DOI: 10.38103/jcmhch.18.3.1

Original research

PREDICTIVE PERFORMANCE OF THE MAYO CLINIC AND NEW YORK RISK SCORES IN PERCUTANEOUS CORONARY INTERVENTION: A SINGLE - CENTER STUDY FROM VIETNAM

Hoang Minh Thanh Tu[1], Hoang Anh Tien[2], Hoang Thi Bach Yen[2], Doan Chi Thang[3], Huynh Thai Long[2]

[1]Vietnam - Cuba Dong Hoi Friendship Hospital, Vietnam

[2]Hue University of Medicine and Pharmacy, Vietnam

[3]Hue Central Hospital, Vietnam

ABSTRACT

Background: *Risk stratification is essential in patients undergoing percutaneous coronary intervention (PCI), particularly for predicting early complications and in-hospital mortality. This study evaluated the Mayo Clinic Risk Score (MCRS) and the New York Risk Score (NYRS) in patients undergoing PCI at Vietnam-Cuba Friendship Hospital, Dong Hoi.*

Methods: *This was a single-center cross-sectional descriptive study with follow-up from PCI initiation to hospital discharge. A total of 102 hospitalized patients undergoing PCI between June 2024 and January 2025 were included. Patients were classified into emergency PCI (n = 60) and elective PCI (n = 42) groups. Baseline clinical, laboratory, echocardiographic, angiographic, and procedural data were collected. Complication risk was assessed using MCRS, and mortality risk using NYRS. Predictive performance was evaluated using receiver operating characteristic (ROC) analysis. Logistic regression was performed to identify independent predictors of in-hospital complications and mortality.*

Results: *The mean age was 70.1 ± 11.8 years, and 72.5% were male. Emergency PCI patients had significantly higher median MCRS and NYRS than elective PCI patients (11 vs. 5 and 10 vs. 5, respectively; both p < 0.001). Overall, 18.6% of patients developed in-hospital complications and 2.9% died. Reperfusion syndrome was more frequent in emergency PCI (13.3% vs. 0%, p = 0.020), whereas periprocedural myocardial infarction was observed only in elective PCI patients (11.9% vs. 0%, p = 0.010). For predicting in-hospital complications, MCRS showed modest discrimination (AUC 0.640, p = 0.041; cut-off > 9). For predicting in-hospital mortality, NYRS showed excellent discrimination (AUC 0.907, p < 0.001; cut-off > 11). In multivariable analysis, NYHA class III-IV independently predicted complications (OR 4.191, p = 0.016), while cardiogenic shock independently predicted in-hospital mortality (OR 7.373, p = 0.028).*

Conclusion: *Emergency PCI patients had a higher risk profile and worse short-term outcomes than elective PCI patients. Both MCRS and NYRS were clinically useful for early risk stratification, with MCRS showing modest value for predicting complications and NYRS demonstrating excellent performance for predicting in-hospital mortality.*

Keywords: *Percutaneous coronary intervention, coronary artery disease, acute coronary syndrome, risk assessment, hospital mortality.*

I. INTRODUCTION

Cardiovascular disease remains the leading cause of death worldwide, with at least 19 million deaths in 2021, and ischemic heart disease continues to be a major cause of premature mortality and disability [1]. Over the past four decades, percutaneous

Received: 29/12/2025. **Revised:** 13/3/2026. **Accepted:** 23/4/2026.

Corresponding author: Doan Chi Thang. Email: thangdoanchi1981@gmail.com. Phone: (+84) 905469595

coronary intervention (PCI) has become a routine revascularization strategy, supported by major advances in devices, techniques, pharmacotherapy, and procedural technology, allowing treatment of increasingly complex lesions and higher-risk patients [2].

In Vietnam, interventional cardiology has expanded rapidly after 25 years of development, with more than 115 centers, nearly 400 principal operators, and nearly 30,000 PCI procedures annually [3]. However, PCI-related complications still occur, including stent loss, coronary perforation, rupture, dissection, and aortic dissection, as reported in previous Vietnamese data [4].

Because PCI outcomes depend on baseline risk and procedural complexity, simple risk scores are useful for predicting complications and mortality. Therefore, this study aimed to describe clinical/paraclinical characteristics, procedural features, complications, mortality, and the distribution of MCRS and NYRS, and to evaluate their associations and predictive value for PCI-related complications and in-hospital mortality.

II. MATERIALS AND METHODS

2.1. Study population, study design and sampling

All inpatients admitted via the Emergency Department at Vietnam-Cuba Friendship Hospital, Dong Hoi, from June 2024 to January 2025, diagnosed with ACS (STEMI, NSTEMI, unstable angina) or CCS (stable angina/chronic ischemic heart disease). This was a cross-sectional descriptive study with follow-up from PCI initiation to discharge, using convenience sampling of all eligible patients.

2.2. Inclusion and exclusion criteria

Inclusion criteria: Eligible patients underwent PCI and were classified as Emergency PCI (urgent/emergent PCI for ACS during index admission) or Elective PCI (planned PCI without emergency indication). Adverse events were categorized as intra-procedural or post-procedural in-hospital complications. Exclusion criteria: Patients were excluded if they had hematologic/coagulation disorders, acute liver failure with encephalopathy, end-stage renal disease on maintenance hemodialysis, diagnostic coronary angiography without PCI, or refusal to participate.

2.3. Data collection and follow-up

Data were collected using standardized case report forms, including demographics, symptom onset for Emergency PCI, hemodynamic status, heart failure severity, comorbidities, and baseline investigations. Patients were monitored during PCI and followed until discharge for clinical status, hemodynamics, ECG, access-site complications, urine output, and clinically indicated tests.

2.4. Risk factors, assessments, and outcomes

Analyzed risk factors included cardiogenic shock, Killip/NYHA class, hypertension, diabetes, anemia, and renal dysfunction. Complication risk was assessed using MCRS and mortality risk using NYRS. Baseline and follow-up assessments, as clinically indicated, included 12-lead ECG, transthoracic echocardiography, hs-troponin T, serum creatinine, blood glucose, and complete blood count. Outcomes included in-hospital complications, mortality, and the predictive value of MCRS/NYRS. Coronary perforation, dissection, and no-reflow were classified using the Ellis system, NHLBI A-F grading, and TIMI flow grade, respectively. Periprocedural myocardial infarction, reperfusion syndrome, and contrast-induced nephropathy were also assessed, with CIN risk evaluated using the Mehran score.

2.5. Statistical analysis

Data were analyzed using SPSS 26.0. Continuous and categorical variables were compared using t-test and χ^2 test, respectively. ORs with CIs were calculated, with $p < 0.05$ considered significant. ROC curves and AUC were used to assess MCRS and NYRS performance, interpreted as excellent (0.90 - 1.00), good (0.80 - 0.89), fair (0.70 - 0.79), poor (0.60 - 0.69), or no value (0.50 - 0.59).

2.6. Ethics

The study was approved by the Biomedical Research Ethics Committee of Hue University of Medicine and Pharmacy, conducted to improve care without added risk. PCI indications were clinically consulted, approved by hospital leadership, and performed after informed agreement from patients' family members.

III. RESULTS

The study included 102 PCI patients, with a mean age of 70.1 ± 11.8 years; most were ≥ 60 years old (82.4%) and male (72.5%). Hypertension

was the most common comorbidity (55.9%), followed by diabetes (24.5%) and chronic coronary artery disease (23.5%). Before PCI, 31.4% had NYHA III - IV and 8.8% had Killip III-IV. Among myocardial infarction patients, the most common symptom-to-admission time was 6 - 24 hours (41.1%). Most patients had preserved or moderately reduced EF, while baseline tests showed mild renal impairment, hyperglycemia, and elevated hs-troponin T (Table 1).

Table 1: Baseline characteristics & pre-PCI assessments

Variable	Overall cohort (n = 102)
Age, years	70.1 ± 11.8; median 70.5 (61.0 - 78.5)
Age ≥ 60 years	84 (82.4)
Male sex	74 (72.5)
Comorbidities / medical history	
Hypertension	57 (55.9)
Diabetes mellitus	25 (24.5)
Chronic coronary artery disease	24 (23.5)
Dyslipidemia	5 (4.9)
Cerebrovascular disease / stroke	4 (3.9)
Prior heart failure	1 (1.0)
Clinical status before PCI	
NYHA class III - IV	32 (31.4)
Killip class III - IV (overall)	9 (8.8)
Time from symptom onset to admission	
< 6 hours	28 (38.4)
6 - 24 hours	30 (41.1)
1 - 14 days	15 (20.6)
Echocardiographic findings	
EF < 29%	3 (2.9)
EF ≥ 29%	99 (97.1)
Moderate-to-severe mitral regurgitation	8 (7.8)
Moderate-to-severe aortic regurgitation	2 (2.0)
Pericardial effusion	3 (2.9)
Baseline laboratory parameters	
Serum creatinine, µmol/L	93.4 ± 26.7; median 88.5 (76.0 - 103.8)
eGFR, mL/min/1.73 m²	74.5 ± 20.1; median 74.4 (62.5 - 87.7)
Glucose, mmol/L	8.9 ± 4.4; median 7.4 (6.2 - 10.2)

Variable	Overall cohort (n = 102)
hs-Troponin T, pg/mL	662.5 ± 1625.9; median 52.7 (14.5 - 390.2)
Red blood cells, T/L	4.7 ± 0.6; median 4.6 (4.3 - 5.0)
Hemoglobin, g/L	136.8 ± 17.3; median 136.5 (126.8 - 146.7)
Hematocrit, %	41.6 ± 4.7; median 41.6 (38.2 - 44.6)
White blood cells, G/L	10.5 ± 4.0; median 9.7 (7.3 - 12.7)
Platelets, G/L	235.5 ± 57.6; median 231.5 (198 - 266.5)

Radial access was used in almost all procedures (97.1%). LAD was the most common stenotic vessel, while total LAD/RCA occlusion was significantly more frequent in emergency PCI. Emergency PCI also had a longer procedure time. Stenting after balloon predilation was the main technique, and overall PCI success was high (98.0%) without significant group difference (Table 2).

Table 2: Angiographic findings and procedural characteristics

Variable	Overall (n = 102)	Emergency PCI (n = 60)	Elective PCI (n = 42)	p - value
Access site				
Radial access	99 (97.1)	-	-	-
Femoral access	3 (2.9)	-	-	-
Significant coronary stenosis (> 50%)				
Left main (LM)	9 (8.8)	6 (10.0)	3 (7.1)	0.733
Left anterior descending (LAD)	62 (60.8)	30 (50.0)	32 (76.2)	0.013
Left circumflex (LCx)	43 (42.2)	24 (40.0)	19 (45.2)	0.685
Right coronary artery (RCA)	39 (38.2)	20 (33.3)	19 (45.2)	0.301
Total occlusion				
LM	0 (0)	0 (0)	0 (0)	-
LAD	24 (23.5)	22 (36.7)	2 (4.8)	< 0.001
LCx	6 (5.9)	3 (5.0)	3 (7.1)	0.688
RCA	24 (23.5)	22 (36.7)	2 (4.8)	< 0.001
Procedure time, min	-	40	35	0.002
PCI technique				
Balloon angioplasty only	3 (2.9)	3 (5.0)	0 (0)	0.266
Direct stenting	5 (4.9)	3 (5.0)	2 (4.8)	> 0.99
Stenting after balloon predilation	94 (92.2)	54 (90.0)	40 (95.2)	0.465
PCI success	100 (98.0)	58 (96.7)	42 (100)	0.511

Overall, 18.6% of patients had in-hospital complications, with no significant difference between emergency and elective PCI. The most common events were reperfusion syndrome, periprocedural myocardial infarction, side-branch occlusion, and access-site bleeding. Reperfusion syndrome occurred only after emergency PCI, while periprocedural myocardial infarction occurred only after elective PCI. In-hospital mortality was low (2.9%) and occurred only in emergency PCI patients (Table 3).

Table 3: In-hospital outcomes, complications, and mortality

Variable	Overall (n = 102)	Emergency PCI (n = 60)	Elective PCI (n = 42)	p - value
Complications				
Any complication	19 (18.6)	12 (20.0)	7 (16.7)	0.798
No complication	83 (81.4)	48 (80.0)	35 (83.3)	
Complication type				
Periprocedural myocardial infarction	5 (4.9)	0 (0)	5 (11.9)	0.010
Side-branch occlusion	4 (3.9)	3 (5.0)	1 (2.4)	0.641
Distal embolization/occlusion	1 (1.0)	1 (1.7)	0 (0)	> 0.99
Reperfusion syndrome	8 (7.8)	8 (13.3)	0 (0)	0.020
Contrast-induced nephropathy (post-PCI)	2 (2.0)	2 (3.3)	0 (0)	0.511
Access-site bleeding	4 (3.9)	2 (3.3)	2 (4.8)	> 0.99
In-hospital mortality	3 (2.9)	3 (5.0)	0 (0)	0.266

The overall mean scores were 7.8 ± 3.6 for MCRS and 9.2 ± 5.3 for NYRS. Median MCRS and NYRS were both significantly higher in the emergency PCI group than in the elective PCI group (11 vs. 5 and 10 vs. 5, respectively; both $p < 0.001$), indicating a substantially higher risk profile in emergency PCI patients (Table 4).

Table 4: Distribution of risk scores (MCRS and NYRS) and comparison by PCI type

Variable	Overall (n = 102)	Emergency PCI (n = 60)	Elective PCI (n = 42)	p - value
MCRS				
Mean ± SD	7.8 ± 3.6	-	-	-
Median (IQR)	7.0 (5.0 - 10.0)	11	5	< 0.001
NYRS				
Mean ± SD	9.2 ± 5.3	-	-	-
Median (IQR)	9.0 (5.0 - 12.0)	10	5	< 0.001

Both MCRS and NYRS were associated with older age, worse heart failure status, lower eGFR, higher glucose and hs-troponin T, emergency PCI, and longer procedure time. Both scores also correlated with mortality, reperfusion syndrome, and complication burden. MCRS and NYRS were strongly correlated with each other ($r = 0.819$, $p < 0.001$) (Table 5).

Table 5: Associations of MCRS and NYRS with baseline, procedural, and outcome variables

Variable	MCRS, r (p - value)	NYRS, r (p - value)
Baseline clinical variables		
Age	0.386 (< 0.001)	0.359 (< 0.001)
Sex	0.035	0.132
Hypertension	-0.034	-0.107
NYHA class III - IV	0.570 (< 0.001)	0.651 (< 0.001)
Chronic coronary artery disease	-0.239 (< 0.05)	-0.301 (< 0.001)
Diabetes mellitus	-0.054	-0.050
Dyslipidemia	-0.112	-0.082
Cerebrovascular disease / stroke	0.228 (< 0.05)	0.259 (< 0.001)
Echocardiographic / laboratory variables		
Ejection fraction (EF)	0.096	0.087
Moderate-to-severe mitral regurgitation	0.376 (< 0.001)	0.355 (< 0.001)
Moderate-to-severe aortic regurgitation	0.070	0.048
Creatinine	0.146	0.071
eGFR	-0.273 (< 0.001)	-0.263 (< 0.001)
Glucose	0.368 (< 0.001)	0.371 (< 0.001)
log10 (hs-Troponin T)	0.425 (< 0.001)	0.530 (< 0.001)
Procedural variables		
Emergency PCI	0.596 (< 0.001)	0.637 (< 0.001)
Procedure time	0.272 (< 0.001)	0.341 (< 0.001)
Access site	0.127	0.132
Balloon angioplasty only	-0.115	0.020
Direct stenting	-0.067	0.000
Stenting after balloon predilation	0.126	-0.012
PCI success	-0.045	-0.161
Contrast volume	0.127	0.109
Outcomes		
In-hospital mortality	0.241 (< 0.05)	0.239 (< 0.05)
Periprocedural myocardial infarction	-0.114	-0.247 (< 0.05)
Side-branch occlusion	0.097	0.100
Distal embolization/occlusion	-0.100	0.058

Variable	MCRS, r (p - value)	NYRS, r (p - value)
Reperfusion syndrome	0.381 (< 0.001)	0.370 (< 0.001)
Number of complications	0.207 (< 0.001)	0.241 (< 0.001)
Inter-score correlation		
MCRS vs. NYRS	r = 0.819, p < 0.001; R^2 = 0.713	NYRS = -0.79 + 1.28 × MCRS

MCRS modestly predicted in-hospital complications (AUC 0.640; cut-off > 9), while NYRS excellently predicted mortality (AUC 0.907; cut-off > 11). However, direct ROC comparison showed no significant difference between the two scores for predicting complications or mortality. In multivariable analysis, NYHA III - IV independently predicted complications, whereas cardiogenic shock independently predicted in-hospital mortality (Tables 6 - 8; Figures 1).

Table 6: ROC performance of MCRS and NYRS

Outcome	Score	AUC	p value	Cut-off	Sensitivity, %	Specificity, %
In-hospital complications	MCRS	0.640	0.041	> 9	47.4	74.7
In-hospital mortality	NYRS	0.907	< 0.001	> 11	100.0	73.7

Table 7: Logistic regression for in-hospital complications

Variable	Univariate OR (95% CI)	p value	Multivariable OR (95% CI)	p - value
Age	1.016 (0.972 - 1.062)	0.474	-	-
Killip class III - IV	4.045 (1.250 - 13.093)	0.020	2.012 (0.594 - 6.818)	0.261
Left main lesion	1.277 (0.244 - 6.698)	0.772	-	-
Emergency PCI	1.250 (0.447 - 3.498)	0.671	-	-
NYHA class III - IV	5.400 (1.872 - 15.574)	0.002	4.191 (1.313 - 13.378)	0.016
Two-/three-vessel disease	1.795 (0.653 - 4.923)	0.256	-	-
LAD occlusion	0.840 (0.250 - 2.823)	0.778	-	-
LCx occlusion	0.867 (0.095 - 7.879)	0.899	-	-
RCA occlusion	2.265 (0.774 - 6.628)	0.136	-	-

Table 8: Logistic regression for in-hospital mortality

Variable	Univariate OR (95% CI)	p value	Multivariable OR (95% CI)	p - value
Age	1.004 (0.909 - 1.108)	0.938	-	-
Sex	1.333 (0.116 - 15.311)	0.817	-	-
Cardiogenic shock	10.189 (1.982 - 52.391)	0.005	7.373 (1.242 - 43.766)	0.028
Ejection fraction	0.041 (0.003 - 0.664)	0.025	0.128 (0.002 - 6.797)	0.311

Variable	Univariate OR (95% CI)	p value	Multivariable OR (95% CI)	p - value
Time from MI onset	0.270 (0.042 - 1.732)	0.167	-	-
NYHA class III - IV	4.600 (0.402 - 52.693)	0.220	-	-
Creatinine	1.012 (0.977 - 1.048)	0.517	-	-
Left main lesion	5.687 (0.464 - 69.768)	0.174	-	-
Two-/three-vessel disease	2.400 (0.211 - 27.339)	0.481	-	-

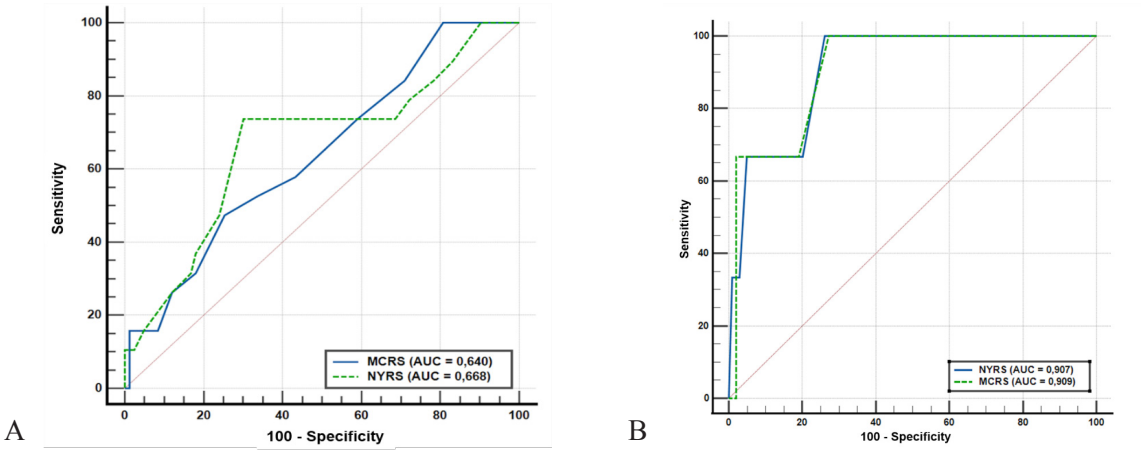

Figure 1: Comparison of ROC curves of the MCRS and NYRS for predicting in-hospital complications (A) and in-hospital mortality (B) in PCI patients

IV. DISCUSSION

The main findings were that MCRS and NYRS were higher in emergency than elective PCI, correlated with greater clinical severity, and had different predictive strengths: MCRS modestly predicted in-hospital complications, whereas NYRS excellently predicted in-hospital mortality. These findings are clinically plausible, as both scores use simple pre-procedural variables and have been validated for short-term PCI risk stratification [5-9].

Higher scores were associated with older age, NYHA III - IV, renal dysfunction, hyperglycemia, elevated hs-troponin T, and more complex emergency PCI features such as total LAD/RCA occlusion and longer procedures. This is consistent with ACS guidelines, which identify hemodynamic instability, heart failure, renal impairment, and infarct severity as key determinants of early PCI risk [10]. In multivariable analysis, NYHA III - IV independently predicted complications, while cardiogenic shock predicted mortality, highlighting the central role of bedside instability. The strong correlation between MCRS and NYRS suggests overlapping assessment of patient frailty and procedural vulnerability, although their performance differs by outcome [5-10].

Practically, these scores may support PCI triage, counseling, and monitoring. NYRS > 11 may help identify patients needing intensive hemodynamic monitoring, critical care support, and early risk communication, while MCRS > 9 may flag patients requiring closer surveillance for complications, renal protection, and bleeding prevention. However, CIN still requires dedicated assessment, such as the Mehran score [11]. Limitations include the single-center design, modest sample size, low event counts, especially deaths, and lack of external recalibration, which may limit model stability, cut-off accuracy, and generalizability. Nevertheless, the findings support previous evidence that MCRS and NYRS remain clinically useful, although performance may vary across populations and settings [5,6,8,9,11].

V. CONCLUSION

In this single-center PCI cohort, emergency PCI patients had higher risk and worse in-hospital outcomes than elective PCI patients. MCRS and NYRS were associated with clinical severity and provided useful prognostic information: MCRS modestly predicted complications, while NYRS excellently predicted mortality. These findings support using simple pre-procedural risk scores, combined with bedside assessment of heart failure and shock, for early PCI risk stratification.

Declaration of conflicting interests

The authors declare no conflicts of interest with respect to the research, authorship, and/or publication of this article.

REFERENCES

1. World Health Organization. Cardiovascular diseases (CVDs). WHO Fact Sheet. 2021; Available from: https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-%28cvds%29.
2. King SB. Percutaneous transluminal coronary angioplasty. Journal of the American College of Cardiology. 1999; 34(3): 615-617.
3. Trương Quang Bình, Hồ Thượng Dũng, Nguyễn Quang Tuấn, Lịch sử hình thành và phát triển tim mạch can thiệp Việt Nam, in Tim mạch can thiệp nâng cao trong thực hành lâm sàng. 2021, Medical Publisher: Hanoi. 12-13.
4. Vũ Văn Tình, Phạm Như Hùng, Phạm Mạnh Hùng. Tìm hiểu đặc điểm một số biến chứng cơ học trong can thiệp động mạch vành qua da. Tạp chí Tim mạch học Việt Nam. 2015(70): 61-68.
5. Brener SJ, Colombo KD, Haq SA, Bose S, Sacchi TJ. Precision and accuracy of risk scores for in-hospital death after percutaneous coronary intervention in the current era. Catheter Cardiovasc Interv. 2010; 75(2): 153-7.
6. Singh M, Peterson ED, Milford-Beland S, Rumsfeld JS, Spertus JA. Validation of the Mayo clinic risk score for in-hospital mortality after percutaneous coronary interventions using the national cardiovascular data registry. Circ Cardiovasc Interv. 2008; 1(1): 36-44.
7. Singh M, Rihal CS, Selzer F, Kip KE, Detre K, Holmes DR. Validation of Mayo Clinic risk adjustment model for in-hospital complications after percutaneous coronary interventions, using the National Heart, Lung, and Blood Institute dynamic registry. J Am Coll Cardiol. 2003; 42(10): 1722-8.
8. Timóteo A, Monteiro A, Portugal G, Teixeira P, Aidos H, Ferreira M, et al. Validation of two US risk scores for percutaneous coronary intervention in a single-center Portuguese population of patients with acute coronary syndrome. Revista Portuguesa de Cardiologia. 2016; 35.
9. Wu C, Hannan EL, Walford G, Ambrose JA, Holmes DR, Jr., King SB, 3rd, et al. A risk score to predict in-hospital mortality for percutaneous coronary interventions. J Am Coll Cardiol. 2006; 47(3): 654-60.
10. Byrne RA, Rossello X, Coughlan JJ, Barbato E, Berry C, Chieffo A, et al. 2023 ESC Guidelines for the management of acute coronary syndromes. Eur Heart J. 2023; 44(38): 3720-3826.
11. Mehran R, Aymong ED, Nikolsky E, Lasic Z, Iakovou I, Fahy M, et al. A simple risk score for prediction of contrast-induced nephropathy after percutaneous coronary intervention: development and initial validation. J Am Coll Cardiol. 2004; 44(7): 1393-9.