Research Article

Using the RISK-PCI Score in the Long-Term Prediction of Major Adverse Cardiovascular Events and Mortality after Primary Percutaneous Coronary Intervention

Lidija Savic,1,2 Igor Mrdovic,1,2 Milika Asanin,1,2 Sanja Stankovic,3 Gordana Krljanac,1,2 and Ratko Lasica1

1Coronary Care Unit, Clinical Centre of Serbia, Emergency Hospital, Belgrade, Serbia
2Cardiology Clinic, Clinical Centre of Serbia, Emergency Hospital, Belgrade, Serbia
3Center for Medical Biochemistry, Emergency Hospital, Clinical Center of Serbia, Belgrade, Serbia

Correspondence should be addressed to Lidija Savic; lidijasavic2007@gmail.com

Received 7 June 2019; Revised 25 August 2019; Accepted 12 September 2019; Published 24 October 2019

Academic Editor: Andrea Rubboli

Background/Aim. The RISK-PCI is a simple score for the prediction of 30-day major adverse cardiovascular events (MACE) and mortality in patients treated with primary PCI (pPCI). The aim of the present study is to evaluate the prognostic performance of the RISK-PCI score in predicting MACE and mortality in the long-term follow-up of STEMI patients treated with pPCI. Method. The present study enrolled 2,096 STEMI patients treated with pPCI included in the RISK-PCI trial. Patients presenting with cardiogenic shock were excluded. The composite end-point MACE comprising cardiovascular mortality, nonfatal reinfarction and stroke. Patients were followed up at 6 years after enrollment. Results. One-year and 6-year MACE occurred in 229 (10.9%) and 285 (13.6%) patients, respectively; and 1-year and 6-year mortality occurred in 128 (6.2%) and 151 (7.2%) patients, respectively. The RISK-PCI score was an independent predictor for 1-year MACE (HR 1.24, 95% CI 1.18–1.31, \(p < 0.001\)), 6-year MACE (HR 1.22, 95% CI 1.16–1.28, \(p < 0.001\)), 1-year mortality (HR 1.21, 95% CI 1.13–1.29, \(p < 0.001\)), and 6-year mortality (HR 1.23, 95% CI 1.15–1.31, \(p < 0.001\)). The discrimination of the RISK-PCI score to predict 1-year and 6-year MACE and mortality was good: for 1-year MACE c-statistic 0.78, for 6-year MACE c-statistic 0.75, for 1-year mortality c-statistic 0.87, and for 6-year mortality c-statistic 0.83. The nonsignificant Hosmer–Lemeshow goodness-of-fit estimates for 1-year MACE \((p = 0.619)\), 6-year MACE \((p = 0.319)\), 1-year mortality \((p = 0.258)\), and 6-year mortality \((p = 0.540)\) indicated a good calibration of the model. Conclusion. The RISK-PCI score demonstrates good characteristics in the assessment of the risk for the occurrence of MACE and mortality during long-term follow-up after pPCI.

1. Introduction

ST-elevation myocardial infarction (STEMI) is a complex clinical scenario that requires immediate diagnosis, rapid therapeutic management, and early risk stratification [1]. Primary percutaneous coronary intervention (pPCI) is a reperfusion therapy of choice for the management of patients with STEMI [2–4]. Despite the very low incidence of major adverse cardiovascular events (MACE) after contemporary pPCI, certain patients with STEMI still have an adverse prognosis [1, 2, 5–7]. The identification and quantification of the patient’s risk profile is of paramount importance to guide medical management, primarily the duration and intensity of in-hospital care, as well as the proper optimization of therapy during follow-up [1, 8]. Today, it is acknowledged that STEMI patients with high risk of adverse events need more aggressive management than lower-risk patients [8]. Prognosis after STEMI predominantly varies depending on the baseline risk profile; however, echocardiographic and angiographic data are also powerful prognostic variables [1, 2, 4]. Risk scores are mathematical models which include clinical, and in some cases, also laboratory, echocardiographic, and angiographic variables. They are used for estimating the risk of the
occurrence of a specific adverse event over a shorter or longer period of time [1]. Several risk scores have been used for the stratification of patients with STEMI, and they can be classified into two groups: risk scores developed in the thrombolytic era and risk scores developed in the pPCI era [1, 9]. The RISK-PCI is a novel, simple score for the prediction of 30-day major adverse cardiovascular events (MACE) and death in STEMI patients treated with pPCI [2, 9]. It has recently been shown that the RISK-PCI score can be used for the prediction of early and late stent thrombosis after pPCI [10]. Although the risk of the occurrence of major adverse cardiovascular events (MACE) and mortality is the highest in the first month after STEMI, for the purpose of devising the best possible treatment plan and providing for secondary prevention, there is a need for assessing the risk of occurrence of these adverse events in the long term, as well. [10–14].

The aim of the present study is to evaluate the prognostic performance of the RISK-PCI score in predicting major adverse cardiovascular events (MACE) and mortality in the long-term follow-up of STEMI patients treated with primary PCI.

2. Method

2.1. Study Population, Data Collection, and Definitions. The present study enrolled 2,096 patients which were included in the RISK-PCI trial. The design and methods of the RISK-PCI trial have been previously published [2, 15]. In brief, the RISK-PCI is an observational, longitudinal, cohort, single-center trial specifically designed to generate and validate an accurate risk model for predicting MACE after pPCI in patients pretreated with 600 mg clopidogrel. Patients were recruited between February 2006 and December 2009. Informed consent was obtained from all patients. The study protocol conforms to the ethical guidelines of the Helsinki Declaration. It was approved by the local research ethics committee and registered in the Current Controlled Trials Register as ISRCTN83474650 (http://www.controlled- trials.com/ISRCTN83474650). The RISK-PCI study enrolled all consecutive patients, aged >18 years, with clinical and electrocardiographic signs of acute STEMI, within 12 h after the onset of symptoms. The exclusion criteria were refusal to give consent for invasive treatment, active or recent internal bleeding, history of bleeding after nonsteroid anti-inflammatory agents, known bleeding diathesis, intracerebral mass or aneurysm, intolerance or allergy to aspirin or clopidogrel, history of hypersensitivity to iodinated contrast media, cardiogenic shock at admission, noncardiac conditions that could interfere with compliance with the protocol or necessitate interruption of the treatment with thienopyridines, and coexistent conditions associated with a limited life expectancy in the short term. Coronary angiography was performed via the femoral approach. All patients received anticoagulation therapy with unfractionated heparin and dual antiplatelet therapy with aspirin (300 mg) and clopidogrel (600 mg) before the procedure. Flow grades were assessed according to the Thrombosis in Myocardial Infarction (TIMI) criteria. After pPCI, patients were treated according to current guidelines.

Demographic, baseline clinical, laboratory, angiographic and procedural data were collected and analyzed. Baseline renal function was assessed at admission using the Cockcroft–Gault formula. Echocardiographic examination was performed between 48 h and 72 h following pPCI and left ventricular ejection fraction (EF) was assessed according to the biplane Simpson method, in classical two- and four-chamber apical projections.

Patients were followed up at 6 years after enrollment. Follow-up data were obtained by scheduled telephone interviews and outpatient visits. Composite end-point major adverse cardiovascular events (MACE) included cardiovascular death, nonfatal reinfarction, and ischemic stroke. Cardiovascular death included any death due to proximate cardiac cause (myocardial infarction, low-output heart failure, and fatal arrhythmia), sudden death, all procedure-related deaths, and death caused by noncoronary vascular causes, such as cerebrovascular disease. Reinfarction was defined as the presence of (a) an increase in cardiac troponin, above the upper reference limit; (b) recurrent ischemic chest pain, lasting longer than 20 min; and (c) reoccurrence of ST-segment deflection, T-wave inversion, or new pathognomonic Q waves in at least two contiguous leads. Stroke was defined as a new onset of focal or global neurological deficit lasting more than 24 h. Computed tomography was used to classify stroke as ischemic or hemorrhagic. The Emergency Hospital’s neurologist was responsible for the diagnosis and treatment of stroke [2].

2.2. The RISK-PCI Score. The RISK-PCI score was originally developed and validated to predict 30-day MACE in STEMI patients treated with pPCI. The independent predictors of MACE at 30 days were assigned a risk score based on their regression coefficients. A sum of weighted points for 12 independent predictors was calculated to define the total score for each patient with a range of 0–20. Risk strata with low (0–2.5 points), intermediate (3–4.5 points), high (5–6.5 points), and very high (≥7 points) risk classes were defined to optimize the discrimination ability of the model [2].

2.3. Statistical Analysis. Continuous variables were expressed as median values with 25th and 75th quartiles, whereas categorical variables were expressed as frequency and percentage. Analysis for normality of data was performed using the Kolmogorov–Smirnov test. Baseline differences between groups were analyzed using the Mann–Whitney test for continuous variables, and the Pearson X² test for categorical variables. The Cox proportional-hazards model was used to assess the value of the RISK-PCI score as a predictor for 1-year and 6-year MACE and mortality. Adjustments were made for variables that were shown to be independent predictors of 1-year and 6-year MACE and mortality in the univariate analysis (age, Killip class >1 at admission, EF, leucocytes count at admission, anterior infarction, and 3-vessel disease). Discrimination of the model (capability to discriminate between true-positive and false-positive outcomes) was measured by c-statistics using the area under the ROC curve (AUC) as an
index of model performance. Calibration or difference between predicted and observed events (goodness-of-fit) was assessed using the Hosmer–Lemeshow $X^2$ estimates. The Kaplan–Meier curves were used to present MACE-free and survival probability during follow-up according to RISK-PCI score classes.

A probability value of less than 0.05 was considered statistically significant. SPSS statistical software, version 19.0, was applied (SPSS Inc, Chicago, IL) (Tables 1 and 2).

### 3. Results

Out of a total of 2,096 patients, 1,529 (72.9%) were men and 567 (27.1%) were women. The median age of all analyzed patients was 59 years (51, 69). The total 6-year follow-up was completed in 2056 (98.2%) patients. One-year and 6-year MACE occurred in 229 (11.1%) and 285 (13.6%) patients, respectively; and 1-year and 6-year mortality occurred in 128 (6.2%) and 151 (7.3%) patients, respectively. Demographic, clinical, laboratory, and angiographic characteristics of analyzed patients according to the occurrence of MACE and mortality at one year and six years are presented in Table 3.

After multivariate adjustment, the RISK-PCI score remained an independent predictor for 1-year MACE (HR 1.24, 95% CI 1.18–1.31, $p<0.001$), 6-year MACE (HR 1.22, 95% CI 1.16–1.28, $p<0.001$), 1-year mortality (HR 1.21, 95% CI 1.13–1.29, $p<0.001$), and 6-year mortality (HR 1.23, 95% CI 1.15–1.31, $p<0.001$). Independent predictors for mortality and MACE are shown in Table 4.

The discrimination of the RISK-PCI score to predict 1-year and 6-year MACE and mortality was reasonably good. The c-statistics for 1-year MACE prediction was 0.78 (95% CI 0.73–0.79, $p<0.001$); the c-statistics for 6-year MACE prediction was 0.75 (95% CI 0.68–0.75, $p<0.001$); the c-statistics for 1-year mortality prediction was 0.87 (95% CI 0.84–0.89, $p<0.001$); and the c-statistics for 6-year mortality prediction was 0.83 (95% CI 0.78–0.86, $p<0.001$).

The discrimination of the RISK-PCI score is shown in Figure 1.

The predictive ability of the RISK-PCI score from one month to one year and 6 years is shown in Figure 2.

In addition, the nonsignificant Hosmer–Lemeshow goodness-of-fit estimates for 1-year MACE ($X^2=4.429$, $p=0.619$), 6-year MACE ($X^2=7.019$, $p=0.319$), 1-year mortality ($X^2=7.373$, $p=0.258$), and 6-year mortality ($X^2=5.027$, $p=0.540$) indicated a good calibration of the model.

Figure 3 shows Kaplan–Meier curves of MACE-free and mortality probability during follow-up in the 4 risk strata.

### 4. Discussion

The results of the present study have shown the RISK-PCI score to have a satisfactory discrimination ability and predictive value in the assessment of risk of the occurrence of MACE during 1-year and 6-year follow-up of patients with STEMI treated with pPCI. The RISK-PCI score has excellent characteristics in assessing the risk of the occurrence of 1-year and 6-year mortality in these patients. When we analyzed the
| Variable                        | 1-year MACE | 6-year MACE | 1-year mortality | 6-year mortality | p value | p value |
|--------------------------------|-------------|-------------|------------------|------------------|---------|---------|
|                                | No N = 1867 | Yes N = 229 | No N = 1811      | Yes N = 285      |         |         |
| Age, med (IQR)                 | 58 (51, 68) | 63 (54, 73) | <0.001           | 59 (51, 68)      | 63 (54, 73) | <0.001 |
| Males (%)                       | 1361 (72.9) | 154 (67.1)  | 0.031            | 1230 (72.9)      | 193 (67.9) | 0.027 |
| Previous MI (%)                 | 189 (10.1)  | 39 (17.2)   | 0.017            | 177 (9.8)        | 49 (17.1) | <0.001 |
| Previous PCI (%)                | 48 (2.6)    | 9 (3.8)     | 0.179            | 45 (2.5)         | 11 (3.8)  | 0.149 |
| Diabetes (%)                    | 353 (18.9)  | 63 (27.4)   | <0.001           | 323 (17.8)       | 77 (27.1) | <0.001 |
| Hypertension (%)                | 1249 (66.9)| 163 (71.2)  | 0.164            | 1188 (65.6)      | 208 (72.9) | 0.013 |
| Hyperlipidemia (%)              | 1150 (61.6) | 116 (50.8)  | 0.011            | 1111 (61.4)      | 155 (54.4) | 0.009 |
| Smoking (%)                     | 1041 (55.8)| 89 (38.9)   | 0.002            | 1010 (55.8)      | 120 (42.1) | 0.006 |
| Family history (%)              | 640 (34.3)  | 15 (6.4)    | 0.002            | 625 (34.5)       | 75 (26.3) | <0.001 |
| Pain duration med (IQR)*        | 2.5 (1.5, 4.5) | 3.5 (2.6, 5.6) | <0.001           | 2.5 (1.5, 4.5)  | 3 (2.5, 5.5) | <0.001 |
| Killip/II and III at admission (%) | 183 (9.8)  | 89 (38.9)   | <0.001           | 176 (9.7)        | 95 (33.3) | <0.001 |
| Systolic pressure** (IQR)       | 140 (120,150) | 130 (110,150) | <0.001           | 140 (120,130)   | 130 (105,150) | <0.001 |
| Heart rate** (IQR)              | 80 (70, 90) | 80 (70, 100) | <0.001           | 80 (70, 90)      | 80 (70, 110) | <0.001 |
| Anterior MI, n (%)              | 721 (38.6)  | 134 (58.4)  | <0.001           | 697 (38.5)       | 154 (54.1) | <0.001 |
| BBB**, n (%)                    | 50 (2.7)    | 35 (15.1)   | 0.001            | 49 (2.7)         | 35 (12.3) | <0.001 |
| 3-vessel disease (%)            | 472 (25.3)  | 91 (39.6)   | <0.001           | 455 (25.1)       | 107 (37.6) | <0.001 |
| Left main stenosis, n (%)       | 114 (6.1)   | 20 (8.7)    | <0.001           | 110 (6.1)        | 24 (8.3)  | <0.001 |
| Stent (%)                       | 2432 (95.2) | 193 (84.1)  | <0.001           | 1723 (95.1)      | 246 (86.3) | <0.001 |
| Postprocedural TIMI<3 (%)       | 83 (3.2)    | 43 (18.8)   | <0.001           | 60 (3.3)         | 44 (15.3) | <0.001 |
| CK, med (IQR)                   | 1842 (9215,3399) | 2697 (1031,5124) | <0.001           | 1820 (908,3392) | 2445 (1046,493) | <0.001 |
| Troponin I, med (IQR)           | 30.5 (9.8,86.2) | 41.3 (8.36,11.89) | <0.001           | 30.6 (9.5,86)   | 36.5 (8.4,110.2) | <0.001 |
| Haemoglobin g/L med (IQR)       | 141 (132,152) | 143 (130,153) | 0.050            | 142 (132,153)   | 143 (129,152) | <0.001 |
| LVEF med (IQR)                  | 50 (44.55)  | 40 (30.50)  | <0.001           | 50 (40.55)       | 40 (35.50) | <0.001 |
| CrCl med (IQR)                  | 92.4 (71.2,114.9) | 62.4 (45.2,86.3) | <0.001           | 92.8 (71.8,115.8) | 77.8 (57.2,97.3) | <0.001 |
| RISK-PCI score, med (IQR)       | 3 (2, 5)    | 5.5 (4, 8)  | <0.001           | 3 (2, 4.5)       | 5 (3, 7.5)  | <0.001 |

Abbreviations: MACE = major adverse cardiovascular events; BBB = bundle branch block; MI = myocardial infarction; PCI = percutaneous coronary intervention; TIMI = Thrombolysis in Myocardial Infarction; LVEF = left ventricular ejection fraction; CrCl = creatinine clearance ml/min; MACE = major adverse cardiovascular events.
In addition to predictors of great prognostic importance, such as age, anterior infarction, bundle branch block, renal dysfunction, ejection fraction, and post-procedural flow TIMI <3, which were present in previous scores, the RISK-PCI score includes variables that were not used in earlier scores, such as previous infarction, complete AV block at admission, glucose intolerance, leukocytosis, post-procedural flow <1, and small vessel size [9, 16]. These variables are well-known predictors of adverse events upon STEMI, both in short-term and long-term follow-up [12, 16]. On the other hand, the RISK-PCI score has been developed without taking into account the variables such as heart failure or heart rate at admission, which may offer incremental prognostic information [7, 9, 12, 16, 18].

The satisfactory characteristics of the RISK-PCI score in the assessment of the risk of occurrence of adverse events in long-term patient follow-up may be explained by the fact that it had been constructed on the basis of the analysis of data from the RISK-PCI observational study, which included all consecutive patients with STEMI treated with contemporary pPCI. This manner of constructing the risk score is not unusual (e.g., the Zwolle score was constructed in this way). However, the majority of risk scores related to patients treated with pPCI (CADILLAC score, PAMI score, etc.) have been constructed through post hoc analysis of data from randomized pPCI studies. Models derived from clinical registries (or observational studies) enrolling consecutive patients are theoretically more applicable to real-life patients than those developed from patients enrolled in clinical trials, which tend to exclude high-risk patients (very old patients, patients with comorbidities, etc.) [8]. This is why the incidence of mortality and other adverse events in the population of patients enrolled in randomized clinical studies is lower than in the general population of patients with STEMI. Therefore, it is considered that the scores obtained by analyzing data from randomized studies may overestimate the risk of mortality or MACE occurrence, both in short-term and long-term follow-up [1–3, 6].

Also, in order for the risk assessment of adverse events to be proper, especially in long-term follow-up, it is important that the population of patients which the risk score is based on be treated in the same way as the population of patients that the risk score will be applied on. This primarily refers to the application of therapy which has proven to have beneficial effect on the patients’ prognosis [1]. In patients with STEMI, this implies that they have been treated with primary pPCI, as well as that they have been taking dual antiplatelet therapy for a sufficient length of time, which is important when assessing the probability of the occurrence of ischemic events in long-term follow-up [2, 10]. In the RISK-PCI study, all of the patients received loading doses of aspirin and clopidogrel, and the average length of dual antiplatelet therapy application was 10 ± 2 months, which makes the RISK-PCI score adequate for the population of patients who are nowadays treated with primary PCI [19]. On the other hand, previously published pPCI scores were derived from trials which did not at all apply dual antiplatelet therapy [20] or did not use clopidogrel before pPCI [21, 22]. When looking at the risk scores obtained in the thrombolytic era, it should first be

| Table 4: Independent predictors for 1-year and 6-year MACE and mortality. |
|-----------------|-------|-------|-------|-------|
|                 | HR    | 95% CI | p value |
| **1-year MACE** |       |       |       |
| Killip class I and II at admission | 1.60  | (1.19–2.15) | 0.002 |
| Ejection fraction % | 0.96  | 0.95–0.98 | <0.001 |
| RISK-PCI score    | 1.24  | 1.18–1.31 | <0.001 |
| **6-year MACE**  |       |       |       |
| Age, years       | 1.01  | 1.00–1.02 | <0.001 |
| Killip class II and III at admission | 1.45  | 1.11–1.89 | 0.006 |
| Ejection fraction % | 0.96  | 0.95–0.98 | <0.001 |
| RISK-PCI score    | 1.22  | 1.16–1.28 | <0.001 |
| **1-year mortality** |     |       |       |
| Age, years       | 1.03  | 1.01–1.04 | <0.001 |
| Killip class II and III at admission | 2.08  | 1.41–3.09 | <0.001 |
| Anterior infarction | 1.47  | 1.03–2.13 | 0.038 |
| Ejection fraction % | 0.92  | 0.90–0.94 | <0.001 |
| 3-vessel disease  | 1.42  | 1.01–1.99 | 0.046 |
| Leukocyte count   | 1.02  | 1.01–1.05 | 0.008 |
| RISK-PCI score    | 1.21  | 1.13–1.29 | <0.001 |
| **6-year mortality** |     |       |       |
| Age, years       | 1.03  | 1.02–1.05 | <0.001 |
| Killip class II and III at admission | 1.91  | 1.35–2.70 | <0.001 |
| Anterior infarction | 1.50  | 1.09–2.08 | 0.014 |
| Ejection fraction % | 0.92  | 0.91–0.94 | <0.001 |
| Leukocyte count   | 1.03  | 1.01–1.05 | 0.012 |
| RISK-PCI score    | 1.23  | 1.15–1.31 | <0.001 |

MACE = Major adverse cardiovascular events; HR = hazard ratio; CI = confidence interval.
reiterated that primary PCI achieves a higher percentage of reperfusion success in comparison with thrombolysis, and therefore, beneficially affects the patient’s prognosis, i.e., decreases mortality, reduces the risk of the occurrence of new ischemic events, improves the quality of life, etc. Also, STEMI patients treated with pPCI generally have different clinical characteristics in comparison with patients treated with thrombolysis [1, 6, 9]. Therefore, many authors agree that original risk models from the thrombolytic era may not be relevant in most patients managed according to current guidelines [1, 9, 14].

4.1. Clinical Implications. Risk assessment for the occurrence of adverse events in long-term follow-up may be useful for the planning of further patient treatment and for secondary prevention [9, 23]. Secondary prevention following STEMI is a very important issue because further ischemic events after the index event are common [24]. The possible clinical significance of evaluating the risk of the occurrence of adverse ischemic events in long-term follow-up, exceeding a year, is the identification of patients with a high risk of the occurrence of ischemic events, who would be candidates for the application of prolonged dual antiplatelet therapy (more than 12 months), taking into consideration, of course, the possible hemorrhagic complications [11].

4.2. Study Limitations. Prognostic assessment was derived using a single-center database. The intent was not to
compare the efficiency of the score of the present study with previously published scores of PCI patients. In keeping with the widely accepted risk models for primary PCI [1], patients with cardiogenic shock at presentation were excluded from the trial. By definition, these patients fall into the highest risk category and their treatment differs from the overall pPCI population [19]. Also, the protocol of the study stipulated that patients with cardiogenic shock at admission should have separate risk stratification and a different treatment strategy [2, 18]. Patients with cardiogenic shock at admission were also excluded from the studies where the most prominent risk scores for patients treated with pPCI were constructed (e.g., CADILLAC and PAMI) [6]. In the present study, patients were treated with clopidogrel; there were no patients treated with more recently developed antiplatelet drugs (prasugrel and/or ticagrelor); and pPCI was predominantly performed using bare-metal stents. Ticagrelor, prasugrel, and/or the new generation of drug-eluting stents or biodegradable polymers were not available for routine administration to patients at the time of their enrollment into the trial, and this could have influenced the prognosis of the analyzed patients. This study was not designed to compare the characteristics of the RISK-PCI

Figure 2: The ROC curves of the RISK-PCI score in predicting MACE and mortality from one month to one year (curves a and b) and from one month to six years (curves c and d). (a) AUC 0.71, 95% CI 0.66–0.75, \( p < 0.001 \). (b) AUC 0.76, 95% CI 0.68–0.84, \( p < 0.001 \). (c) AUC 0.65, 95% CI 0.61–0.71, \( p < 0.001 \). (d) AUC 0.71, 95% CI 0.63–0.76, \( p < 0.001 \).
score with that of other risk scores related to patients treated with primary PCI, neither to perform the external validation of the model.

5. Conclusion

The RISK-PCI score demonstrates a good discrimination and predictive value in the assessment of the risk for the occurrence of major adverse coronary disease and mortality during long-term follow-up of up to 6 years, in patients with STEMI treated with primary PCI. This simple risk score could be of use to doctors in planning further patient treatment (after hospital discharge), carrying out secondary prevention programs and rehabilitation. Further studies are warranted to externally validate this model and confirm the results from the present study.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors report no financial relationships or conflicts of interest regarding the content herein.

Acknowledgments

The authors express their gratitude to physicians and nurses of the Coronary Unit and Catheterization Laboratory participating in the primary PCI program.

References

[1] S. Buccheri, P. Capranzano, A. Condorelli, M. Scalia, C. Tamburino, and D. Capodanno, "Risk stratification after ST-segment elevation myocardial infarction," Expert Review of Cardiovascular Therapy, vol. 14, no. 12, pp. 1349–1360, 2016.
[2] I. Mrdrovic, L. Savic, G. Krljanac et al., "Predicting 30-day major adverse cardiovascular events after primary percutaneous coronary intervention. The RISK-PCI score," International Journal of Cardiology, vol. 162, no. 3, pp. 220–227, 2013.
[3] B. A. Alvarez, A. B. C. Alvarez, A. R. Dieguez et al., "Short-term and long-term validation of the fastest score in patients with ST-elevation myocardial infarction after primary angioplasty," International Journal of Cardiology, vol. 269, pp. 19–22, 2018.
[4] A. Synetos, G. Georgiopoulos, V. Pylarinou et al., "Comparison of prognostic risk scores after successful primary percutaneous coronary intervention," International Journal of Cardiology, vol. 230, pp. 482–487, 2017.
[5] T. Fujii, T. Suzuki, S. Torii et al., "Diagnostic accuracy of Global Registry of Acute Coronary Events (GRACE) risk score in ST-elevation myocardial infarction for in-hospital and 360-day mortality in Japanese patients," Circulation Journal, vol. 78, no. 12, pp. 2950–2954, 2014.
[6] M. Chiostri, S. Valente, E. Crudeli, C. Giglioli, and G. F. Gensini, “A new post-PCI scoring system for in-hospital mortality in STEMI patients,” Journal of Cardiovascular Medicine, vol. 11, no. 10, pp. 733–738, 2010.
[7] A. Barchielli, G. M. Santoro, D. Balzi et al., "Long-term prognosis after primary PCI in unselected patients with ST-elevation myocardial infarction," Journal of Cardiovascular Medicine, vol. 13, no. 12, pp. 819–827, 2012.
[8] H. Bueno and F. Fernández-Avilés, “Use of risk scores in acute coronary syndromes,” Heart, vol. 98, no. 2, pp. 162–168, 2012.
[9] M. Asanin, I. Mrdovic, L. Savic et al., “B-type natriuretic peptide and RISK-PCI score in the risk assessment in patients with STEMI treated by primary percutaneous coronary intervention,” Clinical Laboratory, vol. 62, pp. 317–325, 2016.

[10] I. Mrdovic, L. Savic, R. Lasica et al., “Usefulness of the RISK-PCI score to predict stent thrombosis in patients treated with primary percutaneous coronary intervention for ST-segment elevation myocardial infarction: a substudy of the RISK-PCI trial,” Heart and Vessels, vol. 28, no. 4, pp. 424–433, 2013.

[11] M. Natsuaki, T. Morimoto, K. H. Yamaji et al., “Prediction of thrombotic and bleeding events after precutaneous coronary intervention: CREDO-Kyoto thrombotic and bleeding risk scores,” Journal of the American Heart Association, vol. 7, no. 11, Article ID e008708, 2018.

[12] H. K. Kim, M. H. Jeong, Y. Ahn et al., "Hospital discharge risk score system for the assessment of clinical outcomes in patients with acute myocardial infarction (Korea Acute Myocardial Infarction Registry (KAMIR) score)," The American Journal of Cardiology, vol. 107, no. 7, pp. 965–971, 2011.

[13] B. Popovic, N. Girerd, P. Rossignol et al., “Prognostic value of the thrombolysis in myocardial infarction risk score in ST-elevation myocardial infarction patients with left ventricular dysfunction (from the EPHESUS trial),” The American Journal of Cardiology, vol. 118, no. 10, pp. 1442–1447, 2016.

[14] K. J. Filipiak, Ł. Kołtowski, M. Grabowski et al., “Comparison of the seven-year predictive value of six risk scores in acute coronary syndrome patients: GRACE, TIMI STEMI, TIMI NSTEMI, SIMPLE, ZWOLLE and BANACH,” Kardiologia Polska, vol. 72, pp. 155–165, 2014.

[15] I. Mrdovic, L. Savic, J. Perunicic et al., “Development and validation of a risk scoring model to predict net adverse cardiovascular outcomes after primary percutaneous coronary intervention in patients pretreated with 600 mg clopidogrel: rationale and design of the RISK-PCI study,” Journal of Interventional Cardiology, vol. 22, no. 4, pp. 320–328, 2009.

[16] S. Littnerova, P. Kala, J. Jarkovsky et al., “GRACE score among six risk scoring systems (CADILLAC, PAMI, TIMI, Dynamic TIMI, Zwolle) demonstrated the best predictive value for prediction of long-term mortality in patients with ST-elevation myocardial infarction,” PLoS One, vol. 10, no. 4, Article ID e0123215, 2015.

[17] D. D. McManus, J. Gore, J. Yarzebski, F. Spencer, D. Lessard, and R. J. Goldberg, "Recent trends in the incidence, treatment, and outcomes of patients with STEMI and NSTEMI," The American Journal of Medicine, vol. 124, no. 1, pp. 40–47, 2011.

[18] V. Auffret, Y. Cottin, G. Leurent et al., “Predicting the development of in-hospital cardiogenic shock in patients with ST-segment elevation myocardial infarction treated by primary percutaneous coronary intervention: the ORBI risk score,” European Heart Journal, vol. 39, no. 22, pp. 2090–2102, 2018.

[19] B. Ibanez, S. James, S. Agewall et al., “2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation,” European Heart Journal, vol. 39, no. 2, pp. 119–177, 2018.

[20] G. De Luca, H. Suryapranata, A. W. J. van’t Hof et al., “Prognostic assessment of patients with acute myocardial infarction treated with primary angioplasty,” Circulation, vol. 109, no. 22, pp. 2737–2743, 2004.

[21] A. Halkin, M. Singh, E. Nikolsky et al., “Prediction of mortality after primary percutaneous coronary intervention for acute myocardial infarction,” Journal of the American College of Cardiology, vol. 45, no. 9, pp. 1397–1405, 2005.

[22] S. Addala, C. L. Grines, S. R. Dixon et al., “Predicting mortality in patients with ST-elevation myocardial infarction treated with primary percutaneous coronary intervention (PAMI risk score),” The American Journal of Cardiology, vol. 93, no. 5, pp. 629–632, 2004.

[23] K. A. Fox, G. FitzGerald, E. Puymirat et al., “Should patients with acute coronary disease be stratified for management according to their risk? derivation, external validation and outcomes using the updated GRACE risk score,” BMJ Open, vol. 4, no. 2, Article ID e004425, 2014.

[24] M. Grabowski, K. J. Filipiak, G. Opolski et al., “Risk factors for adverse outcomes of patients with acute coronary syndrome: single-centre experience with long-term follow-up of treated patients,” Kardiologia Polska, vol. 76, no. 5, pp. 881–888, 2018.