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Investigation of the effectiveness of the Quick Sequential Organ Failure Assessment-Troponin scores in non- ST-elevation myocardial infarction

Başar Cander[1], Bahadır Taşlıdere[1*], Ertan Sönmez[1]

SUMMARY

OBJECTIVE: A reliable predictor is needed for non-ST-elevation myocardial infarction patients with high mortality risk. The aim of this study was to assess the effectiveness of the Global Registry of Acute Coronary Events and Quick Sequential Organ Failure Assessment-Troponin (qSOFA-T) scores on in-hospital mortality rate in non-ST-elevation myocardial infarction patients.

METHODS: This is an observational and retrospective study. Patients admitted to the emergency department with acute coronary syndrome were evaluated consecutively. A total of 914 patients with non-ST-elevation myocardial infarction who met inclusion criteria were included in the study. The Global Registry of Acute Coronary Events and qSOFA scores were calculated and investigated its contribution to prognostic accuracy by adding cardiac troponin I (cTnI) concentration to the qSOFA score. The threshold value of the investigated prognostic markers was calculated by receiver operating characteristic curve analysis.

RESULTS: We found the in-hospital mortality rate to be 3.4%. The area under the receiver operating characteristic curve for Global Registry of Acute Coronary Events and qSOFA-T is 0.840 and 0.826, respectively.

CONCLUSION: The qSOFA-T score, which can be calculated easily, quickly, and inexpensively and obtained by adding the cTnI level, had excellent discriminatory power for predicting in-hospital mortality. Difficulty in calculating the Global Registry of Acute Coronary Events score, which requires a computer, can be considered a limitation of this method. Thus, patients with a high qSOFA-T score are at an increased risk of short-term mortality.

KEYWORDS: Acute coronary syndrome. Troponin I. Mortality. Non-ST elevated myocardial infarction.

INTRODUCTION

Chest pain constitutes a significant portion of all emergency department (ED) admissions[1]. Approximately 5–20% of patients who enter the ED with chest pain (typical or atypical) are diagnosed with acute coronary syndrome (ACS)[2]. This syndrome is one of the leading causes of death[3]. Even in ACS patients with timely medical intervention, 1-year mortality is 5%, and in-hospital mortality is 7.5%[4]. Approximately 70% of all ACS present as non-STEMI (ST-elevation myocardial infarction)[5]. The international cardiac guidelines recommend that patients presenting to the ED with chest pain should be evaluated using a risk score[6]. A frequently used and high-performing tool for this purpose is the Global Registry of Acute Coronary Events (GRACE)[7]. The GRACE identifies risk factors that help independently predict in-hospital and 6-month mortality rates. The score is calculated based on clinical parameters such as creatinine, troponin value, Killip class, and vital signs. The Quick Sequential Organ Failure Assessment (qSOFA) tool was developed to predict the prognosis and need for intensive care in sepsis patients. The qSOFA measurement is a simple score composed of three parameters, i.e., respiratory rate, Glasgow Coma Scale, and blood pressure[8]. Many studies have shown that the qSOFA score can be used to predict the need for intensive care and the probability of mortality[9]. Serum cardiac troponins are used to verify a diagnosis of ACS and predict its prognosis[10]. But a more reliable predictor is needed for ACS patients with high mortality risk. Therefore, we investigated the prognostic accuracy of the qSOFA score by adding cTnI concentration (as a fourth parameter). The aim of this study was to assess the effectiveness of the GRACE and qSOFA-T scores on in-hospital mortality rate in non-STEMI patients.

METHODS

This study was conducted retrospectively between January 1, 2016, and December 31, 2018, on patients over the age of 18 years who were admitted to the ED. All patients who presented to the ED with ACS were evaluated consecutively (symptoms

[1]Bezmiâlem Vakıf Üniversitesi, Faculty of Medicine, Department of Emergency Medicine – İstanbul, Turkey.
*Corresponding author: drbahadir@yahoo.com
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determined by the American Heart Association). Patients diagnosed with non-STEMI were included in the study. Informed consent was waived (a retrospective study). This is an observational study, in accordance with the Declaration of Helsinki. The Ethics Committee's approval was obtained. Patient information was obtained using the International Classification of Diseases (*ICD*)-10. The study excluded patients with trauma, pregnant women, patients with missing data, patients whose scores could not be calculated, patients with STEMI, patients with unstable angina pectoris (USAP), and patients with a Charlson Comorbidity Index (CCI) score of 3 or higher. The CCI is a useful measure of comorbidity to standardize the evaluation of patients. Infectious pathologies affecting the qSOFA score were excluded. A total of 1,996 patients were evaluated. Of these, 126 were discharged from the ED. There were 641 patients with a CCI score of 3 or higher, 126 had chest pain due to other causes, 146 patients were hospitalized in non-cardiology departments, and 43 refused treatments.

Definitions and variables

All patients were managed as per the institutional protocol. The blood sample and scores were calculated in the first 6 h of observation in the ED. Documentation that was previously produced was used to record the collected variables, including demographic data, comorbidities, laboratory test results, vital parameters, and physical examination findings. The GRACE and qSOFA scores were calculated. We selected the GRACE score, which is recommended for long-term prognosis and mortality prediction, as the appropriate score for comparison. GRACE score parameters include age, heart rate, blood pressure, Killip class, ST segment, creatinine, and troponin level. By definition, the qSOFA score consists of three parameters, namely, blood pressure, respiratory rate, and Glasgow Coma Scale[9]. We defined the qSOFA-T score by combining these characteristics with the troponin value. Anyone with a cTnI value greater than 40 ng/L received 1 point (the value where the corporate reference value is positive). The precision of the qSOFA-T score obtained by adding troponin to the qSOFA score has never been investigated in any previous study. Two emergency medicine physicians worked independently during the acquisition of the data. The serum high-sensitive cTnI levels were based on patients' baseline values at admission (the normal reference range in our biochemistry laboratory was 0–40 ng/L; Abbott Lab., Chicago, IL, USA). Receiver operating characteristic (ROC) curve analysis was used to determine the threshold value for the prognostic markers (GRACE score and qSOFA-T score) that were investigated in the study. All patients with ACS who required cardiac follow-up constituted the study sample (medical or CABG in their follow-up). In a sample of size n=869, we had 80% power at an α value of 0.05 to find a difference of 1%.

Statistical analysis

Centralization and measures of variance, such as mean±standard deviation (SD), were used to express quantitative variables. Fisher's exact test and the chi-square test were used to identify differences in the ratios and relationships between categorical variables. To determine the behavioral differences in the group averages, the Mann-Whitney U test was used when the assumptions of normality and equivalence were not met. The ROC analysis was used to determine the threshold values of the numerical parameters that were used to predict disease status and to evaluate the indicators' accuracy. The statistical significance level was set at p=0.05 and below. For this purpose, the IBM SPSS Statistics for Windows software package (Armonk, NY) was used. Distribution statistics for the categorical demographic variables are shown as n (%), and distribution statistics for the numerical variables are shown as mean±SD// median (min-max).

RESULTS

Of the 914 patients, 628 (68.7%) were male and 286 (31.3%) were female (p=0.478). The mean age was 52.95±13.73 years (p=0.003). The number of in-hospital deaths was 31 (3.4%). The most common chronic diseases in deceased patients were coronary artery disease, hypertension, and diabetes mellitus, and in living patients, they were hypertension, diabetes mellitus, and coronary artery disease. There was no statistically significant difference between the hemogram and routine biochemistry tests between the two groups. The mean GRACE score in the in-hospital deceased group was 149.77±29.31. In the survivor group, it was found to be 103.3±34.58 (p<0.001) (Table 1). The mean qSOFA-T score for the in-hospital deaths group was 2.03±1.09. It was calculated as 1.09±0.34 in the survivor group (p<0.001) (Table 1). The GRACE score has already been a proven prognostic scoring system. In our study, the area under the ROC curve was 0.840 (95% confidence interval (CI): 0.782–0.899) with a cutoff value of 139.5. The ROC analysis was also performed to determine whether the qSOFA-T

Table 1. Risk scores.

	Deceased patients	Living patients	p
GRACE score	149.7±29.3	103.3±34.5	<0.001
qSOFA-T	2.03±1.09	1.09±0.34	<0.001

score had a diagnostic value for in-hospital mortality. The area under the ROC curve was 0.826 (95%CI 0.743–0.91) with a cutoff value of 1.5 (Table 2; Figure 1). Considering the area covered by the ROC curve, the GRACE score was 139.5 and the qSOFA-T score was 1.5.

DISCUSSION

When compared to participants in similar previous studies, our patients were younger, more often male, and had similar prevalence rates of diabetes and hypertension[11]. This study examined the predictive value of GRACE score, and qSOFA-T score in a large sample of patients who were diagnosed with non-STEMI. qSOFA is widely used to predict mortality in many diseases. For example, it has been demonstrated to have a significant correlation with mortality from conditions such as acute decompensated heart failure and sepsis[12]. These successful results were due to the precise selection of the reviewed parameters. Systolic blood pressure is a combination of cardiac output and systemic peripheral resistance. A normal-to-high measurement may indicate better-preserved cardiac function. Another parameter, respiratory rate, was found to be a predictor of mortality in patients with ACS in selected studies[13], owing to changes in respiratory control due to cardiac dysfunction manifested themselves as an increase in respiratory rate. This suggests that respiratory rate should be included in risk assessment strategies for patients with ACS[14]. Many studies[15] have shown that the third parameter, the Glasgow Coma Scale, has a predictive value for survival after hospital discharge. Despite these features, the effectiveness of the qSOFA score in determining prognosis in ACS (especially non-STEMI) patients at high risk of adverse events has not been adequately studied. To increase the logistic regression power of qSOFA, we added the cTnI level as a fourth parameter in the score. In doing so, we found that the AUC of the qSOFA-T score reached 0.826 (an excellent discriminatory power). As a result, the qSOFA-T score is appropriate for use in EDs since it is easy, quick, inexpensive, and effective. Studies have shown that the GRACE score has the highest predictive accuracy for mortality in patients with ACS[16]. In addition, the European Society of Cardiology guideline accepts GRACE as a method of risk scoring. GRACE score has been thoroughly validated for assessing prognosis in non-STEMI, based on registries and large trials[16]. Our study found that the AUC of the GRACE score was 0.840 (the qSOFA-T score was found to be 0.826). When the results obtained are found to be 0.8≤AUC<0.9, it indicates excellent discriminating power[17]. In a similar study, GRACE score (AUC=0.80) for non-STEMI patients was found to have excellent discriminatory power[18]. The qSOFA-T score has never been studied before for predicting mortality in ACS patients. According to the study, both scores can be used to identify patients at high risk of coronary events in the context of non-STEMI. In a study, it was shown that a GRACE score >133 is significant in terms of acute conditions[19]. In our study, the mean GRACE score in the in-hospital mortality group was 149.77 with a cutoff value of 139.5. According to GRACE's guidelines, in-hospital mortality is above 3% when the score is above 140 points[20]. In our study, this rate was similarly found to be 3.4%. The mean value for qSOFA-T was 2.03 with a cutoff value of 1.5. For this reason, it is necessary to ensure that the qSOFA-T score is positive for at least two of the four parameters.

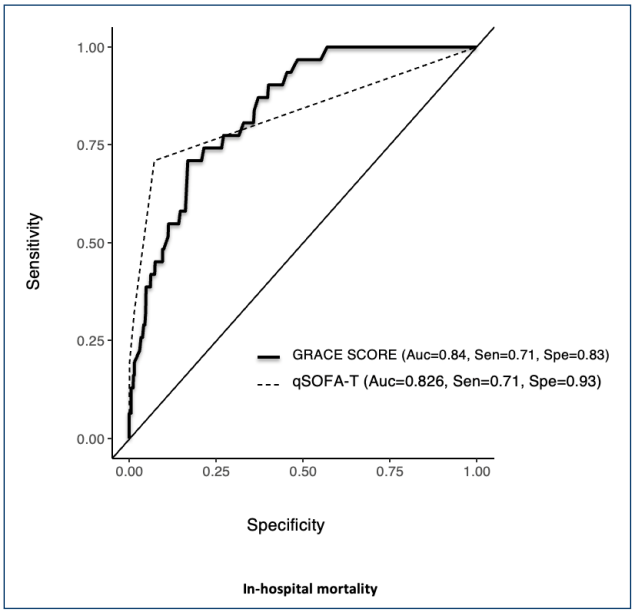

Figure 1. Comparison of in-hospital mortality using Global Registry of Acute Coronary Events and qSOFA-T.

Table 2. Comparison of scores by receiver operating characteristic analysis.

Variable	AUC	95%CI	Sensitivity	Specificity	Threshold
GRACE score	0.840	0.782–0.899	0.710	0.831	139.5
qSOFA-T score	0.826	0.743–0.91	0.710	0.928	1.5

Limitations

One limitation is that this is a single-center and retrospective design study. Second, anyone with a cTnI value above 40 received 1 point. This could be a bias point.

CONCLUSION

A reliable predictor is needed for non-STEMI patients with mortality risk. The GRACE score is a previously known score with proven effectiveness. Difficulty in calculating the GRACE score, which requires a computer, can be considered a limitation of this method. The qSOFA-T score, obtained by adding cTnI level to the qSOFA score, has excellent discriminatory power for predicting in-hospital mortality. The AUC of the GRACE score was 0.840, and the AUC of the qSOFA-T score was 0.826; both scores had excellent discriminatory power for predicting in-hospital mortality ($0.8 \leq AUC < 0.9$, an excellent discriminating power). In estimating the qSOFA-T score as a predictor of in-hospital mortality, the cutoff value was 1.5, and the mean value was 2.03. Care should be taken if the calculated qSOFA-T score is 2 or higher. According to the results of this study, patients who have a high qSOFA-T score, which can be calculated easily, quickly, and inexpensively, are at a higher risk of short-term mortality.

ETHICAL APPROVAL

The study was approved by the ethics committee of the Bezmialem Vakif University (approval number 2022-45; dated August 2, 2022).

HUMAN RIGHTS STATEMENTS AND INFORMED CONSENT

All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation and with the Helsinki Declaration of 1964 and its later amendments. Informed consent was obtained from all patients to participate in the study.

AUTHORS' CONTRIBUTIONS

BT: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **ES:** Formal Analysis, Project administration, Resources, Writing – original draft, Writing – review & editing. **BC:** Data curation, Formal Analysis, Supervision.

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