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Original Contribution

Association of triage time Shock Index, Modified Shock Index, and Age Shock Index with mortality in Emergency Severity Index level 2 patients☆,☆☆,★

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ABSTRACT

Background: Shock Index (SI) is considered to be a predictor of mortality in many medical and trauma settings. Many studies have shown its superiority to conventional vital sign measurements in mortality prediction.
Objectives: The objectives were to compare mortality and intensive care unit admission prediction of triage time SI, Modified SI (MSI), and Age SI with each other and with triage time blood pressure in Emergency Severity Index (ESI) level 2 patients.
Methods: A retrospective medical record review was performed in the internal medicine emergency department of a general hospital in Kerman, Iran. Triage time vital signs were used to calculate the indices. Multivarible regression analysis was used to create the final model.
Results: A total of 1285 patients triaged to ESI level 2 were enrolled in the study. In the multivariate analysis, SI, MSI, and Age SI were found to be the only variables independently associated with mortality, whereas none of them were associated with intensive care unit admission. Sensitivity, specificity, and area under curve in the receiver operating characteristic curve for the model including SI, MSI, and Age SI were 60.8%, 65.4%, and 0.675, respectively. Sensitivity, specificity, and area under curve did not change significantly by excluding SI, MSI, or Age SI from the final model.
Conclusion: In nontrauma adult patients, triage time SI, MSI, and Age SI are superior to blood pressure for mortality prediction in ESI level 2. They can be used alone or in combination with similar results, but their low sensitivity and specificity make them usable only as an adjunct for this purpose.

1. Introduction

The Emergency Severity Index (ESI) system is a modern 5-level system for triage of patients presenting to the emergency departments (EDs). In this system, both the acuity of illness and resources needed for patient management are considered for labeling of the patients. Patients with life-threatening conditions are assigned as level 1, and those with high-risk states (confusion, disorientation, severe pain, or distress) are assigned as level 2. Otherwise, patients are categorized to level 3 (2 or more resources needed), level 4 (1 resource needed), or level 5 [1]. Differentiating between levels 2 and 3 is one of the most challenging tasks performed on a routine basis by triaging staff. This could be done by the assistance of vital sign measurement. Heart rate (HR) more than 100, respiratory rate more than 20, and blood oxygen saturation less than 92% are the criteria for assigning these patients as level 2 [2,3]. The validity and reliability of the ESI system for triage are studied extensively in different age groups [4–6].

Shock Index (*SI*), defined as HR divided by systolic blood pressure (SBP), is reported to be more useful in the assessment of ill-appearing patients than conventional vital sign measurement [7]. An increase in SI means a decreased left ventricular output and acute circulatory insufficiency. Persistent rises in SI are associated with increased mortality [8]. This index could be useful in predicting the severity of hypovolemic shock [9]. Numerous studies have unraveled potential benefits of using SI in predicting mortality and admission duration in trauma patients, predicting mortality in pneumonia, predicting ruptured ectopic pregnancy, categorization of pulmonary emboli patients, and predicting prognosis in acute myocardial infarction [10–17].

Modified Shock Index (*MSI*), defined as HR divided by mean arterial pressure (MAP), factors the role of diastolic blood pressure (DBP) into

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the SI calculation. Increased or decreased MSI may reflect the hypo- and hyperdynamic states of circulation, respectively, and is related to increased mortality in the ED [18].

Age Shock Index (*Age SI*), defined as age multiplied by SI, accounts for the age of the patient in addition to the factors addressed by SI. This index was shown to be correlated with a higher mortality rate when increased to more than 50 in trauma patients [19].

Utilization and the potential benefits of SI as a predictor of mortality and intensive care unit (ICU) admission were evaluated by many other studies as well, and its superiority to conventional vital sign measurements were demonstrated in most of them in prehospital and in-hospital settings in trauma and medical patients [20–23]. However, no study has yet focused on evaluating all of these indices (SI, MSI, and Age SI) in one patient population and comparing them with conventional vital sign measurement and with each other in a specific subgroup of triaged patients. In the present study, we have compared these 3 indices with blood pressure at triage time of an internal medicine ED in level 2 ESI patients to determine the association of each index with the mortality and ICU admission. We try to answer the following questions: First, are these indices superior to blood pressure measurement alone in their association with mortality or ICU admission? Second, may 1 of these 3 indices play a more important role in prediction of these adverse outcomes in relation to the others?

1.1. Why ESI level 2 patients?

Rationally, in critically ill level 1 patients, there seems to be a clear association between these indices and the outcome. Moreover, in levels 4 and 5, patients are expected to have vital signs in the reference range, so the calculation of shock indices in this population seems to be useless. The main existing challenge is for level 2 and 3 patients. Although unstable vital signs or higher shock indices may be hypothesized to be related to the adverse outcomes (eg, mortality) in all ESI categories, the aggressiveness of resuscitation and treatment the patient receives is not similar in different levels of triage. To reduce the confounding effect of resuscitation and treatment, we preferred to choose only 1 ESI level. We preferred level 2 over level 3 patients in the preprogramming of this study because we expected a higher number of outcomes (mortality and ICU admission) in this population relative to ESI level 3 patients, making comparisons and conclusions more sensible.

2. Methods and materials

2.1. Study design and settings

This was a retrospective medical record review performed in Afzalipoor Academic General Hospital. Afzalipoor Hospital is the main referral center for internal medicine, pediatrics, general and thoracic surgery, and obstetrics and gynecology in Kerman, a large city with a population of nearly 1 million in the southeast of Iran. Annual ED census for internal medicine patients—comprising our study population—is more than 45,000 in Afzalipoor Hospital. Our data were obtained from hand-recorded files of patients admitted to the ED after triage. Triage in Afzalipoor Hospital is performed by a qualified and instructed nurse and confirmed by a general practitioner or an internal medicine resident (postgraduate year 1). The system used for triage in our hospital is the 5-level ESI. Blood pressure is measured by automated cuff inflation method (oscillometric technique) in all patients; in patients with conditions that hinder obtaining reliable blood pressure by this device, measurement was performed by the triage nurse with a mercury-operated blood pressure cuff. Pulse rate and respiratory rate were measured by the triage nurse using radial pulse and chest wall movements over 1 minute, respectively.

According to Gilbert et al [24], we considered the following items for data collection: inclusion criteria (see "Participants and study outcome"), abstractor training, standardized abstraction forms, periodic abstractor monitoring, and abstractor blinding to our hypotheses. The abstractor of recorded files was a trained nurse with 2 years of experience in data abstraction blinded to our study objectives and hypotheses. A predesigned data sheet was used by the abstractor to fill the required fields using the original recorded files. Periodic monitoring was done by random sampling of recorded files and completed sheets by an attending physician of emergency medicine. In 11 cases, there was some disagreement solved by reviewing of original records by both investigators. Because there was one abstractor for all files, no concerns about interobserver agreement was present in this study. Calculations of SI, MSI, and Age SI were done by an attending physician of emergency medicine using a simple electronic calculator (see "Introduction" for details of calculations). There was no random monitoring for calculations.

This study was conducted in accordance with the Declaration of Helsinki (1975) revised in Hong Kong (1989).

2.2. Participants and study outcome

All patients older than 14 years admitted to the internal medicine ED between 21 March 2012 and 20 March 2013 with ESI triage level 2 were included in the study. The documented vital signs by the triage nurse were used for calculation of SI, Age SI, and MSI. In-hospital mortality and ICU admission were defined as the primary and secondary outcomes of this study, respectively. Intensive care unit admission was chosen to be a secondary outcome because there may be some differences in interpretation among several physicians for labeling patients "ICU admitted."

2.3. Definition of variables

Age, sex, SBP, DBP, pulse pressure (PP), SI, MSI, and Age SI were the variables considered to be potentially correlated with the outcomes in ESI level 2 patients. These variables are considered quantitatively for their association with mortality and ICU admission regardless of cutoff points determined by previous studies (see "Results").

2.4. Statistical analysis

For description of quantitative variables with normal and nonnormal distribution, mean (± SD) and median (± interquartile range) were used, respectively. For qualitative (categorical) variables, percentage of frequency was used. Odds ratio (OR) and 95% confidence interval (CI) for expressing the severity of this association were used.

A P value of less than .05 was considered statistically significant in all statistical tests. All variables with a P value of less than .25 in the t tests and χ^2 tests were included in the logistic regression model (both univariate and multivariate) [25]. The final multivariate model was created by the backward conditional method. SPSS version 16.0 (SPSS Inc, Chicago, IL) was used for analysis.

3. Results

3.1. Basic characteristics

A total of 47,395 patients presented to the internal medicine ED during the period of study. The triage staff distributed the patients into the 5 levels of triage, as follows: 275 (0.6%) as level 1; 1285 (2.8%) as level 2; 3375 (7.1%) as level 3; 10,679 (22.5%) as level 4; and 31,800 (67%) as level 5. From 1285 patients triaged as ESI level 2, 565 (44%) were female and 720 (56%) were male with a mean (± SD) age of 57.72 (± 20.29) years, with 201 (15.6%) expired cases during hospital admission. Table 1 shows the descriptive data regarding ESI level 2 patients. The ICU admission rate was 7.9% (101 patients).