Heart & Lung 57 (2023) 124–129

Contents lists available at ScienceDirect

Heart & Lung

journal homepage: www.heartandlung.com

Risk of complications after a non-ST segment elevation acute myocardial infarction in a Latin-American cohort: An application of the ACTION ICU score

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ARTICLE INFO

Article History:
Received 16 February 2022
Revised 6 September 2022
Accepted 7 September 2022
Available online 29 September 2022

Keywords:
Coronary care unit
Acute coronary syndrome
Cardiogenic shock
Non-ST segment elevation
Acute myocardial infarction

ABSTRACT

Background: European Society of Cardiology (ESC) guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation (NSTEMI) recommend Intensive Care Unit (ICU) surveillance during the first 24–48 h. Interestingly, the in-hospital mortality of NSTEMI patients has consistently decreased, giving some patients the option to be managed in general hospital wards. The ACTION ICU score has been proposed to identify high-risk patients with NSTEMI and guide the selective risk-based need for ICU care.
Objective: To evaluate the usefulness of the ACTION ICU score to predict patients' risk of developing complications requiring ICU care in a Latin-American cohort with NSTEMI.
Methods: We applied the ACTION ICU score in a retrospective cohort. A composite primary outcome included: cardiorespiratory arrest, shock, high-grade atrio-ventricular block, respiratory failure, stroke, or death. The predictive performance of this model was estimated with a conditional multivariable logistic regression analysis.
Results: Of 1,062 patients with NSTEMI, the primary outcome was present in 75 patients (7.1%), and 1,019 (96%) were admitted to ICU. The most common event was respiratory failure (4.0%), followed by cardiogenic shock (3.7%), and cardiac arrest (1.7%). The presence of heart failure signs or symptoms had the highest association with the primary outcome (OR:2.16; 95%CI:1.61–2.92). The best cut-off point for this population was 3 (complications risk: 4.0%, SEN:96%, SP:15.4%, NPV:98.1%, PPV:7.9%).
Conclusion: The ACTION ICU score may be a promising tool to identify the need for ICU care in Latin-American patients with NSTEMI. Furthermore, additional research is needed to evaluate the cost-effectiveness of this strategy.

Introduction

Cardiovascular disease is a leading cause of morbidity and mortality worldwide;[1,2] with 179 incident events per 100,000 person-year.[3] Nowadays, non-ST segment elevation myocardial infarction (NSTEMI) is one of the main manifestations of cardiovascular disease, accounting for 60%–70% of myocardial infarction hospitalizations.[4] With the advent of high-sensitivity troponin assays, the diagnosis of NSTEMI has increased.[5] Therefore, it becomes a priority to evaluate, classify and assign patients with NSTEMI promptly to the appropriate hospital routes to ensure timely and efficient attention according to the severity of the diagnosis.

European Society of Cardiology (ESC) guidelines for the management of patients with NSTEMI recommend Intensive Care Unit (ICU) surveillance during the first 24 to 48 h.[6] However, in-hospital

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https://doi.org/10.1016/j.hrtlng.2022.09.002

mortality due to NSTEMI has been consistently decreasing between 2001 and 2011 as follows: from 4.97% to 2.91% in patients treated with coronary artery bypass graft (CABG), from 1.73% to 1.45% in patients who underwent percutaneous coronary intervention (PCI), and from 8.87% to 6.26% in patients undergoing medical treatment alone. As a result, the in-hospital mortality from NSTEMI has recently been estimated at 3.4%.[7]

Some analyses revealed that the value attributable to ICU care after an acute coronary event varies between 23% - 45% of the total cost of hospitalization.[8] In Colombia, this amount corresponds to 2050 USD, with an average ICU length of stay (LOS) of 60 h.[9] In developed countries such as Switzerland, this trend is mantained with an approximate value of 2660 USD and a similar average LOS .[10] Reducing the number of patients requiring ICU surveillance could be a beneficial and effective way to decrease the cost associated with the disease. Based on the statistics described above, the well-judged selection of high-risk patients with NSTEMI for ICU admission is critical for the efficient use of resources.

The ACTION ICU score is a tool developed by Fanaroff et al.[11] The score was derived from the ACTION quality improvement registry (**A**cute **C**oronary **T**reatment and **I**ntervention **O**utcomes **N**etwork), which evaluated 29,973 admissions of patients older than 65 years with NSTEMI between April 1, 2011, and December 31, 2012. The ACTION ICU score uses 9 variables to assign a total score ranging from 0 to 19 (Table 1). The 9-variable predictive model was applied at the time of hospital admission to determine the likelihood of developing complications requiring ICU care with an area under the receiver operating characteristic (ROC) curve of 0.73 with an R^2 of 0.95.[11]

In the ACTION ICU score, values of 0–1 correspond to a low risk of complications (<3.4%), whereas scores equal to or greater than 14 represent a high risk of complications (39.3%). A score of 5 has a 9.3% risk of complications, and the use of this cut-off shows that non–ICU treated patients would have a < 10% predicted likelihood of developing complications requiring ICU care.

Unlike the results obtained by Fanaroff et al.,[11] a recent study conducted in a single Latin-American center (Brazil) reported low accuracy of the ACTION ICU risk stratification score in the prediction of complications requiring ICU care in this population.[12] Therefore, considering the aforementioned discrepancies between reported results, the present study sought to determine the accuracy of the ACTION ICU score to predict the risk of complications requiring ICU care after the first 24 h of hospital admission in a different Latin-American (Colombian) cohort of patients diagnosed with NSTEMI.

Table 1
Action ICU Score.

Variable		Points
Age, years	<70	0
	>70	1
Serum Creatinine, mg/dL	<1.1	0
	>1.1	1
Heart rate, beats/min	<85	0
	85–100	1
	>100	3
Systolic Blood Pressure, mmHg	<125	3
	125–145	1
	>145	0
Initial Troponin, x ULN	<12	0
	>12	2
Signs or Symptoms of Heart Failure	No	0
	Yes	5
ST Depression	No	0
	Yes	1
Prior Revascularization	No	1
	Yes	0
Chronic Lung Disease	No	0
	Yes	2

COPD: Chronic obstructive pulmonary disease, ULN: Upper limit of normal.

Methods

Design, sample and setting

A retrospective cohort study of patients admitted with a diagnosis of NSTEMI in a cardiovascular care referral center in Bogotá (Colombia) between January 2017, and February 2020. We included all patients older than 18 years old with a billed diagnosis of NSTEMI according to the fourth Universal Definition of myocardial infarction.[13] The medical records were reviewed to collect information as follows: past medical history, vital signs at the moment of first contact in the emergency room (ER), blood chemistry test (hemogram, serum creatinine, sodium, potassium and high-sensitivity troponin I assay), vasoactive drugs use (type of medication, dose and length), electrocardiogram (ECG) records, chest X-ray reports, ICU length of stay and presence of outcomes (according to those described in the definition below).

Patients with cardiorespiratory arrest or cardiogenic shock at the first contact with the ER as well as readmissions for acute coronary syndromes in the six months prior to index presentation were excluded.

A sample size estimation was done, to validate the predictive capacity of the variables included in the original ACTION ICU score in the study patients. The presence of signs or symptoms of heart failure was the strongest predictor with an expected OR of 1.9, alpha error 0.05%, power of 80%. Estimating losses of 10% of data in the outcome variables, we calculated that a sample of 1244 patients was required.

Measures

NSTEMI diagnosis was established by the presence of symptoms of chest pain and/or dyspnea, an ECG tracing without ST-segment elevation, elevated troponin values (greater than the 99th percentile of the general population), and coronary artery disease with obstruction greater than 80% of the lumen according to coronary angiography report.

Patients' clinical variables (age, sex, medical history, vital signs), coronary angiography, and blood chemical tests for the diagnosis of NSTEMI had to be performed at our institution during the index hospitalization. The ACTION ICU score was applied to all patients based on collected data.

The primary outcome was the presence of one or more complications 12 h after NSTEMI diagnosis. These complications were the same used as outcomes in the initial model for the development of the ACTION ICU score as follows: cardiorespiratory arrest, shock (sustained systolic blood pressure less than 90 mmHg or mean arterial pressure less than 60 mmHg, and/or serum lactate greater than 2 mmol/L without response to intravenous fluids administration), high-grade atrio-ventricular block (AVB) (Mobitz type 2, second-degree AVB, complete AVB), respiratory failure (need for invasive or non-invasive positive pressure mechanical ventilation or PaO2/FIO2 ratio less than 150), stroke, or death.

Secondary outcomes were defined as other conditions that would be indications for ICU admission but were not included in the primary outcomes, these included: hypertensive crisis (blood pressure >180/110 mmHg), the requirement of vasodilator medications (due to hypertensive crisis or chest pain persistence or recurrence), ventricular arrhythmias (non-sustained or sustained ventricular tachycardia) and requirement of mechanical circulatory support.

Protocols

All data were collected by the authors, in a database platform. The study was approved by Institutional Review Board which deemed

the study to be without risk and thus there was no need for informed consent. All the data processed for the present study were free of any personal information of the patients. Privacy was guaranteed.

A descriptive analysis of the dependent and independent variables was performed. Continuous variables were evaluated using the Shapiro-Wilk test of normality test and were reported by means and standard deviation or median and interquartile range as appropriate. The ordinal or nominal categorical variables were described in absolute and relative frequencies.

Based on the initial model for the development of the ACTION ICU score and clinical judgment, a total of 32 variables were primarily identified as risk factors for NSTEMI complications (primary outcome). Univariable and multivariable conditional logistic regression analyses were applied to evaluate the relationship between baseline characteristics and the primary outcome. Variables selected for the logistic regression were included when p-value $\leq$0.2 in bivariate analyses (NSTEMI complications vs non-STEMI complications). The final multivariable model was constructed by backward deletion of the least significant characteristics strategy, previous verification of collinearity, interaction, and confusion variables. The predictive performance of the final multivariate model was evaluated for statistic discrimination and calibration by plotting the observed versus predicted probabilities, expressed with confidence intervals for the C statistic. The precision of this approximation was verified by calculating the R^2 for the score as a predictor and the Akaike index. All analyzes were performed in R Statics V.4.1.1(NJ, USA).

Results

A total of 1062 patients with a diagnosis of NSTEMI were identified and included in the analysis. The mean age in the cohort was 66 $\pm$ 13 years and 70% were male. Table 2 shows the baseline demographic and clinical characteristics of the cohort included in the analysis. Also, patients were subdivided based on the occurrence of

Table 2
Baseline demographic and clinical characteristics of the patients with NSTEMI.

Characteristics n (%)	Total 1062	No complications 987 (92.9)	Complications 75 (7.1)	P-value
Age, mean (± SD)	66 (13)	66 (11.2)	68 (11.0)	0.033
Female, n (%)	312 (29.4)	292 (29.6)	20 (26.7)	0.687
BMI, mean (± SD)	26 (3.9)	26 (3.9)	25 (4.1)	0.013
Arterial hypertension, n (%)	696 (65.5)	639 (64.7)	57 (76.0)	0.064
Overweight, n (%)	608 (57.3)	574 (58.2)	34 (45.3)	0.0411
Dyslipidemia, n (%)	441 (41.5)	401 (40.6)	40 (53.3)	0.0422
Smoke, n (%)	467 (44.0)	437 (44.3)	30 (40.0)	0.549
Diabetes, n (%)	290 (27.3)	265 (26.8)	25 (33.3)	0.280
Hypothyroidism, n (%)	169 (16.0)	156 (15.8)	13 (17.3)	0.853
Family history of premature coronary artery disease, n (%)	162 (15.3)	149 (15.0)	13 (17.3)	0.724
Obstructive sleep apnea, n (%)	58 (5.5)	57 (5.8)	1 (1.3)	0.171
Peripheral artery disease, n (%)	30 (2.8)	21 (2.1)	9 (12.0)	0.001
Atrial fibrillation, n (%)	24 (2.3)	24 (2.4)	0 (0.0)	NA
Renal replacement therapy, n (%)	26 (2.4)	17 (1.7)	9 (12.0)	0.001
COPD, n (%)	29 (2.7)	27 (2.7)	2 (2.7)	1.000
Myocardial revascularization	**332 (31.2)**	**308 (31.2)**	**24 (32%)**	**0.835**
Prior PCI, n (%)	231 (27.9)	214 (27.8)	17 (29.3)	0.873
Prior CABG, n (%)	36 (3.4)	34 (3.4)	2 (2.6)	0.576
PCI and CABG, n (%)	65 (6.1)	60 (6.0)	5 (6.6)	0.743
BASELINE CLINICAL AND LABORATORY FINDINGS				
Heart rate BPM, mean (± SD)	75 (16)	74 (15)	83(19)	0.020
Systolic blood pressure (mmHg), mean (± SD)	136 (23.4)	136 (22.4)	127 (33.2)	0.006
Diastolic blood pressure (mmHg), mean (± SD)	78 (13.9)	79 (18.0)	72 (18.0)	0.102
Respiratory rate /min, mean (± SD)	18 (2)	18 (2)	19 (5)	0.033
Troponin pg/mL, mean (± SD)	4.19 (9.9)	4.14 (9.9)	4.9 (9.2)	0.630
Creatinine mg/dL, mean (± SD)	1.16 (1.24)	1.09 (0.97)	2.13 (2.90)	0.069
Sodium mEq/L, mean (± SD)	149 (10)	149 (8)	138 (5)	0.571
Potassium mEq/L, mean (± SD)	4.2 (0.50)	4.19 (0.45)	4.26 (0.63)	0.795
White blood cells/mm3, mean (± SD)	8697 (2760)	8558 (2614)	10521 (3821)	0.007
Hemoglobin g/dl, mean (± SD)	15.0 (2.2)	15.1 (2.1)	13.6 (2.6)	0.055
New or presumably new decline in ST-segment or T wave inversion, n (%)	408 (38.4)	365 (37.0)	43 (57.3)	0.001
Chest pain at time of presentation, n (%)	378 (35.6)	352 (35.7)	26 (34.7)	0.960
New onset atrial fibrillation, n (%)	36 (3.4)	24 (2.4)	12 (16.0)	0.002
Signs or symptoms of heart failure, n (%)	85 (8.0)	54 (5.5)	31 (41.3)	0.001
Left ventricular ejection fraction, %, mean (± SD)	50 (10)	50 (10)	44 (15)	0.730
CLINICAL COURSE AND MANAGEMENT STRATEGY				
Persistent or recurring chest pain beyond the first 24 h, n (%)	71 (6.7%)	7 (0.7%)	64 (85.3%)	0.001
Time to coronary angiography (hours), n (%)				
0-24 h	639 (60.2)	589 (59.6)	50 (66.6)	0.040
25-48 h	323 (30.4)	18 (32.2)	5 (6.6)	0.070
49-72 h	64 (6.0)	53 (5.4).	11 (14.6)	0.200
>72 h	36 (3.4)	27 (2.7)	9 (12.0)	0.001
ICU length of stay, hours, median (IQR)	60 (56-64)	49 (46-51)	94 (81-107)	0.001
Number of involved coronary arteries, median (IQR)	2 (1-3)	2 (1-3)	2 (0-4)	0.789

BMI: Body mass index, **COPD:** Chronic obstructive pulmonary disease, **CABG:** Coronary artery Bypass grafting, **PCI:** Percutaneous coronary intervention, I**QR**: interquartile range, **LVEF**: left ventricle ejection fraction.

Table 3
Description of primary and secondary outcomes.

PRIMARY OUTCOMES	
Events	**Total population *n* = 1062**
Respiratory failure, n (%)	43 (4.0)
Shock, n (%)	39 (3.7)
Cardiac arrest, n (%)	18 (1.7)
In-hospital death, n (%)	17 (1.6)
High degree AVB, n (%)	10 (0.9)
Stroke post AMI, n (%)	4 (0.003)
SECONDARY OUTCOMES	
Total Events, n (%)	
Vasodilator support requirement, n (%)	128 (12.1)
Hypertensive crisis, n (%)	54 (5.1)
Mechanical assistant device (IABP), n (%)	27 (2.5)
Ventricular arrhythmia (NSVT or SVT), n (%)	18 (1.7)

AMI: Acute Myocardial Infarction; **AVB**: Atrioventricular Block, **IABP**: Intra-aortic balloon pump; **NSVT:** Non-sustained ventricular tachycardia; **SVT:** Sustained ventricular tachycardia.

the primary outcome, as well as clinical course and management strategies.

According to the current guidelines' recommendations and institutional protocol, most of the patients (*n* = 1019; 96.0%) were admitted to the ICU. The primary outcome was present in 75 patients (7.1%) with 131 total events. Out of the patients with the primary outcome, 56 of them (74.6%) had more than 1 event contributing to the primary outcome. All the patients with the primary outcome had initially been admitted to the ICU.

Regarding to items included in the ACTION ICU score, patients with the primary outcome were more likely to have higher heart rates (83 ± 19 vs. 74 ± 15, p = 0.02), lower systolic blood pressure (127 ± 33 vs. 136 ± 22, p = 0.006), signs or symptoms of heart failure (41.3% vs. 5.5%, p = 0.001), new or presumably new ST depressions or T wave inversions (57.3% vs. 37% p = 0.0008) at presentation. There was no difference in the rates of myocardial revascularization between the groups (32.0% vs. 31.2%, p = 0.835). (Table 2).

A total of 131 individual events were contributing to the primary outcome (Table 3). The most common event was respiratory failure in 43 patients (4.0%), followed by cardiogenic shock (*n* = 39; 3.7%), and cardiac arrest (*n* = 18; 1.7%). In-hospital death occurred in 17 patients (1.6%). The secondary outcome was present in 138 patients, corresponding to 227 events. The most common secondary outcome was the need for vasodilatory support for refractory chest pain or hypertensive crisis (*n* = 128; 12.1%) (Table 3).

ACTION ICU score

In this cohort, 700 patients (66%) had an ACTION ICU score ranging between 0 and 5 points. Eighteen patients (1,7%) with and ACTION ICU score 0–5 points developed a complication of the composite primary outcome. The proportion of patients with complications for each score category is described in Table 4.

The estimated risk of developing the primary outcome at a threshold of 5 in our cohort was 16.0%, with a sensitivity (SEN) of 84.0% and a specificity (SP) of 48.4%; the positive predictive value (PPV) and negative predictive value (NPV) were 11.0% and 97.6% respectively. A cut-off of 3 predicted a complications risk of 4.0% (SEN: 96.0%, SP: 15.4%, NPV: 98.1%, PPV:7.9%). Table 5 shows the operative characteristics of the ACTION ICU score in our population.

The variable with the highest correlation with the risk of developing the primary outcome was the presence of signs of heart failure (OR:2.16; 95%CI: 1.61–2.92), followed by new or presumably new ST-segment depression or T wave inversion (OR:1.5; 95%CI: 1.1–2.06), and high serum creatinine values (OR:1.29; 95%CI: 1.1–1.47). The presence of signs of heart failure and the new or presumably new decline in ST-segment or T wave inversion were particularly useful in patients under 65 years old (Table 6).

Table 4
Distribution of patients for each point in the ACTION ICU Score.

Score	Total *n* = 1062	Patients with primary outcome *n* = 75	Proportion of patients with primary outcome (%)
0	6	0	0.0
1	49	0	0.0
2	100	3	3.0
3	142	6	4.2
4	193	3	1.5
5	210	6	2.9
6	120	7	5.8
7	110	11	10.0
8	49	12	24.5
9	17	2	11.7
10	20	10	50.0
11	19	4	21.1
12	10	3	30.0
> 13	17	8	47.1

The area under the ROC curve for the ACTION ICU score was: 0.78; 95%CI: 0.72–0.84 (Fig. 1). There were no significant differences in the area under the curve (AUC) after stratifying by age groups older and younger than 65 years (AUC:0.82; 95%CI: 0.73–0.9 and AUC: 0.75; 95%CI: 0.7–0.84, respectively).

Discussion

In this cohort of Latin-American patients with NSTEMI, the ACTION ICU score yielded good discrimination (AUC: 0.78; 95%CI: 0.72–0.84). Our results suggest using an ACTION ICU risk score threshold of 3 to select patients with NSTEMI at low risk of developing complications for their admission to general hospital wards (risk of complication: 4.0%, SEN:96.0%, SP:15.4%, NPV:98.1%, PPV:7.9%).

In our cohort, 7.1% of patients with NSTEMI developed complications, which was lower than the 14% reported in the original study. Furthermore, the ACTION ICU score performed similarly to the one described in the original publication.[11] Compared to the original model, the presence of signs and/or symptoms of heart failure and new or presumably new decline in ST-segment or T wave inversion

Table 5
Operative characteristics of the ACTION ICU score.

Score	n	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Estimated risk of develop a complication during general Hospitalization
1	49	100.0%	5.6%	7.5%	100.0%	0.0%
2	100	100.0%	5.6%	7.5%	100.0%	0.0%
3	142	96.0%	15.4%	7.9%	98.1%	4.0%
4	193	88.0%	29.2%	8.6%	97.0%	12.0%
5	210	84.0%	48.4%	11.0%	97.6%	16.0%
6	120	76.0%	69.1%	15.6%	97.4%	24.0%
7	110	66.7%	80.6%	20.7%	97.0%	33.3%
8	49	52.0%	90.6%	29.6%	96.1%	48.0%
9	17	36.0%	94.3%	32.5%	95.1%	64.0%
10	20	33.3%	95.9%	37.9%	95.0%	66.7%
11	19	20.0%	96.9%	32.6%	94.1%	80.0%
12	10	14.7%	98.4%	40.7%	93.8%	85.3%
13	8	10.7%	99.1%	47.1%	93.6%	89.3%
14	3	6.7%	99.6%	55.6%	93.4%	93.3%
15	3	6.7%	99.9%	83.3%	93.4%	93.3%
16	3	4.0%	100.0%	100.0%	93.2%	96.0%
17	0	1.3%	100.0%	100.0%	93.0%	99.0%
18	0	1.3%	100.0%	100.0%	93.0%	99.0%

Table 6
Multivariable model of variables associated with NSTEMI complications requiring ICU care.

VARIABLE	Total		< 65 years-old		> 65 years-old	
	OR	IC 95%	OR	IC 95%	OR	IC 95%
Heart failure signs or new heart failure syndrome	2.16	1.61–2.92	3.8	1.92–8.41	1.93	1.38–2.7
New or presumably new decline in ST-segment or T wave inversion.	1.5	1.10–2.06	3.16	1.89–5.37	0.95	0.63–1.43
Heart rate (for every 5 beats over 85 bpm)	1.1	1.05–1.16	1.16	1.07–1.26	1.07	1–1.13
Creatinine (For every 1 mg/dL over 1,1 mg/dL)	1.29	1.15–1.47	1.34	1.15–1.59	1.25	1.04–1.58
Systolic blood pressure (For every 10 mmHg over 125 mmHg)	1.25	1.18–1.34	1.39	1.24–1.56	1.21	1.12–1.32
Troponin (For every 5 UI over 0,026 pg/mL)	1.02	0.93–1.11	1.07	0.94–1.19	0.99	0.87–1.11
Medical history of COPD	0.41	0.13–1.12	0.87	0.02–21.51	0.36	0.1–1.04
History of myocardial revascularization	1.37	0.88–2.1	1.46	0.82–2.55	1.21	0.56–2.47
Age (For every 5 years over 60 years-old)	1.06	0.99–1.15	1.07	0.87–1.31	1.12	0.95–1.31

were the variables with the strongest association with the primary outcome (Table 6).

A recent study from Brazil analyzed a cohort of 1263 patients with NSTEMI (mean age 62 years). In this cohort, the complication rate was lower (4.9%), and the ACTION ICU score had a low discriminative yield (AUC:0.55; 95%CI: 0.47–0.63).[14] It is plausible that two factors contributing to these different results are: the younger population included in the study and their lower rate of complications.

The original model establishes a value less than or equal to two as the score with the lowest proportion of patients with complications (4.8%). This proportion increases as the score rises to a maximum of 39.3% in patients with more than 14 points.[11] However, in our cohort, the proportion did not show a trend towards an increase, particularly, for scores ranging from 3 to 6 (Table 4). This result could be attributed to the small number of patients with complications in these groups. To estimate the risk of developing the primary outcome, we used the relationship between false-positive patients and the total of patients with complications (n = 75) for each score. In our cohort, this value showed an increasing tendency (Table 5).

In the study reporting the ACTION ICU score, a threshold of 5 was proposed to prioritize ICU beds for higher-risk patients. Thus, 50% of patients with NSTEMI would be targeted to the ICU for closer monitoring, and non–ICU treated patients would have a <10% predicted likelihood of developing a complication.[11] Using an ACTION ICU risk score of 5 in our cohort, we found 16.0% of the non–ICU treated patients with NSTEMI developing a complication (SEN:84.0%, SP:48.4%, PPV:11.0%, NPV:97.6%).

Our findings suggest that an ACTION-ICU score ≤ 3 could be used to select patients with NSTEMI who can be hospitalized safely in a general ward with a low risk of developing complications. According to this cut-off, only one patient for every 50 who is not admitted to the ICU will present some complications during hospitalization. Regarding ICU admissions, for each patient who is selected to be admitted to the ICU (score > 3), and presents some complication, five additional patients will be admitted and will not develop any complications during their hospital stay. Particularly, in our cohort, an ACTION ICU score ≤ 3 could lead to a 30% decrease in the UCI admission of NSTEMI patients, meaning a saving of approximately 537,100 USD per year.

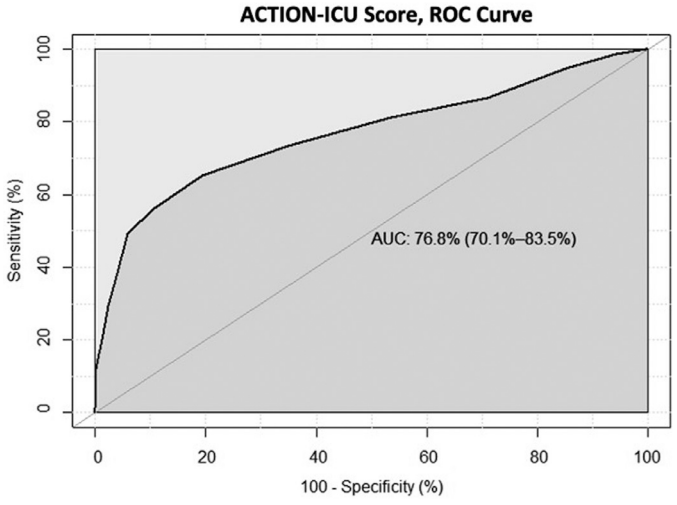

Fig. 1. ROC curve for the ACTION-ICU risk score and complications requiring ICU care.

The significant improvement in patients' outcomes has become a cornerstone in determining the ICU indication in patients with NSTEMI. A recent registry of the Critical Care Cardiology Trials Network reported that acute coronary syndromes correspond to up to 30% of all ICU admissions including less comorbid patients, with low requirement for advanced therapies and admitted only for monitoring as guidelines recommended up to 95% of patients. As a consequence, a large number of low-risk patients could be safely monitored and treated in a non–ICU setting.[15]

The importance of these prognostic evaluations resides in the need for properly establishing the risk. Accordingly, selection of the appropriate treatment and anticipation of complications will improve outcomes and consequently will reduce morbidity and mortality.

Nowadays, some prediction models are designed to establish mortality and cardiovascular complications in the short and middle term. The most popular models are GRACE and TIMI scores.[16,17] These scales predict all causes of mortality, cardiovascular mortality, recurrent ischemia, and the requirement for urgent re-intervention in the first 14 days to 6 months after the event. However, they were not developed to predict in–hospital complications requiring ICU care. Furthermore, information concerning other acute events involving a worsening in the patients' prognosis during the first 48 h is not included in the model. It might be that the higher the risk estimated by these scales, the greater the need for ICU monitoring.

Other tools for risk stratification in patients with NSTEMI include the ProACS score[18] and the shock index.[19] Two simple, easy-to-apply models assessing mortality risk in patients with acute coronary syndrome and achieving adequate performance.

Altogether, unlike the ACTION ICU score, the risk scales mentioned above mainly assess in-hospital mortality risk. However, they neither predict the development of complications nor classify patients for ICU admission.

We want particularly to emphasize the presence of conditions that in our usual clinical practice are indications for ICU admission in patients with NSTEMI and that are not included in the outcomes evaluated in the ACTION ICU score. These events were: Vasodilator support requirement, Hypertensive crisis and, Mechanical assist device (Intra-aortic balloon pump) requirement, which occurred in 13% of the population (138 patients) and could have affected the ACTION ICU score performance.

The ACTION ICU score is an advisable tool for risk assessment to classify patients with NSTEMI for general hospitalization care or ICU admission. In our population, risk prediction models like ACTION ICU score are necessary to optimize the resources of intensive care since

the availability of ICU beds is lower compared to developed countries such as the United States (1.9 × 1000 inhabitants vs. 2.9 × 1000 inhabitants).[20,21]

Nowadays, limited data is available to predict acute complications following the index event in patients with NSTEMI. Although the ACTION ICU score has proved a good performance in predicting the development of complications requiring ICU–level care, its application has shown some inter-populations variability. Further research is needed to develop clinical scales that might not only be feasible for routine implementation in different populations but also might ensure efficient and safe use of limited ICU resources.

Limitations

This study had some limitations. First, our sample size was less than expected (1062 vs.1244). However, since the literature recommends that the maximum likelihood estimation used in the logistic regression with less than 100 cases is "risky" and 500 is generally "adequate" our study included an appropriate number of patients to accomplish the recommendation. Second, the number of patients with at least one complication was low, which may explain that some of the evaluated variables do not have the same significance as in the original study. Third, this was a retrospective study carried out in a tertiary cardiovascular-dedicated center. It is possible that our patients could be a high-selected population and not-measured variables may alter the results presented here.

Conclusion

The ACTION-ICU score yielded good discriminative performance in selecting patients with NSTEMI for general hospitalization care with a low likelihood of developing complications requiring ICU care. Indeed, our results suggest implementing the ACTION ICU score with a modified threshold of 3 in the Latin-American (Colombian) population with NSTEMI. Retrospective application of the ACTION ICU risk score to identify low-risk patients with NSTEMI would have led to a reduction of 30% in ICU admission with high sensitivity and negative predictive value.

Declaration of Competing Interest

None declared.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Acknowledgments

We would like to thank the Fundación Cardioinfantil-LaCardio for its continuous efforts in the development of cardiovascular medicine in Latin America and its support to clinical research in this area.

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