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Emergency Severity Index Triage in Iran

A Comparison Between Age Groups in a Trauma Center

Shima Javidi, MD
Mitra Movahedi, MD
Amin Honarmand, MD
Amirhossein Mirafzal, MD

Abstract
There are concerns about the accuracy of Emergency Severity Index (ESI) triage system in the geriatric population. This study was performed to compare the correlation of ESI triage with injury severity score (ISS) between adults with trauma younger than 60 years and those 60 years of age and older and to determine the ability of ESI to predict an ISS of greater than 15 in these two age groups. This was an observational study performed in an academic trauma center in Kerman, Iran. A convenience sample of trauma patients older than 16 years was included. Five-level ESI triage was performed by nurses with 2–10 years of exclusive experience in triage. The ISS scores were calculated by the researchers. Both numerical and categorical (ISS >15) forms of the score were considered as outcomes. Ultimately, a total of 556 patients were enrolled in the study. No difference in undertriage was seen between the age groups ($p = 0.51$). Spearman's correlation coefficient between ESI level and ISS was −0.69 and −0.77 in patients younger than 60 years and those aged 60 years or older, respectively ($z = 1.20$). The areas under the curves (AUCs) for prediction of ISS of greater than 15 were also similar between the two age groups (0.89 in less than 60 and 0.85 in 60 or more). In conclusion, the performance of ESI was similar between the two age groups. Therefore, the application of the ESI triage system for initial categorization of trauma patients seems to be a reliable and easy-to-learn method for the triage of elderly as well as younger age groups. **Key words:** age, Emergency Severity Index, trauma, triage

IMPLEMENTATION of an appropriate triage system in a busy emergency department (ED) is of utmost importance for taking the first steps of management and decision making on the intensity of monitoring and the resources required for patients. Both undertriage and overtriage can have devastating effects on the destiny of patients and the costs of care (Haas et al., 2010; Kulstad & Kelley, 2009; Mills, Shofer, Chen, Hollander, & Pines, 2009; Oredsson et al., 2011). Although the five-level Emergency Severity Index (ESI) triage system is the most popular triage tool in the United States and is increasingly used worldwide, there are emerging concerns on its accuracy and concordance with reference standards, especially when patients are

Author Affiliation: *Department of Emergency Medicine, Kerman University of Medical Sciences, Kerman, Iran.*

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Corresponding Author: *Amirhossein Mirafzal, MD, Department of Emergency Medicine, Kerman University of Medical Sciences, Bahonar Academic Hospital, Kerman, Iran (a.mirafzal@yahoo.com or mirafzal@kmu.ac.ir).*

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assigned to a specific triage level by nurses (Mistry et al., 2018). One of the main factors shown to be associated with the decreased accuracy of the ESI triage system is age, which may make the elderly prone to undertriage (Grossmann et al., 2012; Hinson et al., 2018; Platts-Mills et al., 2010). Moreover, although the general performance of the five-level ESI system has been reported in the moderate to good range and comparable with the other popular triage systems (Kuriyama, Urushidani, & Nakayama, 2017; Zachariasse et al., 2019), few studies have been conducted specifically on the predictive capability of the ESI system in trauma patients. Alternatively, in the setting of trauma, there are a number of scoring systems that have been shown to have excellent predictive capability for adverse outcomes such as mortality. One of the traditional and the most reliable of these systems is the injury severity score (ISS), which comprises anatomic assessment of injuries in six different body systems (Chiang et al., 2012; Javali et al., 2019; Watts, Kerem, & Kulstad, 2012). However, calculation of ISS is not practical at the time of triage. Moreover, as stated before according to some studies published in the literature, the ESI system may be misleading in some cases, especially in the elderly. In the current study, we focused on a population of trauma patients and evaluated the correlation of ESI triage system with the calculated ISS and the predictive capability of the triage level for higher ISS values in two age groups after completion of clinical and imaging assessments. Therefore, we aimed to find out whether the routine use of five-level ESI triage system could be accurate in terms of the severity of injuries in a trauma center and compare this accuracy between two age groups: those younger than 60 years and those 60 years of age or older.

METHODS

Study Design and Setting

This was an observational study performed prospectively in Bahonar Hospital, an urban Level 1 trauma center, which is the main referral trauma center in the southeast region of Iran with an annual ED census of approximately 90,000. Patients are triaged routinely by registered nurses who were trained specifically for triage according to the standard protocols of the ministry of health and routinely pass refreshment courses, which are routinely held twice a year. These training and refreshing courses are parts of the mandatory professional development program in which all nurses have to participate and an element of the scoring of hospitals all over the country. The course instructors are assistant professors of emergency medicine and each session takes 2 hr to complete. Currently, there are six fixed nurses who are dedicated solely to the task of triage and have been working on this duty for 2–10 years. In our hospital, triage is exclusively performed according to the Official Persian translation of five-level ESI system. Trauma patients, comprising more than 90% of cases presenting to this center, are assigned to Levels 1–4 and are all visited by an emergency medicine specialist. Expert consultations are requested at the discretion of the emergency physician.

Study Population and Protocol

A convenience sample of adult (older than 16 years) trauma patients presenting to the ED between February 1, 2022, and April 1, 2022, were included in the study. Patients who did not complete their ED observation time to calculate the accurate ISS were excluded. The researchers did not interfere with the processes of triage, workup, or management, and were entirely focused on data collection and accurate calculation of ISS based on abbreviated injury scale (AIS) scores. The ISS scores were calculated by a trained general practitioner and were randomly recalculated by an emergency medicine specialist. Disagreements were solved by consensus.

Study Variables and Outcomes

Demographic information, initial vital signs, Glasgow Coma Scale score, ESI triage level, background diseases, initial hemoglobin, and

base deficit were obtained. The AIS scores for body systems were calculated and ISS scores were determined as the primary outcome. Patients were grouped to those younger than 60 years and those 60 years of age or older for the purpose of comparison of correlations between ESI triage levels and ISS scores. Instead of outcomes such as mortality, resource utilization, or admission length, which are influenced by the working routines of the hospitals, available facilities, and the management choices of physicians, we considered ISS as the outcome that is not impacted by such factors and also has been shown to have excellent associations with the destiny of patients. For the purpose of prediction, an ISS score of more than 15 was determined as the outcome as a result of the conventional definition of major trauma in the current literature using ISS (Brown et al., 2017; Van Ditshuizen et al., 2021). Undertriage and overtriage rates were recorded in each age group at the discretion of in charge Emergency Medicine (EM) specialist by noting errors in obtaining vital signs, the identification of high-risk situations or patient evaluation at triage time, or, more often, by calculation of ISS after completion of initial assessments and making comparisons with the initial positioning of patients to the critical or noncritical parts of the ED.

Sample Size

Based on the findings of a pilot study that had been performed before the main study, correlation coefficients and areas under the curves (AUCs) for the two age groups were included in the MedCalc software. As a result, the calculated sample size for participants younger than 60 years and those 60 years of age and older were 494 and 50 (544 in total), respectively.

Statistical Analysis

For description of quantitative variables with normal and nonnormal distributions, mean (*SD*) and median (interquartile range) were used, respectively. For qualitative (categorical) variables, percentage of frequency was used. Correlations were determined using Pearson's or Spearman's correlation coefficient depending on the normality of data distribution. For the purpose of comparison of correlations, z statistics were calculated, with a z score of more than 1.96 being as the significant difference. Chi-square test or Fisher's exact test was applied for comparison of categorical variables between age groups.

A p value of less than 0.05 was considered statistically significant in all tests. Receiver operating characteristic curve (ROC) and AUCs were used for determining the predictive capability of ESI triage level for ISS scores of more than 15. Statistical package for the social sciences (SPSS) version 16.0 (SPSS Inc., Chicago, IL) was used for analysis.

RESULTS

Basic Characteristics and Their Comparisons Between the Two Groups

A total of 556 patients were enrolled in the study, of whom 102 (18.3%) were females. The number (%) of patients aged 60 years and older was 66 (11.8%). Basic information on key quantitative variables was presented in Table 1. Table 2 shows the proportions of each triage level in each age group. Overall, 92 (16.5%) patients had ISS values of more than 15, of whom 24 (4.3% of total) patients were 60 years of age and older.

There was no statistically significant difference in gender combination between the two groups ($p = 0.09$). Similarly, there were not statistically significant differences in undertriage, correct triage, and overtriage between the two age groups (see Table 3). Table 4 demonstrates comparisons of quantitative variables between the two age groups. As could be found, although ESI triage levels were not significantly different between the two groups, the median value for ISS in the older group was significantly higher (see Table 4). Moreover, the total number of patients with ISS scores of greater than 15 was 68 (13.8%) in the group younger than

Table 1. Basic characteristics of quantitative variables

	Age (years)	Pulse rate	Systolic blood pressure (mmHg)	Initial Glasgow Coma Scale score	Injury severity score	Emergency Severity Index triage level
Median (IQR)	32 (23)	84 (11)	120 (10)	15 (5)	4 (7)	3 (1)
Minimum/maximum	17–86	50–150	75–180	3–15	1–4	2–46

Note. IQR = interquartile range.

60 years and 24 (36.3%) in the group 60 years of age and older, which showed statistically significant difference ($p = 0.01$).

Comparison of Correlations Between the Groups

The Spearman's correlation coefficient between ESI triage level and ISS for the age group of those younger than 60 years was −0.69, whereas this parameter for the age group of those 60 years and older was −0.77. Although the coefficient value for the older age group seems to be higher, the z score for their comparison was 1.20, which showed no statistically significant difference between the two groups in their correlations between ESI triage level and ISS.

ROC Curve

Figure 1 demonstrates the ROC curves for the whole study population and for each of the age groups separately, with detailed information provided in Table 5. As shown, ESI triage system predictive capability for ISS of more than 15 in the whole group, those younger than 60 and those aged 60 years and older, was all in the excellent range of performance. Moreover, no statistically significant difference was seen among the AUCs.

DISCUSSION

Our study results showed strong correlations between ESI triage level and ISS scores in all age groups. Moreover, the rates of undertriage and overtriage were low, and although undertriage rate was slightly higher in the group aged 60 years and older, there was no statistically significant difference between the two age groups. Therefore, the overall accuracy of ESI system was high in our study, which was in concordance with many published articles in the literature (Cairós-Ventura et al., 2019; Fong, Glen, Jamil, San Tam, & Kowitlawakul, 2018; Grossmann et al., 2012; Mirhaghi, Heydari, Mazlom, & Hasanzadeh, 2015). In addition to being reliable for triage, ESI has been also shown to be

Table 2. Number (%) of trauma patients assigned to each triage level based on the age group

ESI triage level	One	Two	Three	Four	Five
≥60 years	4 (6)	19 (29)	37 (56)	6 (9)	–
<60 years	29 (6)	124 (25)	237 (48)	100 (21)	–
Total	33 (6)	143 (26)	274 (49)	106 (19)	–

Note. ESI = Emergency Severity Index.

Table 3. Comparison of undertriage, correct triage, and overtriage between the two age groups

	Undertriage	Correct triage	Overtriage
<60 years, n (%)	14 (2.8)	454 (92.8)	22 (4.4)
≥60 years, n (%)	4 (6)	60 (91)	2 (3)
p	0.76	0.96	0.85
Kappa	0.01	0.00	0.00
Standard error	0.04	0.01	0.04

Table 4. Comparison of baseline quantitative variables between the two groups: 50 years or less and more than 50 years[a]

		PR	SBP (mmHg)	Hemoglobin (mg/dL)	BD (mmol/L)	ESI level	GCS	ISS
Median (IQR)	<60	84 (11)	121 (10)	13.3 (4.3)	2.6 (8.0)	3 (1)	15 (5)	4 (8)
	≥60	82 (12)	130 (21)	13.1 (4.6)	4 (9.9)	3 (1)	14 (2)	8 (9)
p		0.90	<0.001[b]	0.55	0.09	0.14	0.89	0.02[b]

Note. BD = base deficit; ESI = Emergency Severity Index; GCS = Glasgow Coma Scale; IQR = interquartile range; ISS = injury severity score; PR = admission time pulse rate; SBP = admission time systolic blood pressure.
[a]All variables showed nonnormal distribution; Mann–Whitney *U* test was performed.
[b]Statistical significance.

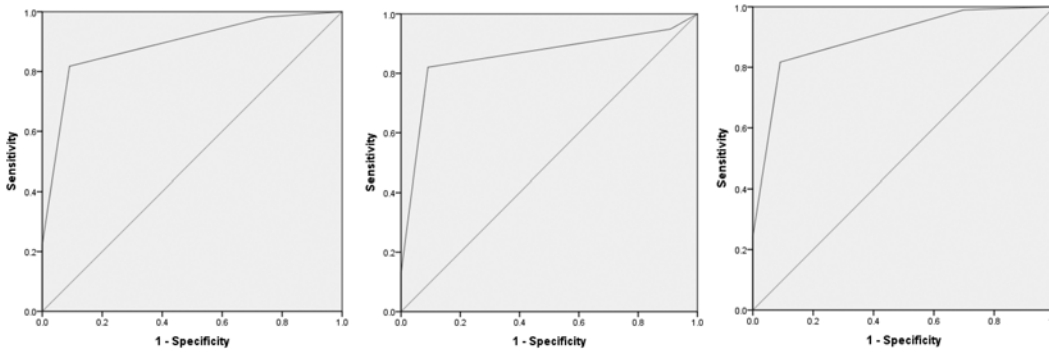

Figure 1. Receiver operating characteristic curves of Emergency Severity Index for the prediction of injury severity score in the whole study population (left), those aged 60 years and older (middle), and those younger than 60 years (right).

Table 5. Receiver operating characteristic curve results for prediction of injury severity score of more than 15 by emergency severity triage system level

	Standard error	p	Area under the curve	95% confidence interval
Whole study population	0.02	<0.001	0.88	0.84–0.93
Aged <60 years	0.02	<0.001	0.89	0.84–0.95
Aged ≥60 years	0.06	<0.001	0.85	0.83–0.97

sensitive in the prediction of mortality due to sepsis (Phungoen, Khemtong, Apiratwarakul, Ienghong, & Kotruchin, 2020). However, high rates of undertriage and overtriage were also reported by some studies, especially in settings with advanced age, vital signs derangements, and specific presentations (Hinson et al., 2018; Mistry et al., 2018).

As stated before, we found no statistically significant difference in the ESI–ISS correlation between younger and older age groups. These findings agree with the results of a number of studies in the literature. For example, a study performed exclusively in geriatric population depicted valid correlations with resource utilization, length of admission, and mortality with the application of ESI triage system (Baumann & Strout, 2007). In addition, in a comparative study recently performed by Kemp et al. (2022a), ESI triage system had a higher AUC for the prediction of early mortality in patients older than 65 years in relation to younger age groups, and there was no difference between the age groups in the prediction of intensive care unit admission. We also found excellent predictive capability of ESI for major trauma, which was defined as ISS of greater than 15. Based on such findings, ESI triage could be recommended for all age groups of adult trauma patients with a high level of reliability.

Nevertheless, our results may not be in agreement with a number of previously published studies which, though unveiling acceptable accuracy for all age groups, had shown some risk for undertriage in the geriatric population. In a study published by Grossman et al. (2012), although the ESI triage was shown to be valid and reliable for all age groups, older patients were found to be at risk of undertriage: the authors proposed neglect of life-threatening situations and failure to interpret vital signs as the main reasons for undertriage. In an Australian study of major trauma elderly patients, the odds of being assigned to a higher level of triage among patients older than 55 years were significantly lower than those among the younger age group. However, this study

utilized Australian triage scale for triage of trauma patients (Lukin, Greenslade, Chu, Lang, & Brown, 2015). The concept of higher undertriage in the elderly (older than 65 years) was also shown in a UK-based study on major trauma patients (Hoyle, Biant, & Young, 2020). In another study, failure to adhere to ESI guidelines has been proposed to be the source of undertriage in the elderly (Platts-Mills et al., 2010). As a solution, adding the first impressions of physicians to vital signs was one of the suggested ways to increase the accuracy of the ESI triage system in the prediction of 30-day mortality (Malinovska, Pitasch, Geigy, Nickel, & Bingisser, 2019). Another solution may be age adjustment: the inclusion of age in the assignment process might lead to placement of some elderly patients in a higher level (Kemp et al., 2022b). The necessity of incorporation of age to the standard triage criteria has been suggested by some other authors as well (Ginsburg et al., 2021).

With regard to the reported positive features of the ESI triage system along with its limitations, we think that the inclusion of clinical impression may be an important factor for the improvement of triage accuracy. Because we did not interfere with the ongoing process of triage in our hospital, we theorized that the exclusive dedication of our nurses rather than the rotation of positions among them, their experience, and their selective negotiation with the EM specialists in the assignment of triage levels would lead to higher accuracy of triage with the ESI system, especially when a clinically complicated scenario such as an elderly patient with many health-related background conditions with trauma is present. In such situations, consideration for a potential or impending life-threatening condition would result in a conversion of a Level 3 (or 4) patient to Level 2 (or even 1) and might decrease the risk of undertriage. Interview with nurses showed that according to their personal experience, all of them were more cautious about triaging the elderly, and there is a selective higher consideration to assign a more critical level to an old trauma patient. As result, triage may be considered as a form of early and rapid interpretative medical practice rather than a robotic task of adherence to a set of numbers and lines.

Although our study was performed in a comparative and prospective setting, a number of limitations were also present. This was a single-center study, which was performed only on adult patients and with the utilization of a limited number of fixed staff for triage, which made our results not generalizable to many EDs. Furthermore, because our main outcome was ISS score, we did not follow patients to the end of their hospital admission and after discharge. However, the scores were calculated with high accuracy, which could be considered reliable predictors of patients' destiny. In fact, because ISS is not altered by the quality of care, it may even be a better representative of undertriage than clinical outcomes such as mortality or resource utilization. Finally, the cutoff for age in our study was 60 years, which may be different from some other studies, which consider 55 or 65 years as the cutoff. Nonetheless, this seems to have little impact on the interpretation of our results.

In conclusion, the application of the ESI triage system for the initial categorization of trauma patients seems to be a reliable and easy-to-learn method for the triage of elderly as well as younger age groups. However, consideration for potentially life-threatening conditions and their predisposing clinical backgrounds in the geriatric population may be invaluable to prevent the devastating consequences of undertriage in this age group.

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