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Original Article

Comparison of the Predictive Power of the CRUSADE, MEHRAN, and ACTION Bleeding Risk Scores in Patients With the Acute Coronary Syndrome

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ABSTRACT

Background: Various risk scores are used to predict the bleeding risk in patients with the acute coronary syndrome (ACS), including ACTION, CRUSADE, and MEHRAN. The purpose of the present study was to compare the accuracy of these 3 risk scores in the prediction of the bleeding risk in patients with the ACS.

Methods: We studied 745 consecutive patients with the ACS undergoing coronary arteriography and calculated the ACTION, CRUSADE, and MEHRAN bleeding risk scores for all the patients. Then, we compared their prediction accuracy for major bleeding events and serious (major or minor) bleeding episodes with C-statistics.

Results: The majority of the patients (72.6%) had non–ST-elevation myocardial infarction (NSTEMI), and the others (25.4%) had STEMI. The mean age of the patients was 62.55±12.12 years, and 62.4% were male. Bleeding complications were reported in 141 (18.9%) patients, with the catheterization site being the most frequent site of bleeding. The major bleeding rate was predicted in 29.1%, 28.4%, and 4.8% of the patients according to the CRUSADE, MEHRAN, and ACTION risk scores, respectively. The C-index values (AUC) for the ACTION, MEHRAN, and CRUSADE risk scores were 0.6182, 0.5413, and 0.6185, respectively. Pairwise comparisons between the scores showed no statistically significant differences in the discriminatory power between the ACTION and the CRUSADE (P=0.970); however, the differences between the CRUSADE and the MEHRAN (P=0.051) or between the ACTION and the MEHRAN (P=0.053) were near to significant.

Conclusions: The bleeding risk score was predicted accurately by the ACTION, CRUSADE, and MEHRAN risk scores without significant differences among the 3 risk scores in our patients with the ACS undergoing coronary arteriography. These results showed that the predictive power was not excellent in any of the 3 risk scores. ***(Iranian Heart Journal 2019; 20(1):6-14)***

KEYWORDS: Acute coronary syndrome, Bleeding, Risk score

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The acute coronary syndrome (ACS) is a critical manifestation of coronary artery disease and underlies acute myocardial ischemia. The ACS encompasses a wide range of diseases such as unstable angina, ST-elevation myocardial infarction (STEMI), and non–ST-elevation ACS (NSTEACS) and is responsible for at least one-third of overall mortality [1-3] with a prevalence of over 15.5 million in American adults. [4,5]

The main treatment of the ACS varies from supportive to invasive therapy, depending on the patient's condition, and includes anti-coagulant therapy (heparin and enoxaparin), fibrinolytics (alteplase and tenecteplase), percutaneous coronary intervention (PCI), and angiography. Antithrombotic and antiplatelet drug therapies such as aspirin or glycoprotein IIb/IIIa inhibitors are also used to target the pathophysiology of atherosclerosis plaque formation, activated by platelet aggregation, [6] which can decrease the ischemic complications of interventions like PCI and angiography. [7]

Despite the significant and favorable effects of antithrombotics on reducing the mortality risk in the ACS, they are associated with a higher risk of bleeding, which may deteriorate the patient's prognosis. [8]

Bleeding is the most important non-thrombotic complication associated with the ACS. Bleeding is mainly caused by antithrombotic treatments and can be life-threatening or cause severe complications for the patient. [9,10] Additionally, bleeding leads to the discontinuation of antithrombotic treatments, which can interfere with the patient's treatment course. [11] Accordingly, patients with the ACS should be categorized and patients at a higher risk for bleeding should be identified in order that the most appropriate treatment strategy for each patient can be selected individually. [12]

Various studies have been conducted to predict the risk of bleeding in patients with the ACS. These studies have suggested different risk scores such as the CRUSADE (Can Rapid Risk Stratification of Unstable Angina Patients Suppress Adverse Outcomes With Early Implementation of ACC/AHA [American College of Cardiology/American Heart Association] Guidelines), [13] the ACTION (Acute Coronary Treatment and Intervention Outcomes Network), [14] the ACUITY (Acute Catheterization and Urgent Intervention Triage strategy) justified by Mehran and colleagues, [15,16] and the GRACE (Global Registry of Acute Coronary Events). [17] Nonetheless, it is not yet clear which classification is the best and should be used in all patients. Comparisons of the CRUSADE, ACTION, and ACUITY/ MEHRAN risk scores have shown the superiority of each classification in different patient settings, including STEMI and NSTEACS, in angiography.[18]

Considering the current dearth of data on the incidence and severity of bleeding in patients using antithrombotics in our country, the present study aimed to compare the predictive power of the CRUSADE, ACTION, and ACUITY criteria in patients with the ACS with a view to determining the best risk score for the classification of patients' bleeding risk.

METHODS

The current prospective observational study was conducted on 800 patients with suspected ACS undergoing coronary arteriography between July 2015 and March 2016 in Afshar Hospital, Yazd, Iran. The study was approved by the Ethics Committee of Afshar Hospital and Shahid Sadoughi University of Medical Sciences in the Iranian province of Yazd. Patients were included in the study based on the following inclusion criteria: entrance to the hospital with sudden symptoms consistent with cardiac ischemia, with at least 1 of the following: increased cardiac markers, electrocardiographic (ECG) changes suggesting the ACS, the result of the stress test indicating ischemia, a history of coronary artery disease, and the result of angiography indicating stenoses of greater than 50%. Patients were

excluded from the study in case of death during the first 24 hours of admission or the occurrence of the ACS by trauma, surgery, sepsis, or hospitalization.

The information was collected by a single physician, who visited the patients upon their admission into the hospital and completed the study checklist for all the eligible patients and followed them until discharge. The checklist comprised demographic data (age, sex, and weight); medical history of diseases (eg, diabetes mellitus, hypertension, peripheral vascular diseases, stroke, MI, and heart failure); history of PCI, coronary artery bypass graft surgery, and dialysis; the records of all medications used (eg, aspirin and oral antithrombotics); the results of physical examinations (eg, the heart rate and the systolic/diastolic blood pressure); and clinical and laboratory findings (eg, the serum levels of leukocytes, hemoglobin, hematocrit, troponin, creatinine, and the glomerular filtration rate). The patients were divided into 2 groups: STEMI and NSTEACS (NSTEMI and unstable angina).

The study end point was considered to be the incidence of bleeding and its severity. According to this aim, for each patient, 3 bleeding risk scores—namely the ACTION, the CRUSADE, and the ACUITY—were calculated via the patients' clinical characteristics.

The CRUSADE criteria consider major bleeding as intracerebral bleeding, retroperitoneal bleeding, hematocrit levels exceeding 12% lower than the baseline value, any blood transfusion with a baseline hematocrit level of less than 28%, or any type of red blood cell transfusion with a baseline hematocrit level of greater than 28%. Minor bleeding was considered to be a clinically important bleeding that did not fit into the definitions of major bleeding. [13] Major bleeding according to the ACUITY or MEHRAN criteria is considered to be a bleeding that involves the brain or when there is ocular bleeding; bleeding that requires invasive examination to find the bleeding site; hematoma greater than 5 centimeters; a hemoglobin level of less than 4 g/dL without an obvious bleeding site; or a reduction of 3 g/dL in the hemoglobin level with an obvious bleeding site requiring re-surgery or blood transfusions. Minor bleeding was considered clinically important when it did fit into the definitions of major bleeding. [15,16]

Statistical Analysis

All the statistical analyses were performed using IBM SPSS 23.0 and STATA 11. Frequencies (percentages) and means (standard deviations) were used to present the qualitative and quantitative variables, respectively.

For the prediction of major bleeding, the predictive power of all the criteria was determined with C-statistics. To that end, the receiver operating characteristic (ROC) curve was used to calculate the area under the curve (AUC). An AUC of 0.5 is a non-informative result; an AUC of more than 0.5 and 0.7 or less is less accurate; an AUC of more than 0.7 and 0.9 or less is moderately accurate; an AUC of more than 0.9 and less than 1 is highly accurate; and an AUC of 1 is a perfect test. [33] Ultimately, all the AUCs of the 3 criteria were compared to each other using the STATA 11 Software. Five risk categories (ie, very low, low, moderate, high, and very high) were considered for the ACTION and CRUSADE scores and 4 risk categories (ie, low, moderate, high, and very high) were considered for the MEHRAN score. A *P* value of less than 0.05 was considered statistically significant.

RESULTS

Baseline Characteristics

This prospective study recruited 800 patients; the response rate was 93% (745/800).

According to Table 1, the mean age and weight of the participants were 62.55±12.12 (range: 24–91) years and 71.31±12.92 (range: 40–135) kg. Males accounted for the majority of the

study population (62.4%). From the perspective of the ACS type, 72.6% of the patients had NSTEMI and only 25.4% had STEMI. Apropos the history of diseases, the highest numbers were related to diabetes mellitus (38%), hypertension (20.1%), and coronary artery bypass graft surgery (14.1%), respectively.

With respect to the complete blood count components, the mean hematocrit and hemoglobin levels were 40.79±4.91 and 13.54±1.95, correspondingly. The systolic/ diastolic blood pressures of the patients had a mean of 132.29/79.08 mm Hg. According to the Killip criteria, the majority of the patients (80.1%) were Class I and 15.1% were Class II (Table 1).

Table 1. Clinical characteristics and in-hospital management of the study population

Variable		Patients (N=745)
Age	Y	62.55 ± 12.12 (range: 24-91)
Weight	Kg	71.31 ± 12.92 (range: 40-135)
Gender	Male	465 (62.4%)
	Female	280 (37.5%)
Type of ACS	ST-elevation MI	189 (25.4%)
	Non–ST-elevation MI	541 (72.6%)
History of diseases	Stroke	12 (1.6%)
	Diabetes mellitus	283 (38%)
	Peripheral vascular disease	1 (0.1%)
	Myocardial infarction	52 (7%)
	Heart failure	7 (0.9%)
	Coronary artery bypass graft	105 (14.1%)
	Hypertension	150 (20.1%)
Serum levels	Hematocrit	40.79 ± 4.91 (range: 23.7-65.7)
	Hemoglobin	13.54 ± 1.95 (range: 6.7-23.2)
	White blood cell count	3.53 ± 8.7 (range: 2.9-43.1)
	Creatinine	1.25 ± 0.59 (range: 0.5-10.5)
Blood pressure	Diastolic	79.08±16.64
	Systolic	132.29 ± 21.85
Killip class	I	598 (80.1%)
	II	112 (15.1%)
	III	32 (4.3%)
	IV	4 (0.5%)

ACS, Acute coronary syndrome; MI, Myocardial infarction

Incidence of Bleeding

Of all the patients, 81.1% experienced no bleeding and only 18.9% experienced the incidence of bleeding. The catheterization site was the most frequent site of bleeding (106 from 141 patients) (Table 2).

Table2. Bleeding complications in the patients

Bleeding Complication		Freq.	%
No		604	81.1%
Yes		141	18.9%
Bleeding Site	Upper gastrointestinal	10	1.3%
	Catheterization site	106	14.2%
	Hematuria	10	1.3%
	Melena	10	1.3%
	Hemoptysis	2	0.3%
	Hematuria with melena	2	0.3%
	Epistaxis	1	0.1%

Risk Assessment of Bleeding

According to the CRUSADE criteria, 15.8%, 25.8%, 29.8%, 20.5%, and 8.6% of the patients were at very low, low, moderate, high, and very high-risk categories of bleeding. The MEHRAN criteria showed that a total of 0%, 32.8%, 28.5%, 20.3%, and 18.1% of the patients belonged to the very low, low, moderate, high, and very high-risk categories of the bleeding risk, respectively. Nonetheless, according to the ACTION criteria, these rates were 8.2%, 44.3%, 34.9%, 4.7%, and 0.1% of the patients, correspondingly (Fig. 1). Thus, the major bleeding rate was predicted in 29.1%, 28.4%, and 4.8% of the study population according to the CRUSADE, MEHRAN, and ACTION risk scores, respectively.

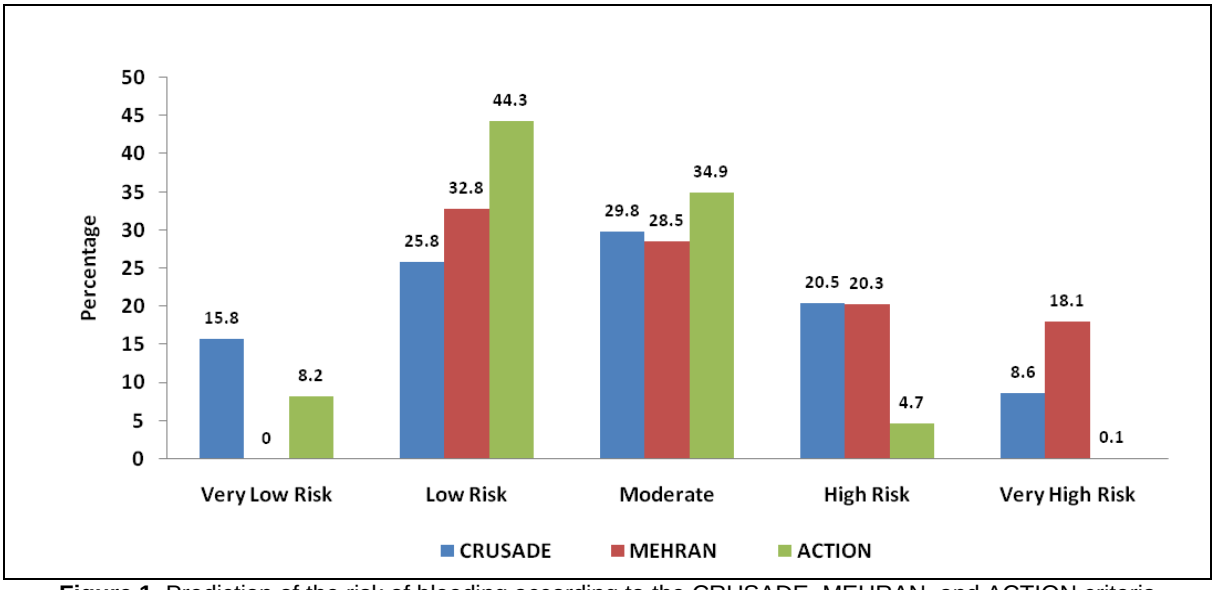

Figure 1. Prediction of the risk of bleeding according to the CRUSADE, MEHRAN, and ACTION criteria

Predictive Power

The discrimination capability of the risk scores for predicting complications is depicted in Table 3. The C-index values (AUC) for the ACTION, MEHRAN, and CRUSADE criteria were 0.6182 (95% CI: 0.532 to 0.701), 0.5413 (95% CI: 0.461 to 0.612), and 0.6185 (95% CI: 0.529 to 0.703), respectively. The highest C-index values were found in the CRUSADE and then the ACTION, with a very small difference between them. The C-index value of the MEHRAN criteria was the lowest of the 3 risk scores (Table 3 & Fig. 2). These values showed that the predictive power was not excellent in any of the 3 risk scores (Fig. 3). Figure 3 demonstrates the actual bleeding rate versus the predicted one according to each bleeding rate score. The highest predicted bleeding rate by the CRUSADE criteria was mild in the no bleeding and minor bleeding categories and severe in the major bleeding category. The highest predicted bleeding rate by the MEHRAN criteria was moderate in the no, minor, and major bleeding categories. Nevertheless, the highest predicted bleeding rate by the ACTION criteria was mild in all the 3 bleeding categories.

A comparison of the AUC of the 3 scores yielded no statistically significant differences in the discriminatory power between the ACTION and the CRUSADE (P=0.970), whereas the differences between the CRUSADE and the MEHRAN (P=0.051) and between the MEHRAN and the ACTION (P=0.053) were very close to statistical significance (Table 3). The differences between the 3 risk scores remained nonsignificant after the classification of the patients based STEMI or NSTEMI ACS.

Table 3. Comparisons of the discriminative power of the of the 3 risk scores for Predicting bleeding according to the area under the ROC curve

Score	AUC	(95% CI)
CRUSADE	0.6185	(0.529-0.703)
MEHRAN	0.5413	(0.461-0.612)
ACTION	0.6182	(0.532-0.701)
CRUSADE vs MEHRAN	*P*=0.051	
CRUSADE vs ACTION	*P*=0.970	
MEHRAN vs ACTION	*P*=0.053	

ROC, Receiver operating characteristic curve; AUC, Area under the curve

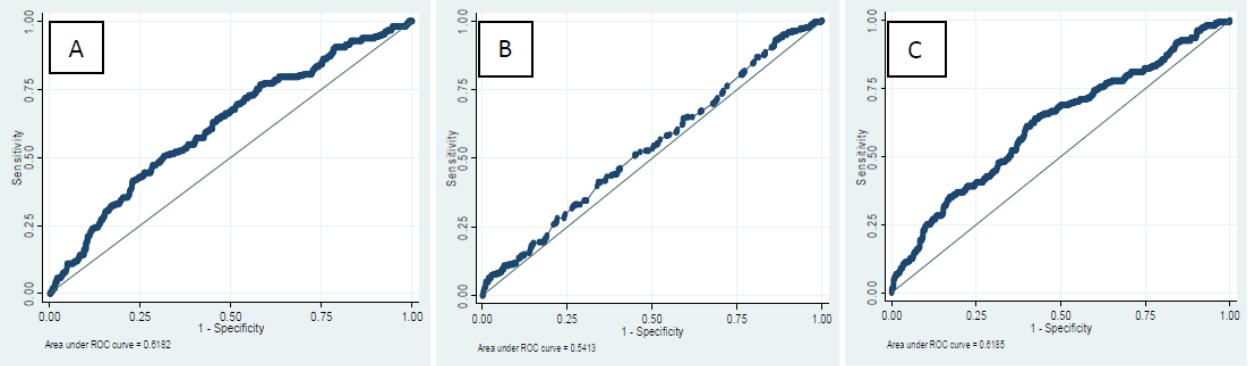

Figure 2. Receiver operating characteristic curves of the A: ACTION, B: MEHRAN, and C: CRUSADE criteria for the prediction of major bleeding

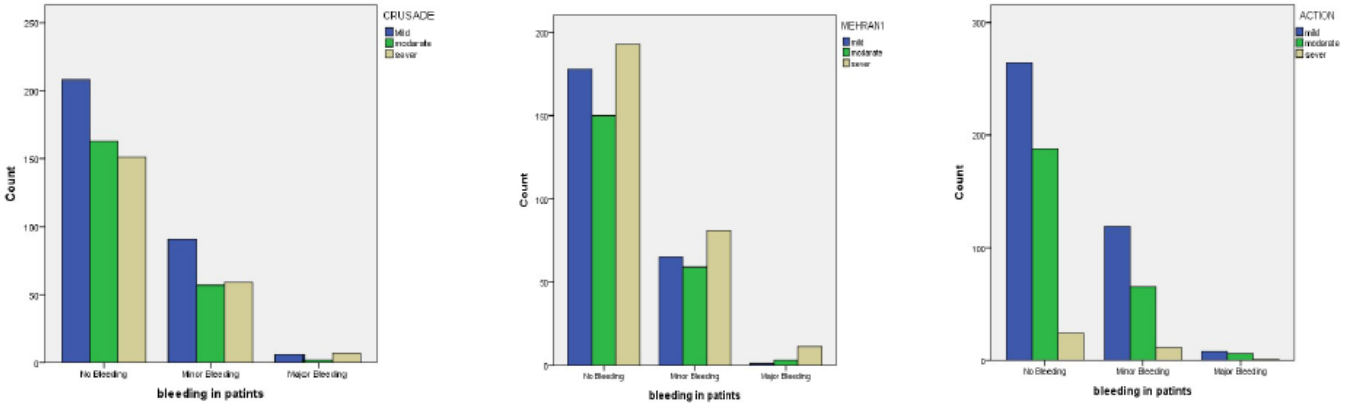

Figure 3. Predicted frequency of bleeding based on the 3 criteria with regard to the actual categories of the patients

DISCUSSION

The findings of the present study showed that the predictive power in none of the 3 risk scores was excellent and none was superior to the others. The AUC of the CRUSADE criteria was slightly greater than that of the other 2 criteria, although our pairwise comparisons did not show any statistically significant differences.

The appropriate performance of these 3 risk scores has been reported previously; still, the difference between the CRUSADE and ACTION criteria have been reported to be statistically significant, indicating a higher accuracy of these 2 criteria in predicting bleeding in all types of the ACS. [18] Similarly, in the present study, the C-statistics of the

MEHRAN criteria was 0.541 and those of the CRUSADE and ACTION criteria were 0.618, while our statistical analyses showed no differences. A comparison of the C-statistics in the present study with those in previous studies [18-20] indicates high C-values for major bleeding by comparison with our study. Our regression analysis and C-statistics showed that the input of the initial variables into the model could not predict the possibility of bleeding well, which might be due to the bias effect of variations in the baseline characteristics of the patients.

The difference between the 3 criteria in the present study was not statistically significant, even after we divided patients into STEMI and NSTEACS groups, while in previous studies the predictive power was more significant in patients with STEMI. [21,22] This discrepancy between the results of our study and the aforementioned ones could be due to the variances in the treatments used since the dissimilarities in anticoagulant therapies and invasive procedures between registries lead to significant differences in the bleeding risk and thus render the comparison between bleeding risk scores very difficult. [21] For instance, in the present study, all the patients underwent angiography, performed via the femoral vein, while over 80% of the arteriography interventions were performed via the radial vessel in a similar study in the United States. [18] These criteria are, however, validated when performed on patients undergoing angiography both via the femoral and radial routes. [23,24] Furthermore, different baseline characteristics such as age, gender, and serum parameters such as anemia play a role in the risk of bleeding, [25] rendering a comparison of studies extremely difficult.

Another salient point of the present research is the bleeding site in the patients insofar as more than 75% of the cases of bleeding were reported from the catheter site, which varies between 25% and 34% in other studies on patients with the ACS undergoing coronary angiography. [21,26] This difference can be caused by a variety of causes, most probably the accuracy of data collection. It should be noted that the present data were retrospectively collected from patients or their medical records. In addition, in the present study, about 19% of the patients had bleeding, while the rate of major bleeding is different among studies based on the antithrombotics used. The overall rate of major bleeding was 11.5%, which rose to 17.5% in consequence of the use of glycoprotein IIb/IIIa inhibitors in a previous investigation, [9] which is close to that of the present study, although various factors such as the type of MI and serum parameters like anemia attribute to the risk of major bleeding.

It could be argued that this is the first Iranian study to compare the predictive power of bleeding risk scores in patients with the ACS with a sufficient sample size and study power (83%). Our results accredited that a wide range of variables might affect the risk of bleeding in patients with the ACS, such as alterations in the treatment strategies used for patients. In addition, in this study, the data were retrospectively collected from medical records and not by the researcher; therefore, any bias in the data records could have affected the results. We did not compare the rates of bleeding between different drug regimens used due to the bias caused by differences in the baseline characteristics.

CONCLUSIONS

The present study examined a sufficient number of patients with the ACS undergoing femoral angiography and the results of the comparison of the 3 bleeding risk scores showed no statistically significant differences between the ACTION, CRUSADE, and MEHRAN criteria, although the C-statistics of the MEHRAN criteria were slightly lower than those of the ACTION and the CRUSADE. The findings of this study showed that the predictive power in none of the 3 risk scores was excellent. Further cohort studies on the data of the registry

systems in Iran could add to the results of the present study.

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Conflict of Interest
Authors have no conflict of interests.

REFERENCES

1. Sanchis-Gomar F, Perez-Quilis C, Leischik R, Lucia A. Epidemiology of coronary heart disease and acute coronary syndrome. Annals of translational medicine. 2016;4(13).

2. Vahedian-Azimi A, Miller AC, Hajiesmaieli M, Kangasniemi M, Alhani F, Jelvehmoghaddam H, et al. Cardiac rehabilitation using the Family-Centered Empowerment Model versus home-based cardiac rehabilitation in patients with myocardial infarction: A randomised controlled trial. Open Heart. 2016;3(1). English.

3. Vahedian Azimi A, Sadeghi M, Movafegh A, Sorouri Zanjani R, Hasani D, Salehmoghaddam AR, et al. The relationship between perceived stress and the top five heart disease characteristics in patients with myocardial infarction. J Zanjan Univ Med Sci Health Serv. 2012;20(78). Persian.

4. Mozaffarian D, Benjamin EJ, Go AS, Arnett DK, Blaha MJ, Cushman M, et al. Executive Summary: Heart Disease and Stroke Statistics--2016 Update: A Report From the American Heart Association. Circulation. 2016 Jan 26;133(4):447-54. PubMed PMID: 26811276. Epub 2016/01/27. eng.

5. Vahedian-Azimi A, Alhani F, Goharimogaddam K, Madani SJ, Naderi A, Hajiesmaeili M. Effect of family - Centered empowerment model on the quality of life in patients with myocardial infarction: A clinical trial study. J Nurs Educ. 2015;4(1):8-21. Persian.

6. Kumar A, Cannon CP, editors. Acute coronary syndromes: diagnosis and management, part I. Mayo Clinic Proceedings; 2009: Elsevier.

7. Cuisset T, Valgimigli M, Mudra H, Muller O, Wijns W, Huber K. Rationale and use of antiplatelet and antithrombotic drugs during cardiovascular interventions: May 2010 update. EuroIntervention : journal of EuroPCR in collaboration with the Working Group on Interventional Cardiology of the European Society of Cardiology. 2010 May;6(1):39-45. PubMed PMID: 20542796. Epub 2010/06/15. eng.

8. Eikelboom JW, Mehta SR, Anand SS, Xie C, Fox KA, Yusuf S. Adverse impact of bleeding on prognosis in patients with acute coronary syndromes. Circulation. 2006;114(8):774-82.

9. Alexander KP, Chen AY, Roe MT, Newby LK, Gibson CM, Allen-LaPointe NM, et al. Excess dosing of antiplatelet and antithrombin agents in the treatment of non–ST-segment elevation acute coronary syndromes. Jama. 2005;294(24):3108-16.

10. Baber U, Kovacic J, Kini AS, Sharma SK, Dangas G, Mehran R. How serious a problem is bleeding in patients with acute coronary syndromes? Current cardiology reports. 2011;13(4):312-9.

11. Bassand J-P. Impact of Bleeding and Transfusion in Acute Coronary Syndromes and Percutaneous Coronary Interventions. 2008.

12. Kinnaird TD, Stabile E, Mintz GS, Lee CW, Canos DA, Gevorkian N, et al. Incidence, predictors, and prognostic implications of bleeding and blood transfusion following percutaneous coronary interventions. The American journal of cardiology. 2003;92(8):930-5.

13. Abu-Assi E, Gracía-Acuña JM, Ferreira-González I, Peña-Gil C, Gayoso-Diz P, González-Juanatey JR. Evaluating the performance of the can rapid risk stratification of unstable angina patients suppress adverse outcomes with early implementation of the acc/aha guidelines (crusade) bleeding score in a contemporary Spanish cohort of patients with non–ST-segment elevation acute myocardial infarction. Circulation. 2010;121(22):2419-26.

14. Chin CT, Chen AY, Wang TY, Alexander KP, Mathews R, Rumsfeld JS, et al. Risk adjustment for in-hospital mortality of contemporary patients with acute myocardial infarction: The Acute Coronary Treatment and Intervention Outcomes Network (ACTION) Registry®–Get With The Guidelines (GWTG)™ acute myocardial infarction mortality model and risk score. American heart journal. 2011;161(1):113-22. e2.

15. Mehran R, Pocock SJ, Stone GW, Clayton TC, Dangas GD, Feit F, et al. Associations of major bleeding and myocardial infarction with the incidence and timing of mortality in patients presenting with non-ST-elevation acute coronary syndromes: a risk model from the ACUITY trial. European heart journal. 2009;30(12):1457-66.

16. Mehran R, Pocock SJ, Nikolsky E, Clayton T, Dangas GD, Kirtane AJ, et al. A risk score to predict bleeding in patients with acute coronary syndromes. Journal of the American College of Cardiology. 2010;55(23):2556-66.

17. Moscucci M, Fox KA, Cannon CP, Klein W, López-Sendón J, Montalescot G, et al. Predictors of major bleeding in acute coronary syndromes: the Global Registry of Acute Coronary Events (GRACE). European heart journal. 2003;24(20):1815-23.

18. Abu-Assi E, Raposeiras-Roubin S, Lear P, Cabanas-Grandío P, Girondo M, Rodríguez-Cordero M, et al. Comparing the predictive validity of three contemporary bleeding risk scores in acute coronary syndrome. European Heart Journal: Acute Cardiovascular Care. 2012;1(3):222-31.

19. Hamm CW, Bassand J-P, Agewall S, Bax J, Boersma E, Bueno H, et al. ESC Guidelines for the management of acute coronary syndromes in patients presenting without persistent ST-segment elevation: The Task Force for the management of acute coronary syndromes (ACS) in patients presenting without persistent ST-segment elevation of the European Society of Cardiology (ESC). European heart journal. 2011;32(23):2999-3054.

20. Flores-Rios X, Couto-Mallon D, Rodriguez-Garrido J, Garcia-Guimaraes M, Gargallo-Fernandez P, Pinon-Esteban P, et al. Comparison of the performance of the CRUSADE, ACUITY-HORIZONS, and ACTION bleeding risk scores in STEMI undergoing primary PCI: insights from a cohort of 1391 patients. European heart journal Acute cardiovascular care. 2013 Mar;2(1):19-26. PubMed PMID: 24062930. Pubmed Central PMCID: Pmc3760576. Epub 2013/09/26. eng.

21. Kadakia MB, Desai NR, Alexander KP, Chen AY, Foody JM, Cannon CP, et al. Use of anticoagulant agents and risk of bleeding among patients admitted with myocardial infarction: a report from the NCDR ACTION Registry–GWTG (National Cardiovascular Data Registry Acute Coronary Treatment and Intervention Outcomes Network Registry–Get With the Guidelines). JACC: Cardiovascular Interventions. 2010;3(11):1166-77.

22. Van de Werf F, Bax J, Betriu A, Blomstrom-Lundqvist C, Crea F, Falk V, et al. Management of acute myocardial infarction in patients presenting with persistent ST-segment elevation. Giornale italiano di cardiologia (2006). 2009;10(7):450.

23. Ariza-Solé A, Sánchez-Elvira G, Sánchez-Salado JC, Lorente-Tordera V, Salazar-Mendiguchía J, Sánchez-Prieto R, et al. CRUSADE bleeding risk score validation for ST-segment-elevation myocardial infarction undergoing primary percutaneous coronary intervention. Thrombosis research. 2013;132(6):652-8.

24. Correia LC, Merelles S, Vasconcelos A, Cerqueira T, Reis T, Esteves C, et al. Validation of a score for predicting bleeding events during acute coronary syndromes. Arquivos brasileiros de cardiologia. 2010;95(4):457-63.

25. Wang R, Mei B, Liao X, Lu X, Yan L, Lin M, et al. Determination of risk factors affecting the in-hospital prognosis of patients with acute ST segment elevation myocardial infarction after percutaneous coronary intervention. BMC cardiovascular disorders. 2017;17(1):243.

26. Subherwal S, Bach RG, Chen AY, Gage BF, Rao SV, Newby LK, et al. Baseline risk of major bleeding in non–ST-segment–elevation myocardial infarction. Circulation. 2009;119(14):1873-82.