Original article

Validity of the emergency severity index in predicting patient outcomes in a major emergency department

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Abstract

Background and Purpose: The emergency severity index (ESI) triage system has been recommended by the Ministry of Health to classify patients at emergency departments. This study aimed to assess the validity of ESI system (version 4) in the emergency department of a teaching hospital. Outcome measures were hospitalization, emergency department (ED) length of stay, resource consumption, in-hospital mortality, and patient service costs.

Methods: In this retrospective cross-sectional study, medical records of 562 ED patients were reviewed to determine the ESI level and outcome measures in April 2013. Possible correlations were assessed using Phi and Cramer's V and Spearman's Rho. Data analysis was performed in SPSS V.16, and P value of 0.05 was considered significant.

Results: In this study, frequency of five ESI levels (1-5) was 24, 14, 365, 158 and 0, respectively. In addition, Phi and Cramer's V for hospitalization and mortality were 0.350 ($P<0.001$) and 0.345 ($P<0.001$), respectively. Spearman's Rho for patient service costs, ED length of stay, and resource consumption were -0.434 ($P<0.001$), -0.015 ($P=0.362$), and -0.411 ($P<0.001$), respectively. According to our findings, the association between triage levels and resource consumption was more significant compared to other outcome measures.

Conclusion: According to the results of this study, ESI triage ratings could successfully predict patient outcomes in terms of hospitalization, in-hospital mortality, resource consumption, and patient service costs. Therefore, use of this valid triage system is recommended for the arrangement of human and physical resources at emergency departments.

Keywords: Emergency severity index, Hospital emergency service, Triage, Validity

Introduction

In an emergency department visit, triage is used as an initial process to prioritize patients. Since emergency departments are normally crowded, accuracy of triage ratings is essential for patient safety and timeliness of care (1). In other words, triage ratings should be valid in the assessment of the acuity of conditions in different patients. If performed properly, the process of triage reduces patient waiting time and improves patient outcomes (2, 3). Furthermore, an accurate triage could help patients and their family to overcome their concerns.

Since 2011, the Iranian Ministry of Health and Medical Education has recommended the Emergency Severity Index (ESI) as an appropriate triage system for hospitals (4). As a result, the latest version of ESI has been widely used in the emergency departments of different hospitals in our country.

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ESI is a five-level triage system, which was first developed in the U.S. to classify patients in terms of the condition acuity and resource consumption (5). According to this scale, level-one ESI patients have the highest acuity and tend to use more resources, whereas level-five ESI patients have the lowest acuity and resource consumption. The ESI algorithm has been revised three times, and the fourth version is available now (5).

Evaluation of the validity of different versions of the ESI triage in international hospitals has proven the efficacy of this scale in the prediction of hospitalization, mortality, emergency department (ED) length of stay, patient service costs, and resource consumption (3, 6-10). However, validity of triage scores in our newly established ESI system requires further assessment. To the best of our knowledge, no studies have been conducted on this subject in East Azerbaijan province in Iran.

This study aimed to evaluate the fourth version of ESI in the emergency department of a teaching hospital in Tabriz, Iran. With its unique features and high volume of referrals, the study site was a novel environment for assessing the validity of ESI. One of the advantages of this study was the consideration of all the ESI outcome measures, including hospitalization, ED length of stay, resource consumption, in-hospital mortality, and patient service costs together (6-13).

Materials and Methods

Study design

In this retrospective cross-sectional study, medical records of all the ED patients referred during the first week of March 2013 were reviewed. This was part of another project on the implementation of electronic triage system funded by Tabriz University of Medical Sciences, Iran (14). Study protocol was approved by the institutional review board which is the Ethics Committee of Tabriz University of Medical Sciences.

Study setting and population

This study was conducted in Imam Reza Hospital of Tabriz (Iran), the largest provincial teaching hospital serving as a referral center for other hospitals of the city and suburbs. Since there are several specialized hospitals for psychiatry, obstetrics, children and burn injuries in the city, these patients do not usually refer to the ED of Imam Reza Hospital, except for the cases with complications. In this department, children aged up to 15 years receive treatment for injuries and trauma only and are transferred to pediatric hospitals for further examinations. The ESI triage has to be implemented for all patient arrivals at the emergency department of Imam Reza Hospital.

Study protocol

All medical records of triaged ED patients were reviewed and deemed potentially eligible for this study. Exclusion criteria of the study were as follows: 1) leaving the ED against medical advice; 2) Leaving the ED without being seen by a physician and 3) lack of documented triage level in medical records.

Out of 848 reviewed records in this study, 204 cases had left the ED without being seen by a physician or against medical advice. In addition, triage levels were not found in the medical records of 107 patients. Eventually, 562 patients were enrolled in the study.

Data abstraction was performed by one trained researcher (abstractor) in order to prevent inter-reviewer variation. The abstractor was clearly instructed on the inclusion and exclusion criteria of the study, definition of the variables, objectives, and procedures of the study. Moreover, a standardized data collection form was used to guide the abstractor and ensure uniform handling of data. In addition, several meetings were held during data collection in order to guarantee the quality of data and monitor the performance of the abstractor.

Data collection tools

Collected data in this study were ESI triage levels and outcome measures of ED patients. Outcome measures included hospitalization, in-hospital mortality, ED length of stay, resource consumption, and patient service costs. To evaluate resource consumption, we only considered the procedures

introduced as resource in the Emergency Severity Index Implementation Handbook.

Hospitalization was defined as being inpatient in the studied hospital, patients who were triaged at the ED and transferred to other hospitals and those who died in the hospital. Length of stay at the ED was determined based on the calculated time interval between the triage and disposition of the patient. In order to categorize ED patients based on hospital working shifts, routine nursing schedules were regarded as follows: morning shift (7:30-13:30), afternoon shift (13:30-19:30), and night shift (19:30-7:30). Disposition time was not documented in the medical records of 12 patients, who were excluded from the evaluation of ED length of stay.

The data for resource consumption and the ED length of stay were abstracted from the medical records of the patients. Other outcome measures, including hospitalization, in-hospital mortality and patient service costs, were double-checked in the medical records of the patients and hospital information system.

Data analysis

To evaluate possible correlations between ESI levels, as an ordinal variable, and the nominal data (i.e., hospitalization and in-hospital mortality), we calculated the Phi and Cramer's V. Moreover, Spearman's rank correlation coefficient (Rho) was used for quantitative variables (i.e., resource consumption, ED length of stay, patient service costs). For this study, V and Spearman's Rho were defined as poor (less than 0.3), moderate (0.3-0.5), and strong (greater than 0.5). Data analysis was performed in SPSS V.16, and P value of 0.05 was considered significant.

Table 1. Hospitalization, in-hospital mortality and emergency department length of stay

*ESI Triage Level	Hospitalization N (%)	Mortality N (%)	**ED Length of Stay (minute) Median (IQR)
1	22 (91.7%)	7 (29.1%)	142 (205)
2	10 (66.7%)	3 (20%)	146 (236)
3	109 (29.9%)	8 (2.2%)	150 (159)
4	25 (15.8%)	1 (0.6%)	135 (149)
5	0 (0%)	-	-

***ESI: Emergency Severity Index; **ED: Emergency Department**

Results

In total, 562 patients were enrolled in this study, 224 of whom (40%) were female. Mean age of the patients was 42.96±20.61 years. Independent-Samples T-test and Chi-square results were indicative of no significant difference between the included and the excluded patients in terms of age and gender. Patients evaluated in this study were within the age range of 1-90 years, and 31 patients (5.5%) were aged less than 15 years.

In total, 171 patients (30.4%) were referred to the ED in the morning shift, while 109 (19.4%) were presented in the afternoon shift, and 282 (50.2%) were referred in the night shift. Distribution of the studied patients based on ESI levels is shown in Figure 1. Accordingly, the majority of the patients were categorized as ESI 3, and none of the patients were categorized as ESI level 5.

Outcome measures of hospitalization, mortality, and ED length of stay are presented in Table 1. According to our findings, there was a statistically significant correlation between increased rate of hospitalization and triage acuity level (Phi and Cramer's V= 0.350, P<0.001). The association was found to be stronger among men (Phi and Cramer's V=0.412, P<0.001) compared to women (Phi and Cramer's V=0.273, P=0.001). These values were estimated at 0.360 (P<0.001), 0.261 (P=0.024) and 0.396 (P<0.001) for morning, afternoon, and night shifts, respectively. Greater value of V for

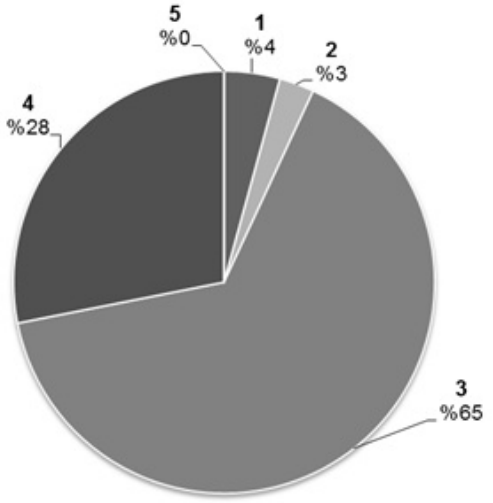

Figure 1. Distribution of patients based on ESI triage levels

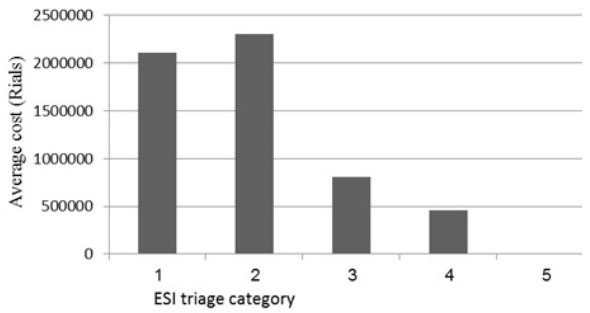

Figure 2. Mean cost of patient services in different triage levels

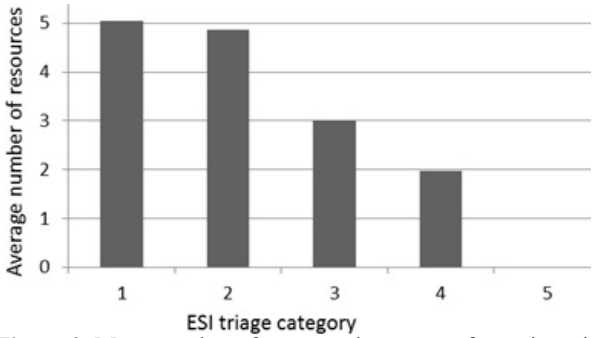

Figure 3. Mean number of consumed resources for patients in each triage level

the night shift denoted the fact that it is more likely for a patient with high level of triage acuity to be hospitalized during the night shifts.

Other results of this study were indicative of a significant correlation between the triage level and rate of in-hospital mortality (Phi and Cramer's V=0.345, P<0.001). As for hospitalization, the association was stronger among men (Phi and Cramer's V=0.383, P<0.001) compared to women (Phi and Cramer's V=0.278, P=0.001). Moreover, the most significant correlation was observed in the night shift (0.418, P<0.001) compared to the shifts in the morning (0.336, P<0.001) and afternoon (0.269, P=0.019).

In this study, no correlations were found between ED length of stay and ESI triage level (Rho=-0.015, P=0.362). Mean cost of patient services for each triage level in the Iranian currency (about 30,000 Iranian Rials equal to one US dollar) is depicted in Figure 2. In this study, a significant correlation was observed between the average cost of patient services and ESI triage level (Rho=-0.434, P<0.001). This association was stronger among women (Rho=-0.471, P<0.001) compared to men (Rho=-0.416, P<0.001).

With regards to working shifts, the most significant correlation was observed in the night shift (Rho=-0.468, P<0.001) compared to the shifts in the morning (Rho=-0.423, P<0.001) and afternoon (Rho=-0.458, P<0.001). Negative values indicated that increased patient service costs were associated with reduced ESI triage level.

According to our findings, triage level was directly correlated with resource consumption of ED patients (Rho=-0.411, P<0.001). In terms of working shifts, these values were estimated at -0.442 (P< 0.001) for women and -0.395 (P<0.001) for men, and they were determined at -0.332 (P<0.001), -0.528 (P<0.001), and -0.444 (P<0.001) for morning, afternoon and night shifts, respectively.

With respect to patient service costs, the association was stronger among women compared to men in terms of Rho values. Furthermore, morning shifts were associated with the lowest Rho values compared to other working shifts. In terms of patient service costs, the negative values were indicative of a reverse correlation between the triage level and resource consumption. Mean number of the consumed resources used for patients of each triage level is shown in Figure 3.

Discussion

According to the results of the present study, the ESI triage scale (version four) could accurately predict different outcome measures including hospitalization, mortality, resource consumption and cost of services. Significant correlations were observed between ESI triage level resource consumption and patient service costs, while ESI ratings could not predict the ED length of stay.

In the present study, hospitalization rate was found to increase with higher triage acuity (Table 1), which is in line with the findings of previous studies on pediatric, adult, geriatric and self-referred patient populations (3, 10, 15-19). However, evaluation of self-referred patients was indicative of a lower hospitalization rate in all ESI triage levels, which could be due to the low acuity of patient conditions (19). In other words, medical conditions

of the patients administered for in-patient care are considered to be more critical than those who are discharged from the ED or referred to outpatient clinics. Therefore, the correlation between the triage level and hospitalization rate indicate that the ESI triage could correctly distinguish patients with acute and non-acute conditions (17).

According to the results of the current study, higher acuity of ESI triage level was associated with higher mortality rate (Table 1). This finding is consistent with the results of previous studies in this regard (7, 20, 21). Higher correlation coefficient of hospitalization and mortality rates among male patients could be due to the over-triaging of female patients or under-triaging of male patients. On the other hand, the stronger association observed in the night shift may be due to the effect of different human factors. For instance, triage nurses engaged in morning and afternoon shifts are fixed, and the same nurse normally triages all the patients of each shift during the week. It is recommended that the potential effect of this factor be further investigated.

As expected, the results of the present study indicated that patients with higher acuity triage levels had higher medical service costs (Figure 2). Some studies have focused on the correlations between patient service costs and ESI triage level confirming the findings of the present study in this regard (11-13). Higher cost of services in female patients could be due to the fact that women are often more concerned about their condition and tend to ask physicians for more tests. This possibility was reinforced based on the obtained correlation coefficient value for resource consumption.

Similar to previous studies assessing ESI triage levels (9, 10, 15), level-two and level-three ESI patients had the highest ED length of stay, followed by level-one and level-four ESI patients (Table 1). This ED length of stay pattern could be applied to the management of medical staff and other resources at EDs (9). However, findings of the present study were indicative of no statistically significant correlation between ESI triage level and ED length of stay. This could be due to the fact that our study site was a tertiary referral hospital with high bed occupancy rates, and many patients who required hospitalization had to wait in the ED until a bed became available. It is noteworthy that about 30% (166 out of 562) of the patients in this cohort were hospitalized, which is a relatively high rate. In their studies, Baumann and Strout stated that ED length of stay among these patients could not be a proper outcome measure to assess the predictive validity of triage ratings (10).

One part of the ESI triage algorithm relies on predicting the resources required for the diagnosis and treatment of ED patients (5); therefore, accurate prediction of resources is of paramount importance. In the current study, a significant correlation was found between the triage level and actual resources used for ED patients. This finding was consistent with the results of previous studies in this regard (10, 15, 19). In another study, Tanabe et al. claimed that this correlation indicates that the available resources are well defined by the ESI team enabling triage nurses to accurately estimate the number of resources needed per patient (9).

Similar to the study by Tanabe et al. (9), the resources used for patients of each triage level were counted in the present study. On the other hand, some studies in this regard have graded the consumed resources as 0, 1, and higher (8, 19). In general, the method used in the current study seems to be comparatively more accurate.

In the present study, none of the ED patients were ranked as level-five ESI (Figure 1), which could be due to the fact that our study site was a tertiary hospital, and only patients with higher acuity levels were transferred to the ED. This is similar to the case reported in a tertiary hospital in Germany, in which level-five ESI patients constituted only 3% of all the patient referrals to the ED (21). Yet, the efficiency of ED nurses in the accurate triaging of the patients remains a matter of debate. In the current study, level-two ESI patients constituted only 3% of all ED referrals (Figure 1). It is possible that over-triage of level-five ESI patients moved them to the fourth level of ESI, and mistriage (under-triage) was the main cause of changing from the second level to the third level of ESI in some patients.

To the best of our knowledge, this was the first

study conducted to separately assess the correlations between different outcome measures and ESI triage levels in male and female ED patients and different hospital working shifts. Therefore, it is suggested that future studies be performed in order to confirm or challenge our findings, as well as to investigate the underlying causes of the reported correlations.

Study limitations

Although there were no statistically significant differences in the demographic characteristics of the included and excluded patients, the high exclusion rate was one of the limitations of the current study. The issue that 204 out of 848 patients left the ED without being seen by a physician or against medical advice requires the prompt attention of the participating ED. This problem could be due to the over-crowdedness of the ED, which occasionally causes non-urgent patients to refer to outpatient clinics instead. Moreover, in some cases, patients with urgent conditions may leave the ED after stabilization in order to receive medical procedures in a more favorable setting. It is recommended that future studies be conducted to clarify this issue. It is noteworthy that in one research performed at another tertiary care ED in Iran, rate of patient discharge against medical advice was reported to be 20% (22), which is similar to our findings.

Another cause of exclusion in the present study was lack of triage documentation in the medical records of the patients. In total, triage levels of 107 cases (12%) out of 848 patients enrolled in this study were not documented in their medical files. This indicates that the triage nurses do not give importance to documentation of patient data and the institutional regulations do not force them to do it.

To validate triage ratings with patient mortality, we evaluated in-hospital mortality in the current study, whereas in some studies, mortality rate of ED patients was assessed after six or 12 months (7, 10). Although assessing survival after a long time after an ED visit requires an accurate database, it proves the triage system's ability to predict long-term outcomes beside the short-term ones.

Conclusion

In conclusion, findings of the present study confirmed the efficacy of the ESI triage system in predicting outcome measures such as hospitalization, in-hospital mortality, resource consumption, and patient service costs in the Iranian teaching hospital setting. However, triage ratings could not predict ED length of stay. It is suggested that ED managers apply the patterns of triage levels and resource consumption, along with the time pattern of ED visitors, for more efficient arrangement of the human and physical resources at the ED.

Implications for practice

Efficacy of the ESI triage scale in predicting outcome measures enables ED administrators to use this system for preparation in the ED and the whole hospital. Furthermore, they could apply the distribution of ED patients within the ESI triage system as a predictor for the required facilities and amenities.

Implications for research

It seems that the accurate evaluation of ED length of stay requires further in-depth investigation. Lack of a statistical correlation between the triage level and ED length of stay could be due to factors such as the crowdedness of ED, inadequate triage skills, and lack of available inpatient beds.

Conflicts of interest

None declared.

Author's contributions

F Pourasghar, A Ala, and A Daemi collected the data, M Asghari Jafarabadi, F Pourasghar, and A Daemi performed data analysis and interpretation, and A Daemi wrote the first draft of the manuscript. F Pourasghar, JS Tabrizi, A Ala, and M Asghari Jafarabadi critically revised the manuscript, A Ala and JS Tabrizi provided administrative support, and F Pourasghar supervised the project.

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