this study, we considered the injury severity score (ISS) as the gold standard, considering the provision of a benchmark-based educational model at Karolinska University as well as the conditions of the modified rapid medical emergency scoring model. For patients who were triaged by ESI method and criteria-directed protocol (CDP) model, we scored it by ISS and mREMS methods. All patients with a history of multiple traumas in all age and gender groups, male and female, who visited the emergency room, were included in this study.

In the cardiopulmonary resuscitation (CPR) department, due to the continuous presence of the emergency medical assistant and the skilled nursing team, emergency diagnostic and treatment procedures were immediately performed for the patient, and the general surgery, neurosurgery, and orthopedic teams quickly arrived at the patient's bedside. If needed, they form the trauma team.

After additional investigations, including Para-clinical measures (radiography-tests-sonography-scan), it is possible to calculate the ISS according to the patient. The mREMS score of the patient was also calculated. Patients who were transferred to the CPR unit by ESI and CDP methods were correctly triaged to CPR if they obtained an ISS score of 15 or higher or received an mREMS of 4 to 6.

But if the patients triaged to CPR receive numbers less than 15 in the ISS method or less than 4 in the mREMS model, it is over triaged, which actually causes a waste of resources.

On behalf of the patients who have been transferred to

the trauma department, they have been correctly triaged to the trauma department when their ISS score is less than 15 and mREMS score is less than 4.

Considering that the subject of the research and its goals are related to the estimation of a small amount, the estimation of the necessary sample size is obtained based on the Cochran formula as follows:

$$n = (Z(1-\alpha/2)^2 \sigma^2) / d^2$$

In this regard, the value of $(Z(1-\alpha/2))$ is the numerical value of the standard normal distribution for the considered error value or type 1 error (α), which is usually considered equal to 0.05, and this value is equal to 1.96. The amount of variance is estimated based on a preliminary study conducted on 20 patients referred to the emergency department who were triaged by the ESI method and ISS was calculated for them. The calculated standard deviation for the ISS of twenty patients was 11.16. The mentioned values were obtained after supplementary and objective investigations (with the reference of the researcher who collected the information) or in Para clinical investigations such as radiography, ultrasound and scanning. Therefore, to determine the sample, two error values were considered, which according to the above formula, a sample of 120 people was calculated.

Considering that in the study plan, the aim was to investigate the triage process, therefore, with the coordination of the statistical consultant, there was no need to randomize the patients, and in fact, confounding selection bias was not detected. With the presence of the researcher in the emergency triage unit, two triage forms, one with the ESI method and the other with the CDP method, were used to refer patients. Considering the number of 120 samples, when the number of selected samples reached this value, sampling was terminated. Level 1 and 2 patients according to ESI means (those who require emergency life-saving interventions or are at high risk such as decreased level of consciousness) were transferred to the CPR unit if they had severe respiratory distress or severe pain.

Also, patients with vital impairment and seven anatomic lesions according to criteria-based guidelines, i.e., those with airway obstruction or respiratory rate less than 10 or greater than 29 per minute or systolic blood pressure less than 90 or GCS less than 14; as well as penetrating lesions of the head and neck and the upper parts of the elbows and knees, fracture of two or more long bones, suspected fracture of the pelvis, wavy chest, paralysis of limbs following trauma, amputation above the wrist or leg bone or a combination of trauma and are burned, drowning, and hypothermic, are taken to the CPR unit to activate the trauma team.

ISS scoring system based on the severity of the trauma to six anatomical regions of victim's body including: head, neck, face, chest, abdomen and external surfaces.

Injury severity of each system is scored according to the Abbreviated Injury Scale (AIS). The 3 body systems with the highest AIS scores are used to calculate ISS. Each of these 3s are squared then summed to produce ISS. It takes values from 0 to 75.

In the REMS, six factors including age, blood pressure, heart rate, respiratory rate, oxygen saturation, and GCS are evaluated.

Results

In the study, out of 120 patients referred to Imam Reza hospital (AS) and hospitalized due to trauma, 95 (79.1%) were men and 25 were women (Table 1).

Out of 120 referring patients, 111 patients were triaged by ESI method in the trauma area (ESI II) and after the necessary examinations including radiography, ultrasound and determining the patient's ISS, 10 of those (8.3%) were sent to the CPR department to be triaged.

On the other hand, nine patients were first triaged as ESI 1, of that four patients were correctly triaged due to the ISS score above 15 and five patients were correctly triaged after necessary investigations according to the ISS score.

According to the ESI, four of nine patients transferred to CPR who were correctly triaged based on the CDP items should also have been triaged to CPR because they had an impaired vital function or specific anatomic lesions.

Out of 10 patients' under-triage, six cases of cerebral hemorrhage, two cases of multiple fractures of long bones, one case of penetrating chest trauma and one case of bilateral pneumothorax were diagnosed after additional investigations (see Table 2).

The results of Fisher exact test analysis showed that both ESI and ISS criteria have a direct and significant relationship in assigning patients to the CPR and trauma department. (It should be noted that considering that 20%

of the houses in the consensus table were less than five, we should have used Fisher's exact test instead of chi-square test) (P value < 0.003).

The results of Fisher's exact test analysis showed that CDP and ISS criteria have a direct and significant relationship in allocating patients to CPR and trauma area (P value < 0.05). For example, only four patients had an ISS greater than 25 and were transferred to the trauma area.

In the case of independent status, it is expected that the minimum of 10 people with ISS scores of more than 25 be transferred to the trauma area.

The results of Fisher's exact test analysis showed that both ESI and mREMS criteria act independently and are not in the same direction in allocating patients to the CPR and trauma area (P value = 0.429).

The results of Fisher's exact test analysis indicated that both CDP and mREMS criteria act independently in allocating patients to CPR and trauma area and are not in the same direction (P value = 0.323).

Discussion

It can be seen that 50% of the patients were between the ages of 20 and 40 years old, indicating the higher prevalence of trauma in young people. Therefore, the level of injury, disability, and subsequent consequences caused by trauma is higher in this age group. In the current study, the prevalence of trauma in men is three times more than that of women.

One of the important issues in triage in the emergency is mis-triaging the patients. Although the ideal criterion of correct triage is when we don't have patients over/under triaged, in practice this goal is not 100% possible.⁶

The committee of the American College of Surgeons recommends that the acceptable level of under-triage and over-triage is less than 5% and between 25 and 30%,

Table 1. Age distribution of patients

Age group	Under 10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	> 80
Frequency	11	15	27	33	13	9	6	3	3

Table 2. Under-triage patients' definition

Age	Gender	Diagnosis	Cause of under-triage	ESI model	CDP model
65	Male	SAH	Nurse fault	Loss of consciousness	Vital dysfunction
43	Male	Femur and tibia fx	ESI fault	Lack of index	Specific anatomical lesion
60	Male	ICH	Nurse fault	Loss of consciousness	Vital dysfunction
17	Male	Both humerus fx	ESI fault	Lack of index	Specific anatomical lesion
49	Male	SDH	Nurse fault	Loss of consciousness	Vital dysfunction
30	Male	Two side pneumothoraxes	Nurse fault	Respiratory distress	Lack of index
10	Female	EDH	ESI fault	Lack of index	Lack of index
7 months	Female	EDH	ESI fault	Lack of index	Lack of index
21	Male	ICH	ESI fault	Lack of index	Lack of index
42	male	Penetrating chest trauma	ESI fault	Lack of index	Specific anatomical lesion

ESI, Emergency Severity Index; CDP, criteria-directed protocol; ICH, intracerebral hemorrhage; SAH, Subarachnoid hemorrhage; SDH, Subdural Hematoma.

respectively.⁸

In many sources, the cut-off for using ISS in the triage of patients is set to the highest treatment level of 15, but in the 2008 updated version of AIS, the cut-off level for major trauma and transfer to the highest level of triage is mentioned as 12.⁹ Some of the studies have tried to predict patients' situation in entrance of emergency department or in triage room.¹⁰⁻¹²

In this study, we considered 15 as the cut-off score for transferring patients to the highest level of triage in order to take care of critical patients and pay them close attention. Totally, under-triage should be minimized to avoid damage caused by lack of prompt attention.

Out of 120 examined patients, 111 people were triaged to the trauma department, and after additional investigations, ten people were triaged to CPR due to the ISS score higher than 15.

The rate of under-triage in our study is 8.3%, which is more than 5% recommended by the American College of Surgeons. In our study, out of 10 patients who were under-triaged, six patients, triaged to the trauma department, had a subdural hematoma or epidural or subarachnoid bleeding and all of them had low GCS. Two cases of multiple fractures of large bones and one case of bilateral pneumothorax and one trauma also had a penetrating injury on the shelf. It seems that paying attention to the patient's GCS in the triage of patients leads to a reduction in under-triage cases.

In this study, we calculated the rate of over triage to be 4.1%, which is far from the rate recommended by the American College of Surgeons (25%-35%). The reason for this is due to the limitation of physical space and nurses available in CPR, the lack of a dedicated unit to provide services to trauma patients, and the resistance of assistants and nurses in admitting patients. There are many sick patients in this department at times.

In a study in North Carolina, out of 782 elderly patients referred to the emergency room due to trauma, an emergency intervention was performed for 26 (3.3%) of the patients who were referred to the highest level of triage. Also, 13 people were triaged to level 3 (under triage) despite emergency measures being taken for them. This study shows that triage is at a low level in the elderly due to the problems of nurses in the proper use of ESI criteria in triage. In addition to this, another important factor is the limitation of ESI criteria to identify these patients.¹³ In several studies, the use of triage criteria in ESI for elderly patients has been emphasized.¹⁴⁻¹⁶ Another research showed that ESI leads to waste of time and energy of staff compared with Manchester triage system.¹⁷ An important issue is unexpected pandemic situations like COVID-19 outbreaks which triage methods had to modify due to resources limitation as well as isolation protocols.¹⁸

In our study, out of 120 examined patients, nine people were triaged to CPR, of which four people were correctly triaged and five people were triaged incorrectly based on

subsequent investigations and ISS score calculation.

Out of ten patients under triage, some have been triaged to a lower level due to ESI deficiency, so that three cases of cerebral hemorrhage, two cases of multiple fractures of long bones, and one case of penetrating trauma on the chest were transferred to the trauma department (60% of cases).

Low level triage can be attributed to lack of clear evidence of loss of consciousness in the first minutes and not paying attention to the patient's GCS. Chest penetrating trauma also may lead to low level of triage as well as fracture of large bones; because they may not affect patient's vital signs in first few minutes after trauma. It should be noted that in ESI level 1 (life-threatening conditions), i.e. airway risk, respiratory distress, cyanosis and shock symptoms, and for level 2 (high-risk patients) high-risk conditions, lethargy and drowsiness and pain or severe distress are the basis of CPR triage. Therefore, patients who did not have these conditions in the early moments may be triaged to a lower level.

In some cases, the lack of attention of the person in charge of triage has caused the triage to a low level. In the current study, three cases of patients were triaged to a low level in spite of cerebral hemorrhage that had decreased consciousness and one case of pneumothorax with an open wound despite the presence of respiratory distress (40%).

It seems that the non-accurate recording of patients' vital signs by assistants and interns, as well as the recording of vital signs only for level 2 and 3 patients by the triage nurse based on the triage guidelines, are the most important factor in the lack of connection between mREMS, ESI, and CDP.

To check the mREMS items, the information recorded in the patients' files was used. Unfortunately, due to the lack of measurement or inaccurate recording of these factors, the relationships between ESI, CDP, and mREMS were not observed. Among the six factors that make up the mREMS, the patient's systolic pressure, heart rate, and breathing rate are among the symptoms. However, they have not been recorded in many cases. Also, the interns' lack of mastery to measure the GCS correctly has led to unrecorded or wrongly recorded vital signs.

Limitations

The sample size was somewhat small, therefore designing a large-scaled multi-centered study strongly is recommended. This study compared methods of triage, although more investigation is needed to show cost-effectiveness of each method especially in resource-limited settings.

Conclusion

Despite the high efficiency of the ESI method and also the appropriate features in the triage of patients, there are pieces of evidence of the inadequacy of this model

Study Highlights

What is current knowledge?

- The most widely used method for triage the trauma patients is Emergency Severity Index (ESI). It seems to be necessary to find out new methods to prevent over-triage in an overcrowded emergency department. Important indicators in trauma scoring such as age, level of consciousness (GCS) and etc are neglected while using ESI.

What is new here?

- Criteria directed protocols using the indicators of age, GCS, ... decrease under-triage cases which will lead to more attention to critical traumatic patients.

in the triage of trauma patients in the literature and our study. Failure to pay attention to age, special conditions such as pregnancy, which is of great importance in the health system, and also the lack of paying attention to the important indicators such as GCS level and vital signs make this model not to be able to show the triage level correctly in some cases. The triage nurse should consider the all aspects of worsening of patient's clinical situation such as any signs of shock and appearance of the patient as well, not only absolute level of blood pressure, heart rate or respiratory rate.

In our study, many cases of triage to a low level occurred due to the lack of attention to the mentioned items. It seems that entering the indicators of age, GCS score, and determining the patient's vital signs will lead to a decrease in the cases of triage to low level, which enable more attention to critical patients and special and quick measures for their diagnosis and treatment in resuscitation units.

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Authors' Contribution

Conceptualization: Rouzbeh Rajaei Ghafouri.

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Competing Interests

There is not any conflict of interest

Ethical Approval

This study was approved by the ethical committee with code: IR.TBZMED.REC.1399.644. It was attained from the local medical ethics committee of Tabriz University of Medical Sciences. Informed consent was obtained from all patients as well.

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