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Original Research

PREDICTIVE VALUE OF THE ACTION ICU SCORE FOR INTENSIVE CARE UNIT ADMISSION IN PATIENTS WITH NON-ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION

Vo Thi Quyen[1], Trinh Thi Hang[1,*]

1. Xuyen A General Hospital, Ho Chi Minh City, Vietnam

* *Corresponding author: Trinh Thi Hang, MD* ✉ *trinhthihang.y2012@gmail.com*

ABSTRACT: Older patients (≥65 years old) with non-ST-segment elevation myocardial infarction (NSTEMI) have a high risk of in-hospital complications. This study aimed to evaluate the predictive value of the ACTION ICU score for the need for ICU admission in this patient population. This was a retrospective, descriptive, cross-sectional study of 122 patients ≥65 years old diagnosed with NSTEMI and hemodynamically stable upon admission at Nhan dan Gia Dinh Hospital from January 2022 to December 2023. The primary endpoint was a composite outcome including cardiac arrest, shock, respiratory failure requiring mechanical ventilation, high-degree atrioventricular block requiring a pacemaker, stroke, or in-hospital death. The predictive value of the ACTION ICU score was assessed using receiver operating characteristic (ROC) curve analysis. The mean ACTION ICU score in the group with complications was significantly higher than in the group without complications (11.6 ± 3.5 vs. 7.5 ± 3.3; $p < 0.001$). The ACTION ICU score showed good predictive ability with an area under the ROC curve (AUROC) of 0.792 (95% CI: 0.688–0.896). The optimal cutoff score was ≥11 points, with a sensitivity of 63.6%, a specificity of 82.0%, a positive predictive value of 43.8%, and a negative predictive value of 91.1%; The ACTION ICU score is a simple and clinically useful tool for risk stratification, helping to predict the need for ICU admission in older NSTEMI patients in Vietnam. The use of this score can support clinical decisions, contributing to a more effective use of ICU resources.

Keywords: non-ST-segment elevation myocardial infarction; ACTION ICU score; elderly; prognosis; intensive care unit.

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1. INTRODUCTION

Non-ST-segment elevation acute myocardial infarction (NSTEMI) accounts for 60–70% of hospitalizations for acute myocardial infarction[1]. Although advances in revascularization and medical therapy have reduced mortality rates, a significant proportion of patients still experience severe in-hospital events that necessitate admission to the intensive care unit (ICU), especially in the elderly population. Traditional prognostic scores such as TIMI (Thrombolysis In Myocardial Infarction) and GRACE (Global Registry of Acute Coronary Events) have been widely used; however, they are primarily designed to predict the risk of death or reinfarction, not to directly predict the need for ICU admission[2, 3].

The ACTION ICU score was developed by Fanaroff et al. in 2018 to predict the risk of ICU admission in NSTEMI patients aged ≥65 years[4]. This score is based on 9 simple clinical and laboratory variables that are easily obtainable in the emergency department, including: age, heart rate, systolic blood pressure, signs of heart failure, serum creatinine, troponin level, ST-segment depression on electrocardiogram (ECG), history of coronary revascularization, and chronic obstructive pulmonary disease. The ACTION ICU score predicts outcomes including: cardiac arrest, shock, high-degree atrioventricular block requiring a pacemaker, respiratory failure requiring mechanical ventilation, stroke, and death. Accurate risk stratification of NSTEMI patients to decide on ICU admission is of significant importance. Therefore, we conducted this study to determine the predictive value of the ACTION ICU score in NSTEMI patients aged ≥65 years.

2. METHODS

2.1. Study Population

The study was conducted on 122 patients ≥65 years old diagnosed with NSTEMI, treated at the Department of Cardiology, Nhan dan Gia Dinh Hospital from January 2022 to December 2023.

2.2. Inclusion Criteria

Patients ≥65 years old were diagnosed with NSTEMI according to the Fourth Universal Definition of Myocardial Infarction[5] and consented to participate in the study after being fully informed.

2.3. Exclusion Criteria

Patients who had events requiring intensive care unit admission at the time of hospitalization, including: cardiac arrest, shock, atrioventricular block requiring a pacemaker, stroke, respiratory failure requiring invasive or non-invasive ventilation. Patients transferred to another hospital before the occurrence of an in-hospital event requiring intensive care unit admission.

2.4. Study Design and Methods

This was a retrospective, descriptive, cross-sectional study. Data were systematically collected from medical records. The independent variables included the 9 components of the ACTION ICU score: age, heart rate, systolic blood pressure, signs of heart failure on admission (defined as Killip class ≥ II), serum creatinine level, cardiac troponin level (calculated as the multiple of the upper limit of the laboratory's reference range), ST-segment depression on ECG (defined as ST-segment depression ≥ 0.05 mV in at least two contiguous leads), a history of chronic obstructive pulmonary disease, and a history of coronary revascularization (percutaneous or surgical bypass).

The primary outcome variable of the study was the occurrence of at least one of the following 6 clinical conditions during hospitalization: cardiac arrest, shock, respiratory failure requiring mechanical ventilation (invasive or non-invasive), high-degree atrioventricular block requiring a temporary pacemaker, stroke, and in-hospital death (including cases of severe illness for which the family requested discharge).

2.5. Statistical Analysis

Data were entered and processed using SPSS software version 20.0. Quantitative variables were presented as mean ± standard deviation (if normally distributed) or median [interquartile range] (if not normally distributed). Qualitative variables were expressed as frequency and percentage (%). The independent T-test or Mann-Whitney U test was used to compare quantitative variables between

the two groups. The Chi-square ($\chi 2$) test or Fisher's exact test was used for qualitative variables. The statistical significance level was set at $p < 0.05$.

To evaluate the predictive value of the ACTION ICU score, the area under the curve (AUROC) and 95% confidence interval (CI) were calculated. The Youden index was used to determine the optimal cut-off point. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were also calculated for different cut-off points.

2.6. Ethical Approval

The study was approved by the Institutional Review Board of the University of Medicine and Pharmacy at Ho Chi Minh City (Approval No. 1295/HĐĐĐ, dated December 25, 2023) and the Ethics Committee of Nhan dan Gia Dinh Hospital (Approval No. 45/NDGĐ-HĐĐĐ, dated April 10, 2024).

3. RESULTS

3.1. Characteristics of the Study Population

Through the analysis of 122 acute myocardial infarction patients, we recorded a median age of 76 [68 – 84.6] years, with females being predominant at 63.9%. Among comorbidities, hypertension had the highest prevalence at 85.2% (104 patients), followed by dyslipidemia at 68.9% (84 patients), diabetes mellitus at 35.2% (43 patients), chronic heart failure at 39.3% (48 patients), chronic obstructive pulmonary disease at 7.4% (9 patients), a history of coronary intervention at 5.7% (7 patients), and smoking at 14.8% (18 patients) (Table 1).

Table 1. General Characteristics of the Study Population (n=122)

Characteristic	Value
Age, Median [IQR]	76 [68 – 84.6]
Female, n (%)	78 (63.9%)
BMI (kg/m^2), Median [IQR]	21.4 [18.8 - 23.7]
Hypertension, n (%)	104 (85.2%)
Dyslipidemia, n (%)	84 (68.9%)
Diabetes mellitus, n (%)	43 (35.2%)
Chronic heart failure, n (%)	48 (39.3%)
COPD, n (%)	9 (7.4%)
History of PCI, n (%)	7 (5.7%)
Smoking, n (%)	18 (14.8%)

IQR: Interquartile Range; BMI: Body Mass Index; COPD: Chronic Obstructive Pulmonary Disease; PCI: Percutaneous Coronary Intervention.

Table 2. Characteristics of Patients With and Without In-hospital Complications

Characteristic	Overall	With Complications (n=22)	Without Complications (n=100)	p-value
Heart failure symptoms (Killip ≥ II), n(%)	54 (44.2%)	17 (77.3%)	37 (37%)	0.001a
Heart rate (beats/min) (Mean ± SD)	100.3 ± 23	106.2 ± 31.3	98.9 ± 20.7	0.311b
SBP (mmHg) Median [IQR]	150 [123-170]	135 [117.5-160]	150 [130-170]	0.046c
ST depression on ECG, n(%)	63 (51.6%)	16 (72.7%)	47 (47.0%)	0.029a
LVEF (% Simpson) Median [IQR]	41.5 [34-60]	37 [32-40]	45 [34.2-60]	0.042c
Troponin (multiple of ULN), Median [IQR]	9.2 [2.3-37]	20.5 [3.1-59.4]	8.45 [5.8-27.9]	0.136c
Creatinine (mg/dL) Median [IQR]	1.2 [0.9-1.7]	1.4 [1.1-1.8]	1.2 [0.9-1.7]	0.121c

a: Chi-square test, b: T-test, c: Mann-Whitney U test

At the time of admission, the group with complications had a significantly higher rate of clinical heart failure (Killip ≥ II) (77.3% vs. 37.0%, p=0.001), a lower median systolic blood pressure (SBP) (135 mmHg vs. 150 mmHg, p=0.046), a higher rate of ST-segment depression on ECG (72.7% vs. 47.0%, p=0.029), and a lower median left ventricular ejection fraction (LVEF) (37% vs. 45%, p=0.042) (Table 2).

There were 22 patients with in-hospital complications, accounting for 18.0%. The most common complication was respiratory failure requiring ventilatory support (9.8%), followed by shock (7.4%), death or discharge against medical advice (4.1%), cardiac arrest (1.6%), atrioventricular block requiring a pacemaker (1.6%), and stroke (1.6%). A key point is the timing of these events. Analysis showed that most complications (19/22, or 86.4%) occurred within the first 24 hours of hospitalization. This highlights the very narrow critical window for monitoring and intervention, which requires an early and effective risk stratification tool (Table 3).

Table 3. In-hospital Complication Rates Requiring ICU Admission (n=122)

In-hospital Complication	n (%)
Cardiac arrest	2 (1.6%)
Shock	9 (7.4%)
Respiratory failure requiring invasive or non-invasive ventilation	12 (9.8%)
Atrioventricular block requiring a pacemaker	2 (1.6%)
Stroke	2 (1.6%)
Death/Discharge against medical advice	5 (4.1%)

3.2. Predictive Value of the ACTION ICU Score

The mean ACTION ICU score for the entire study population was 8.3 ± 3.7. When analyzed by group, the mean score in the group with complications (11.6 ± 3.5) was statistically significantly higher than in the group without complications (7.5 ± 3.3) ($p < 0.001$) , indicating a strong association between the score and the risk of events.

ROC curve analysis showed that the ACTION ICU score had good discriminatory ability between patients with and without complications, with an area under the curve (AUROC) of 0.792 (95% CI: 0.688-0.896; $p < 0.001$) (Figure 1).

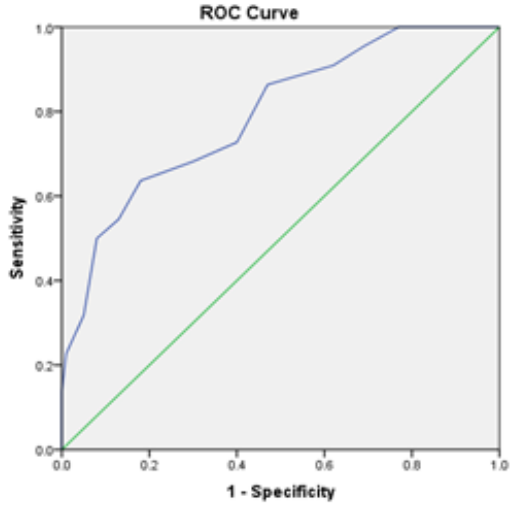

Figure 1. The ROC curve of the ACTION ICU score

Based on the Youden index, the optimal cutoff point for the ACTION ICU score in this study population was determined to be ≥11 points. At this threshold, the score had a sensitivity of 63.6%, a specificity of 82.0%, a positive predictive value (PPV) of

Table 4. Sensitivity, specificity, positive predictive value, and negative predictive value of the ACTION ICU score at each cutoff point

Cutoff	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
9 points	72.7	60.0	28.6	90.9
10 points	68.2	70.0	33.3	90.9
11 points	63.6	82.0	43.8	91.1
12 points	54.5	87.0	48.0	89.7
13 points	50.0	92.0	57.9	89.3

43.8%, and a very high negative predictive value (NPV) of 91.1% (Table 4).

4. DISCUSSION

This study is the first in Vietnam to evaluate and validate the value of the ACTION ICU score in older NSTEMI patients. The main findings show that this score is an effective prognostic tool, with good discriminatory ability (AUROC = 0.792) for the need for ICU admission due to serious in-hospital events.

The AUROC value of 0.792 in our study is consistent with and reinforces the results from previous international studies, such as the score's development study by Fanaroff et al. (AUROC 0.73) and a cohort study in Colombia by Juan Felipe et al. (AUROC 0.78))[4,6]. These consistent findings suggest that the ACTION ICU score demonstrates good external validity and applicability across different populations, including Vietnamese patients.

The in-hospital complication rate in our study was 18.0%, which is higher than that in Fanaroff's study (14.2%). This difference can be explained by considering the baseline characteristics of the study population. Our patient cohort had a significantly higher prevalence of a history of chronic heart failure (39.3% vs. 23.0%) and a higher rate of acute heart failure symptoms on admission (Killip ≥ II) (44.2% vs. 25.2%) compared to Fanaroff's study. This suggests that older NSTEMI patients in Vietnam have a more advanced cardiovascular disease background at the time of admission, leading to a higher risk of adverse events.

From a clinical application perspective, the ACTION ICU score, with its 9 simple variables, can be calculated quickly in the emergency department, providing an objective method to support initial clinical assessment. The cutoff point of ≥11 points, with a very high negative predictive value (91.1%), is a powerful tool to "rule out" patients at risk of events. Patients with a low score (<11) can be treated in a regular cardiology ward, thereby freeing up ICU beds for those who truly need them.

The result that 86.4% of events occurred within the first 24 hours of hospitalization also emphasizes the importance of early risk stratification. This finding supports the ESC recommendation for continuous monitoring during the first 24–48 hours in NSTEMI patients, particularly those classified as high-risk according to the ACTION ICU score. The application of this score can proactively place high-risk patients in an environment with intensive monitoring from the start, rather than passively waiting for signs of deterioration.

This study has some limitations that should be considered. First, the retrospective design may lead to information bias due to dependence on the quality of medical record keeping. Second, this is a single-center study, so the results may not be fully generalizable to other hospitals with different patient characteristics and resources. Finally, the sample size is relatively small (n=122), which, although statistically sufficient for ROC analysis, may limit the ability to detect weaker associations in more detailed analyses.

To address these limitations, prospective, multicenter studies in Vietnam are needed to re-confirm these results in a larger and more diverse population. Future studies could also evaluate the actual impact of applying the ACTION ICU score on clinical outcomes, length of hospital stay, and treatment costs.

5. CONCLUSION

The ACTION ICU score is a valuable, simple, and effective risk stratification tool for predicting the need for intensive care unit admission in older patients with non-ST-segment elevation myocardial infarction in Vietnam. With an area under the ROC curve of 0.792 (95% CI: 0.688-0.896; p < 0.001), the score shows good predictive ability. A cutoff point of ≥11 points helps to identify the high-risk group that requires intensive monitoring, while also allowing the safe classification of low-risk patients into regular care units, thereby contributing to the optimization of healthcare resource utilization.

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